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Islamabad

Study on Evaluating Energy Conservation Potential of Brick Production in SAARC Countries

A Report on Nepal



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List of Abbreviations

BKEM	Brick Kiln Emission Management
CBS	Central Bureau of Statistics
CDM	Clean Development Mechanism
CEN	Clean Energy Nepal
CESEF	Cost Effective Social and Environment Friendly
CIL	Coal India Limited
CO	Carbon monoxide
CO ₂	Carbon dioxide
CP	Cleaner Production
DANIDA	Danish International Development Agency
DCSI	Department of Cottage and Small Industry
EE	Energy Efficiency
EEC	Energy Efficiency Centre
EIA	Environment Impact Assessment
ENPHO	Environment and Public Health Organization
ESPS	Environment Sector Programme Support
FCBTK	Fixed Chimney Bulls Trench Kiln
FNBI	Federation of Nepal Brick Industry
FNCCI	Federation of Nepalese Chambers of Commerce and Industry
GDP	Gross Domestic Product
GIZ	German Technical Cooperation
GoN	Government of Nepal
HHK	Hybrid Hoffman Kiln
IEE	Initial Environmental Examination
IEM	Institute of Environmental Management
IEMP	Industrial Energy Management Project
IFC	International Finance Corporation
MCBTK	Movable Chimney Bulls Trench Kiln
MJ	Mega joule



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MoE	Ministry of Environment
MoEST	Ministry of Environment, Science and Technology
MoICS	Ministry of Industry, Commerce and Supplies
MOPE	Ministry of Population and Environment
NA	Not Available
NCL	Nepal Coal Limited
NEEP	Nepal Energy efficiency Programme
NORAD	Norwegian Agency for Development Cooperation
NRs	Nepalese Rupees
PDD	Project Design Document
PREGA	Promotion of Renewable Energy, Energy Efficiency and Green House Abatement
RENP	Renewable Energy Nepal Programme
RSPM	Respiratory Suspended Particulate Matter
SAARC	South Asian Association for Regional Cooperation
SDC	Swiss Agency for Development and Cooperation
SEC	Specific Energy Consumption
SKAT	Swiss Resource Centre and Consultancies for Develop
SO ₂	Sulphur dioxide
SPM	Suspended Particulate Matter
TERI	Tara Energy Research Institute
TOR	Terms of Reference
TRDC	Technology Research and Development Committee
TSPM	Total Suspended Particular Matter
UNDP	United Nations Development Programme
USD	United States Dollar
VDC	Village Development Committee
VSBK	Vertical Shaft Brick Kiln
WECS	Water and Energy Commission Secretariat

1 Executive Summary

The spike on global energy demand to fuel the growing socio-economic development activities is further depleting the already scarce non-renewable energy sources. As a result, there is growing acceptance that Energy Efficiency and Conservation is a least cost option to meet the increasing energy demand while mitigating climate change impact. The technological advancement for energy-efficiency in the brick industry in the SAARC countries is taking place at a slow pace in spite of efforts made towards that direction. This study with the main objective to “Evaluate Energy Conservation Potential of Brick Production in SAARC Region” was conducted in Nepal, as part of a larger study on four SAARC countries. The study focuses on the sector status and energy efficient techniques in the targeted member countries to reduce the cost of production, and the efficient utilization of fuel. This study is based on Secondary information. The study will recommend strategy for efficient use of coal in brick industry, outline the objectives, priority areas, technologies and best practices.

The contribution of bricks in the construction sector of Nepal is significant as it is the most common and preferred construction material. There are 429 officially registered brick kilns in Nepal while the Federation of Nepalese Brick Industries (FNBI) estimates more than 700 brick kilns in the country. Based on the secondary data analysis of the year 2009, the study estimated production of 3.2 billion bricks per year. Similarly, the total initial investment in the sector is estimated to be US\$ 37,615,000. About 140,000 people are estimated to be employed in the sector.

