Executive Summary

Project background

Republic of Malawi is a land locked country situated in Southern Africa. With a population of around 15 million, it has one of the highest rate of urbanization at 5.22%. This high rate of urbanization puts tremendous pressure on the entire building material sector. With constraints in supply of material both the quality of material (brick) and the application (house) has degraded to an alarming extent resulting in poor quality and increasing construction costs. The main and only building material in Malawi is "burnt clay bricks". Use of alternate materials is sparse, limited only to subsidized construction activities. It has been estimated that with the current rate of urbanization, a minimum of 21,000 housing units are required to meet the urban housing demand. Thus Malawi will require around 1.7 billion units of burnt clay bricks annually. If the rural housing demand is also considered then the annual brick consumption will be much more.

Objectives

The current state of housing has put an immense pressure on the low cost housing sector. Most often it has reached beyond the means of common beneficiaries. To construct a 1 m^2wall with traditional bricks, approximately MK 2,575 is spend which is around 70% more than similar construction with good quality bricks. Thus use of quality bricks can drastically bring down the cost of construction of a low cost housing. Keeping this in mind, Centre of Community Organization and Development, Lilongwe initiated the idea of technology transfer of Vertical Shaft Brick Kiln (VSBK) for Malawi. The major objective in this initiative was to introduce an energy efficient and environment friendly technology to produce consistent quality bricks throughout the season.

Thus an assessment study was undertaken to study the feasibility of introducing Cleaner Brick Production Techniques and Methods through the implementation of VSBK technology.

The Malawian brick industry

The main building materials in both urban and rural setting are bricks. In rural areas unburnt bricks are common. However in the last two decades there has been a significant shift from mud walls to burnt bricks. In urban areas the entire construction sector has shifted to burnt bricks.

Majority of the brick making in Malawi is small scale, unorganized activity. They are fired in traditional clamp kilns using fuelwood as fuel. In the entire country there are only three organized brick industry producing good quality bricks. Brick making activity is scattered throughout the country but concentrated in and around the major three cities of Mzuzu, Lilongwe and Blantyre. During the feasibility study it was found out that the two major concerns in the Malawi brick sector are increased deforestation due to use of fuelwood and poor brick quality resulting in poor construction quality.

Assessment findings

Technical

Varied types of soil were found in Malawi used in brick making by traditional means. In some cases black coloured plastic clays are being used to produce good quality bricks. On the other had extremely poor quality sandy soils are also used. There are neither proper testing facilities nor knowledge on the suitability of soils in brick making.

Fuel used in firing bricks in Malawi is fuelwood. It is estimated that around 850,000 tonnes of fuelwood will be required to produce around 1.7 billion bricks if alternate technologies are not adopted. No waste materials are used in green brick making for use as body fuel.

In Malawi traditional brick making process uses slop moulding. The soil is dug out from the nearby moulding area and aged with water. They are then manually mixed and moulded. Due to slop moulding process, the green bricks contain a high amount of water. Faulty mould design and high water content deforms the just moulded bricks. Shapes are also distorted with drying cracks due to rough moulding area also.

In some soils due to high plasticity there were high shrinkage cracks during initial drying. To control the drying process and avoid shrinkage cracks, green bricks were covered with biomass. Since the green bricks are not of uniform shape they cannot be stacked in a proper manner. Thus green bricks were just dumped in heaps for drying.

The entire Malawi brick industry uses open clamps for firing. Due to poor quality of green bricks, clamps are not stacked high enough. Most of the clamps are small ranging from around 10,000 to 50,000 bricks. There is no control over the firing process in the clamps. Besides fuelwood, fuel in the form of leafy biomass is also used to provide additional energy. However the quantity and quality is not suitable to provide additional heat to uniformly fire the upper layers of the clamp. Thus the brick

quality in a clamp is extremely non-uniform. Only in one area scoved clamps were seen fired in a scientific manner. These fired bricks were of consistent and high quality compared to the normal clamp brick firing process.