Coal, which is imported mainly from India, is a major fuel for brick firing in Nepal. The annual coal consumption by the brick sector in the country is estimated to be of 449,358 tons. There are five main brick firing technologies prevalent in Nepal viz. Clamp Kiln, Movable Chimney Bulls Trench Kiln (MCBTK), Fixed Chimney Bulls Trench Kiln (FCBTK), Vertical Shaft Brick Kiln (VSBK) and Hoffman Kiln. MCBTK constitute 57% of the market share and is the major prevalent technology in Nepal, followed by FCBTK with 33%, Clamp kiln 6.7%, VSBK 3.6 %and Hoffman 0.3%. The government has recently banned the MCBTK since 2011.

VSBK is the most energy efficient. The environmental performance of VSBK is superior to all other technologies. The Suspended Particulate Matter (SPM) of VSBK is 28.5 % less compared to FCBTK and 33.6% less compared to MCBTK respectively. The Sulphur Dioxide (SO₂) emission is 84.2 % less for VSBK compared to FCBTK. This study estimated 1,107,667 tons of CO₂ is annually emitted by brick kilns in Nepal.

Air pollution is identified as a major cause for higher healthcare cost in urban cities of Nepal. The economic cost of urban air pollution in Nepal is estimated at US\$ 21 million or 0.29 percent of GDP (World Bank, 2007). Brick kilns are a major contributor to these health costs since brick kilns are identified as third largest source of air pollution in the Kathmandu Valley, the first being vehicular pollution and second being road dust re-suspension (Gautam, 2006). Safety and occupational health of workers are key issues associated with brick kilns.



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The major stakeholders in the sector are brick consumers, brick entrepreneurs and their associations, government agencies, donor-funded projects and technology providers. A number of donor-supported projects are involved in providing support for technology establishment and energy audit. Similarly, a number of local organizations are involved in local level applied research and development (R&D).

The government has formulated various national regulations that promote cleaner technology and energy efficiency. They focus on environmental issues particularly regarding the brick sector. Some of them are the Environment Protection Act 1997, Industrial Policy Act 2010. The effective implementation of policies has contributed to promotion of cleaner technologies. In 2009, the Industrial Promotion Board decided to replace MCBTK all over Nepal within two years. Also, the Industry Policy Act 2010 mentions that industries adopting environment friendly technology and that save energy will be provided technical and financial support. The technical supports, financed through external funding agencies, have been instrumental in promotion of energy-efficient technologies. However, the confidence building of brick kiln entrepreneurs is a key factor to introduce new technology and practices. The increased awareness level of communities around the brick kilns and local level lobbying against pollution has positive impact on change in technologies.

The study mentions that due to unfavourable investment environment, entrepreneurs prefer investing in shorter payback period, which hinders the introduction of lower emission, higher efficiency kilns. A number of positive policies have contributed to the promotion of cleaner technologies. However, ineffective implementation of positive policy incentives hinders the rate of energy-efficiency measures adoption. Policy incentives coupled with access to commercial lending will accelerate the rate of dissemination of energy-efficiency measures. Programmatic approach to develop skilled brick kiln operators will be an effective strategy to achieve energy-efficiency on the backdrop of the proven results that improving the operational practices can achieve energy-efficiency. Skill enhancement of local technology service providers and working through the locally available capacities will help to sustainable availability of services for wider dissemination.

In conclusion the report mentions that the brick sector in Nepal has a huge potential for saving energy and reducing emission through suitable interventions such as improving operational practices, upgradation of existing technologies and introducing feasible new technologies. Focus should be given to allocation of financial resources on technology development; development of long-term and phase-wise sectoral plan along with a range of technological options and emission standards including ground level activities to demonstrate the solution.

2 Introduction

This report has been prepared on Nepal for the SAARC Energy Centre (SEC) based in Islamabad, Pakistan as part of the project “Evaluating Energy Conservation Potential of Brick Production in SAARC Countries”.

The report is divided into three parts as follows:

- A. Context of the Study
- B. Results of the Study
- C. Annexes

The study report is prepared by the team members of MinErgy Initiatives (MinErgy hereafter). MinErgy (www.minergynepal.com) is an organization dedicated to and working on improved energy, environment and health conditions. It inherits the competencies, know-how and expertise having worked alongside in the Vertical Shaft Brick Kiln (VSBK) Project in Nepal, funded by Swiss Agency for Development and Cooperation. It has expanded its services to other sectors of renewable energy, climate change mitigation, adaption and preparedness on climate-induced disasters with a team of technical and social development backgrounds.

Part A – Context of the Study

This chapter portrays the context under which the study has been carried out.

3 Background

Energy demand around the world is growing to contribute to socio-economic development while energy sources are being scarce in an immense pace. Adverse effects of green house gases and its co-relation to energy use, particularly the fossil fuels, has generated global concern, particularly that of the South Asian Region to opt for strategy in all sectors of economy. There is growing acceptance that Energy Efficiency and Conservation is a least cost option to meet the increasing energy demand while mitigating the climate change impact.

Being an energy deficient region, it is imperative to set goals for use of energy and energy intensity to increase the resources and reduce cost of production, increasing affordability and minimizing the effects on climate change.

According to SEC, brick industry within the SAARC region is the third largest consumer of coal after power plants and steel industry. The technological advancement for energy-efficiency in the brick industry in the SAARC Countries is taking place in slow pace in spite of some efforts towards that direction.

In this context, SEC carried out a study in major brick producing SAARC Member Countries namely Bangladesh, India, Nepal and Pakistan. For Nepal, SEC entrusted this study to Ms. Usha Maskey Manandhar on behalf of MinErgy, who has been working in the brick sector for improved energy, environment and health conditions.

4 Objective of the Study

The main objective of the study is to “Evaluate Energy Conservation Potential of Brick Production in SAARC Region” to understand the sector status and energy-efficient techniques in the targeted member countries in order to reduce the cost of production, efficient utilization of fuel.

SEC intends to publish and disseminate the report in all the SAARC member countries in order to assist in the development and expansion of the market of energy-efficient technologies through the implementation of the report recommendations. The study is expected to recommend strategy for efficient use of coal in brick industry; outline the objectives, priority areas, technologies and best practices.

5 Scope of Work

The major scope of work covered in the Study is as follows:

- Economic and industrial conditions
- Social and environmental impacts
- Identification of relevant institution, activities for capacity building for promotion of energy efficiency in the sector
- Mapping of active stakeholders in the market, covering financiers/investors, technology providers
- Identification and analysis of barriers of the private sector for investment
- National coal policy and present situation of coal industry
- Environment policy for brick kiln
- Experiences, expertise and best available practices
- Energy, environment and economic comparison of prevalent technologies

The terms of reference (TOR) is in Annex 1 for the details on work scope.

6 Methodology

Secondary information collection and analysis was the primary methodology adopted for the Study. Secondary information was collected through published reports to the possible extent. Information was also collected through interviews with representatives of different stakeholders and actors. The major group of stakeholders interviewed are concerned government agencies, brick kiln entrepreneurs and their associations, service providers and donor-funded projects. The list of people interviewed is in Annex 2. The qualitative information, obtained from the interviews, was utilized to substantiate the analysis made based on the secondary information. The checklist, as in Annex 3, was developed and utilized to carry out the interviews.



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6.1 Methodological Limitations of the Study

The analysis and findings of the study is primarily based on published and unpublished reports from different sources having wide range of data variation and inconsistencies. There lack comprehensive primary data. There is no recent published data available to carry out analysis on current situation. Additionally, the brick entrepreneurs do not have the practice of recording data and usually have the tendency not to provide real data regarding production and coal consumption. Hence, the analysis is done with these limitations. The information derived through interactions and interviews were representative and perception-based than of statistical significance.

Part B – Findings of the Study

This part of the report provides the findings on different aspects of the brick sector.