In Malawi due to high demand of bricks, all bricks produced are sold irrespective of quality. No class division is made of fired bricks. Fired colour of the bricks being produced ranges from bright red to even soil coloured denoting unfired quality. However in scoved clamp properly fired bricks were seen with consistent quality. No bricks in Malawi had a metallic sound indicating the poor quality also.

Energy and environment

All the brick making activity uses fuelwood fired in clamps. It has been calculated that the brick industry in Malawi alone consumes around 850,000 MT of fuelwood per year. At this rate of fuelwood consumption, the entire country will be deforested within 25-30 years only from the brick industry. In Malawi, because more fuelwood is consumed than re-grown, the combustion of wood results in an increased amount of carbon dioxide emission in the atmosphere which add to the greenhouse gas effect.

In the clamp around 20MT wood is consumed to fire 40,000 bricks. For smaller diameter wood, the consumption is more. With the kind of wood being used the average specific energy consumption in clamps is around 3.66 MJ/kg. This is expected to be much higher since the required temperature and quality is not achieved.

Business economics

The brick business in Malawi is based on market dynamics controlled by affordability and purchasing power of consumers. Since most of the consumers are looking at cheaper products without any quality, thus brick prices are also low. A burnt brick in Malawi sells between MK 3.50 to 5. Despite the dominance of the market with this brick quality, there is a considerable market of good quality product sold between MK 15 to 25. Production cost of clamp fired bricks ranges between MK 4 to 5. Out of the total production cost, fuel accounts for over 50%. There is also no trend for investment in the brick making sector. Generally the investment sector in Malawi is not matured enough. Small industries run on private capital. However recent trends show that the Government is encouraging both private and public investment in the SME sector to boost the country's economy.

Social aspects

The working conditions of brick kilns are generally unhealthy and unsafe. With no social security in brick making business and activity it is generally treated as an additional income generating activity to earn some quick money. This is due to the unorganized and informal nature of business. On an average a brick kiln worker earns around MK 250 per day which is far less than the minimum subsistence amount.

The skill levels of Malawi brick workers are generally low. However they are extremely hardworking and sincere. No formal skill has also been imparted with basic skill developed through on-the-job experience. A surprising fact was that unlike other countries the brick industry in Malawi is entirely controlled by male workers. No female workforce was seen in any of the brick kiln visited.

Institutional scenario

The existence of organized brick making activity is lacking in Malawi. There are no formal brick associations or institutions supporting the brick sector. Almost all the Government agencies are well aware of the issues and problems of the brick making activity especially the use of fuelwood. Awareness does not exist on the use of coal for quality brick making. The government is even considering banning burnt clay brick to save the environment. However it has been held under abeyance due to lack of alternatives.

Feasibility of Vertical Shaft Brick Kiln technology in Malawi

Choice of technology

During the assessment study it was apparent that depending upon the socio-economic conditions of Malawi most of the technologies practiced in other countries will not be suitable for implementation. The basic criteria's used to select technologies were based on production capacity, fuel type, product quality, investment capacity and ability to tap the carbon market. Based on all the above criteria, the Vertical Shaft Brick Kiln technology became the obvious choice especially looking at the scale of production and the fuel type in Malawi.

Vertical Shaft Brick Kiln technology is the most energy efficient technology available globally till date. Greenhouse gas emissions are also enviably less making it an obvious choice for the carbon market. Valid PDD is already available and willing carbon investors are available. VSBK is versatile and can be adapted to any scale of production. It

produces consistent quality bricks with higher returns than clamp brick production.

Technical solutions

From the technical viewpoint there are no issues for designing and construction of a VSBK in Malawi. All the materials required for construction, including high quality refractory bricks are locally available. Expert masons are also available to do a quality construction. However during the initial couple of years, the design and construction of the VSBK has to be under expert supervision. This is required for masons and engineers to absorb and practice the critical steps required for the VSBK.

Most of the equipments can also be manufactured in Malawi. Competent workshops also exist for the same. The local skills available are sufficient to develop the same with technical backup and skill enhancement support during the initial stages. However specialized metals required needs to be imported from neighbouring countries.

Soil quality is suitable for producing good quality bricks in a VSBK firing system. However proper training needs to be given to make the right choice. The various types of soils are also appropriate to introduce the practice of internal fuel mixing for producing green bricks. It has been seen that a maximum of 5-7% by weight of internal fuel can be mixed without compromising on the brick quality. More than the required quantity might create operational issues especially during the summer months.

Malawi has one of the most suitable quality of coal required to be used in VSBK system. With a calorific value between 26 - 29 MJ/kg it is of appropriate quality. Adequate quantity is also available in the Northern part of Malawi with explorable deposits in the Southern past also. During the feasibility study a substantial quantity of industrial waste materials from coal, tobacco and other industries have been seen. Tests show a result of around 27 MJ/kg (Duff coal) - 9MJ/kg (Tobacco dust) making it most suitable to be used in green brick making without affecting the quality of the fired product.

The process of producing green brick needs to be entirely revamped to sand moulding or semi mechanization. This should be done without drastically changing the social process and acceptance of traditional green brick making method. Semi mechanization will not only introduce quality but also ensure proper shape and size required for use in the VSBK technology.

The most critical factor for the acceptance of a VSBK is the demand and supply of the high quality of bricks to the market. More than often VSBK produced bricks are and will be notionally compared with those available in the market in terms of price. Bricks produced in a VSBK will always be better in technical terms of compressive strength and water absorption. They will also fulfill all the required qualities as specified in the Malawian Standards (MBS 6:1994). The only negative issue will be the price of the bricks compared to the locally available ones. Thus it is recommended to devise and work upon an extensive marketing awareness campaign for promotion of VSBK produced bricks. An appropriate starting point would be promotion of “Eco Bricks” through Government systems.

Energy and environmental emissions

A major characteristic of the VSBK technology is its ability to operate throughout the year subject to availability of green brick stock and absence of any water logging in and around the kiln site. During regular operation the specific energy consumption is expected to be around 0.8 MJ/kg. With an 70: 30 internal: external fuel consumption it amounts to approximately 55 kg of internal fuel (Duff coal) per 1000 bricks and an external fuel consumption of 30 kg (Peas coal) per 1000 bricks. This is in comparison to the 500 kg of fuelwood used per 1000 bricks in traditional kilns.

The most important aspect of VSBK is that it can only be operated with coal or a combination of dense biomass briquettes. Under no circumstances fuelwood can be used in VSBK. Thus adoption of VSBK will automatically arrest the deforestation caused by rampant use of wood in all firing technology in Malawi.

Adoption of VSBK will substantially reduce environmental emissions. This needs to be substantiated with stack and ambient air quality monitoring. However no black smoke will be visible during VSBK operation indicating the complete combustion of coal. It is estimated (from previous measurements in other countries) that stack and ambient emissions will be reduced by almost 70-80% compared to traditional clamp firing technologies.

Financial viability

The economic and financial analysis of the VSBK technology shows that it can be an alternate technology to replace the clamp kilns and stop use of fuelwood. Although the capital expenses are much higher compared to clamp (no capex required) kilns, the payback period will be around 2-3 years (considering 1 year as stabilization and training period). VSBK is expected to have its own niche

market amongst all the brick production capacities thereby promoting the growth of SME sector in Malawi. It is also expected that the attractiveness of the VSBK will be more to new entrants in the brick business since reluctance is expected amongst traditional brick makers until and unless forced by Government policies. It is expected that during the initial period the acceptance of VSBK will be higher in the three major cities of Mzuzu, Lilongwe and Blantyre.

Promotion of VSBK technology will also be a good financial business for financial institutions and the banking sector. It is estimated that more than 1000 VSBK (single shaft) are required to replace the clamp technologies only in urban areas. These will require financing and hence a profitable business. However this requires extensive support and policy changes from the Malawian Government and bilateral agencies e.g. World Bank, African Development Bank, Standard Bank.