7 Economic and Industrial Conditions

This chapter outlines the economic and energy scope of the brick sector within the national context.

7.1 Economy of the sector

The contribution of bricks in the construction sector is significant due to the fact that it is the most common and preferred construction material, particularly in the urban, semi-urban and growing cities. Its popularity since ancient times is demonstrated in temples and monuments in different parts of Nepal built with red bricks.

According to the National Account Estimate 2011/2012 of Central Bureau of Statistics, the contribution of the construction sector to Gross Domestic Product (GDP) of Nepal is 6.73 (CBS, 2012). The data and information on brick sector economy varies with different sources. An overview and trends on brick sector over the few years period and collected from different sources is presented in the following table.

Table 1: Overview of the Brick Sector Information from Different Sources



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Parameter	Census manufacturing establishment (2006-2007)	Heierli -2007	CBS -2008	CEN-2009	FNBI - 2011 (informal source)	Estimated for the purpose of this study
Number of Brick Kilns	429		429		700	728 ^b
Quantity of Bricks Sold (annual)	872 million pieces	4 billion	753 million pieces	2 billion ^a	2 billion	3.2 billion ^c
Value of Sales			2.3 billion NRs		14 billion NRs ^d	22.4 billion ^d
Persons Employed			42,003			

Note: NRs – Nepali currency in Rupees (Current value of 1 US\$ = 84 NRs)

- a. Calculated based on data given by Baseline Study of Brick Kilns in Nepal, CEN, 2009 on assumption of 700 brick kilns except VSBKs and Hoffman's Kilns. (refer Table A1 in Annex)
- b. Total 728 kilns including 26 VSBK and 2 Hoffman's Kilns
- c. Refer table 2
- d. The average selling price of brick is taken NRs 7.0 per brick

The officially registered brick kilns in Nepal are recorded to be 429 while the Federation of Nepalese Brick Industries (FNBI) estimates about 700 brick kilns in Nepal with 107 numbers being operated within the Kathmandu Valley. The variation in data shows that substantial numbers of brick kilns are operating without formal registration process. There are also reported to be number of clam kilns, which can be operated without formal registration. Effort to bring all the kilns under the formal registration process is not reported yet.

The Central Bureau of Statistics (CBS, 2008) results showed the selling of 753 million bricks through 429 registered brick kilns. While the census of manufacturing establishments (2006-2007) showed that 429 registered brick kilns are annually selling about 872 million bricks. However, it can fairly be concluded that actual number of bricks consumed would be higher considering the substantial number of brick kilns operating informally without official registration.

Hence for the purpose of this study, an analysis is done with available secondary data of the year 2009 and by taking the best possible scenarios of different sources as presented in the following table. Based on this analysis, about 3.2 billion bricks (rounding figure) are estimated to be produced and consumed (*assuming consumption equivalent to production*) per year. This estimation of 3.2 billion brick consumption is used for further analysis throughout the following chapters for this study purpose.

Table 2: Estimation of Annual Brick Production

S. No.	Kiln Type	Kiln Composition in % ^a	Number of kilns ^b	Per Unit Annual Production Capacity	Total Production
1	Clamp Kiln	7	49 ^b	344,000 ^a	16,856,000



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2	MCBTK (Movable Chimney Bulls Trench Kiln)	59	413 ^b	4000,000 ^d	1,652,000,000
3	FCBTK (Fixed Chimney Bulls Trench Kiln)	34	238 ^b		
3.1	FCBTK inside Kathmandu Valley		103 ^f	8,100,000 ^d	834,300,000
3.2	FCBTK outside Kathmandu Valley		135	4,221,000 ^a	569,835,000
4	VSBK (Vertical Shaft Brick Kiln)		26 ^c	2,884,615 ^c	75,000,000 ^c
5	Hoffman kiln ^e		2	17,500,000	35,000,000
Total					3,182,991,000*

* This sum is rounded to 3.2 billion and which is used in this report for other estimation.

Note: Production capacity of brick kilns in and out of the Kathmandu Valley are assumed to be of similar quantity

a. Baseline Study of Brick Kilns in Nepal; (CEN, 2009)

b. Calculated number of kilns assuming total 700 bricks kilns except VSBK and Hoffman's Kiln

c. External Review of Clean Building Technologies For Nepal VSBK-CESEF PROJECT 2008-2011, Premchander et al., (2011)

d. Brick By Brick : The Herculean Task of Cleaning up the Asian Brick Industry; Heierli and Maithel,(2008)

e. Mr. Durga Prasad Malla, Managing Director, Bhaktapur Ita Tatha Tile Udyog (P.) Ltd.

f. FNBI, 2011

7.2 Investment in the sector

Investment per unit of brick kiln establishment largely depends on the brick firing technologies being used. The information about investments in fixed assets for clamp kilns is not available since these are operated in informal conditions in rural areas. Clamp kiln requires very low initial investment. The initial investment of MCBTKs is also extremely low compared to FCBTK. The initial investment required for VSBK is higher in reference to the production capacity compared to the prevalent technologies in Nepal.

The total investment in the sector is estimated to be US dollars 37,615,000, calculated and presented in the following table. The estimation is done for initial investment during the establishment (*not the operational cost*) taking the references of technology-wise per unit and total investment.

Table 3: Capital requirements for brick enterprises based on different types of kilns, including land and equipment cost

S. No.	Kiln Type	Kiln Composition in % ^a	Total number of Kiln	Fixed Investment required for setting up an enterprise (USD)	Total Estimated Investment (USD)
1	Clamp Kiln	7	49 ^b	NA	-
2	MCBTK	59	413 ^b	35,000 ^c	14,455,000
3	FCBTK	34	238 ^b	70,000 ^c	4,147,000
4	VSBK (Shafts)		58 ^d	71,500 ^e	3,640,000



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5	Hoffman kiln		2 [£]	715,000 [£]	1,430,000
Total					36,692,000

Note: The exchange value of USD is 65 as of 2008. The inflation is not considered. The land value has gone up hence the present investment would be higher.

- a. Baseline Study of Brick Kilns in Nepal, CEN, (2009)
- b. Calculated number of kilns assuming total 700 bricks kilns except VSBK and Hoffman's Kiln
- c. Brick BY Brick : The Herculean Task of Cleaning up the Asian Brick Industry; Heierli and Maithel (2008)
- d. External Review of Clean Building Technologies For Nepal VSBK-CESEF Project 2008-2011, Premchander et al., (2011)
- e. Mr. Mangal Krishna Maharjan, Entrepreneurs of OmSatya VSBK and Mr. Raj Singh Dangol, Entrepreneur of Sworna VSBK (2012)
- f. Mr. Durga Prasad Malla, Managing Director, Bhaktapur Ita Tatha Tile Udyog (P.) Ltd., (2012)

7.3 Employment of the Sector

The brick sector of Nepal pre-dominantly employs manual labour with its low level of mechanization status in production line. In the Kathmandu Valley, 27,798 workers migrate seasonally from rural hills (ENPHO, 2001). According to CBS - 2008, more than 40,000 workers were employed by registered brick kilns in Nepal in 2006. It can fairly be stated that this is an underestimation given the number of unregistered kilns and the informal and seasonal of employment around 82% of the unskilled labourers working in the brick kilns of the Kathmandu Valley are Nepali and 18% are from India (ENPHO, 2001). A traditional brick has from 150 to 300 labourers, and a VSBK can have from 70 to 200 labourers, depending on the number of shafts (Premchander et al., 2011). Labourers are grouped according to the tasks they perform (making green bricks; transporting; loading, firing and unloading; etc.); and according to their national/caste/ethnic origins. About 140,000 people are estimated to be employed in the sector. The estimation is obtained with a straight-forward calculation of average 200 labourer per kiln in about 700 brick kilns.