Carbon finance opportunities

Financial incentives known as carbon credits can be accessed to facilitate and motivate the switch to more fuel-efficient technologies that both contribute to the sustainable development of Malawi and to the reduction in global greenhouse gas emissions.

The improved fuel efficiency and the equivalent greenhouse gas emission reduction can be demonstrated by the improved brick-making technologies compared to the old or 'baseline' technology. Once demonstrated and validated by auditors, many brick makers can be paid for reducing emissions. By being part of such a programme, brick makers may be better placed to access the initial investment required to make the shift.

Although carbon finance is a new concept with few practical examples that are established and generating finance, there is solid demand for credits from Africa, particularly those that have strong sustainable development benefits. Improved brick-making technologies is an eligible activity in a recently initiated programme called African Biomass Energy Conservation Programme that is taking place in various African countries, including Malawi. The programme is being developed by Hestian[1] and aspires to be registered by the Gold Standard Foundation.[2]

Impact of Vertical Shaft Brick Kiln in Malawi

The various meetings and workshop conducted in Lilongwe on the VSBK technology has created a substantial interest amongst all major stakeholders in Malawi. The Department of Energy Affairs, Department of Environment Affairs, National Construction Industry Council etc. has taken a keen interest in the VSBK technology with options of suggesting VSBK as a replacement to clamp kilns. It is expected that entrepreneurs will be interested in adopting the same due to enhanced profits and compliance with Government regulations. Workers will be willing to contribute due to enhanced incomes and favorable working conditions. Regulatory agencies will be interested in enforcing the same since deforestation will be arrested. Thus if VSBK is adopted only in the urban cities replacing clamps, then it will result in:

- Saving of 850,000 tonnes of fuelwood annually
- Saving of 1,500,000 tonnes of CO_2 annually
- Recurring income of USD 9 million worth of foreign exchange annually
- Creation of more than 1,000 small to medium scale enterprises in the SME sector and ancillary industries
- Creation of more than 20,000 sustainable "GREEN JOBS" thereby helping in reducing poverty
- Use of more than 90,000 tonnes of industrial waste (e.g. boiler ash and leftovers of tobacco industry, duff coal) supporting the Malawi's contribution towards reducing pollution
- Recurring use of 50,000 tons of coal creating a business of USD 10 million within the country thereby promoting inclusive growth.
- Improving the quality of housing in Malawi and incurring a saving of around 40% from bricks and mortar alone
- Reducing the embodied energy in housing, thereby pioneering the path of energy saving in Africa

Challenges

To get the benefits of VSBK it is expected that the Government of Malawi will play a critical role through a "carrot and stick" approach. On one hand it should provide the stick through stringent laws and stricter enforcement. On the other it should also provide the carrot through easy financing, subsidies, awareness and promotional events.

New approaches to operational practices requires a paradigm shift from the conventional practices and the mentality amongst entrepreneurs of conducting regular business thereby integrating the whole process innovations with new technology process and re-engineering of existing methods. Change in mentality, technology innovations and trained human resources are the most valuable asset of improving

[1] www.hestian.com
[2] http://www.cdmgoldstandard.org/

the environment and benefitting the society in a business-like manner. However the advantage of all this can only happen if all the brick industry stakeholders are ready to change its mind set and working habit. All this requires extensive awareness, widespread demonstration, intensive training and long term technology support and making both workers and entrepreneurs learn, practice and adopt improved technology options.

The above is the key to the success of pilot demonstration initiatives and can only be achieved in time. In the absence of learning, the work force simply repeats the old practices and therefore, continuing learning and commitment to re-learning are crucial for overall improvement in the brick sector especially with regards to stopping use of fuelwood, energy conservation, minimizing pollution and better quality of brick.

Thus it is recommended that a pilot demonstration of VSBK be initiated for demonstrating technical viability and creating awareness. The pilot demonstration is to be seen as a compliment to initiate a larger demonstration initiative in all the major cities and towns of Malawi with attractive business opportunities and enhanced environmental benefits.