7.4 Energy Consumption in the Sector

Coal is a major fuel for brick firing in Nepal while other fuel such as agriculture residue, fire wood, rice husk, saw dust, etc are also used. The central bureau of statistics, accounted the coal consumption of 93,484 tons worth value of 659 million Nepali Rupees, which is a national spending to import coal from India since Nepal has very less coal resources available (CBS, 2008).

The Energy Synopsis Report of Water and Energy Commission Secretariat (WECS) reported that in the year 2008/09, Nepal imported about 293 thousand ton of coal from India, 40% of which is consumed in Kathmandu (WECS, 2010). This coal is mainly used in industrial sector like cement, lime and brick (Ibid.).

Apart from coal, other fuel types are also used in brick firing. As put forward by the Baseline Report of CEN, 2009: Firewood was dominant (67%) among the used fuel types followed by saw dust (7%). Agriculture residue were least used in the production of bricks. Other less significant amount of the non coal fuel were plastic, Tyres, Kerosene. These substitutes were not regular source of fuel in those kilns and believed to be used during the ignition process.



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In order to control the use of firewood for brick firing and avoid deforestation, government has the rule that brick kilns are not allowed to register within one km distance from forests. This rule is applicable to all the prevailing technologies with an exception of VSBK technologies. It is not required to get the verification from the department of forest to register VSBK technology unlike for fixed chimneys.

The following table also gives an overview of fuel consumption and fuel economics in the brick sector.



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Table4: Fuel Consumption of Nepali Brick Sector (Registered Establishments Only)

Parameter	Value
Firewood	76,847 tons
Coal	93,484 tons
Diesel	1.7 million liters
Petrol	140,455 liters
Kerosene	130,990 liters
LPG	1,431 kg
Value of Imported Coal	659 million Rupees
Value of Imported Diesel	88 million Rupees
Value of Imported Petrol	9.3 million Rupees
Value of Imported Kerosene	6.5 million Rupees
Value of Imported LPG	92 thousand Rupees

Source: CBS (2008)

An analysis done for the purpose of this study estimated the coal consumption of 449,358 tons annually by the brick sector in Nepal. This estimation is done for 700 brick kilns which also include non-registered brick kilns. The following table shows the calculations for the estimation.

Table 5: Estimation of coal consumption in the brick sector

S. No.	Kiln Type	Total Brick Production ^a	SEC (MJ/kg of fired brick) ^b	Coal consumption (tons) ^c
1	Clamp Kiln	16,856,000	2.36	4,378
2	MCBTK	1,652,000,000	1.50	272,699
3	FCBTK			
	FCBTK inside Kathmandu Valley	834,300,000	1.25	84,411
	FCBTK outside Kathmandu Valley	569,835,000	1.25	78,386
4	VSBK	75,000,000	0.72	5,943
5	Hoffman kiln	35,000,000	1.25 ^d	3,541
Total				449,358

a. Refer Table 2 of this report

b. External review of the VSBK and CESEF projects in Nepal, Heierli et al., (2007)

c. Calculated based on following assumptions

- ✓ Brick weight in Kathmandu Valley is 2.03 Kg (CEN,2009)
- ✓ Brick weight outside Kathmandu is 2.76 kg (CEN, 2009)
- ✓ CV of coal is 6000 kcal/kg

- d. Based on assumption that SEC of FCBTK and Hoffman's Kilns are more or less same (information provided by Hoffman's Kiln entrepreneur)

8 Brick Firing Technologies in the Sector

Brick firing is an important and crucial step in the production line for this industry as the major initial investment and operating cost is incurred in this stage. It is also important in terms of energy and environmental point of view since the major concerns of different stakeholders and public in general has to do with the brick firing.

There are four main brick firing technologies prevalent in Nepal viz. Clamp Kiln, MCBTK, Straight-line FCBTK with natural draught and forced draught, zig-zag FCBTK with normal and forced draught and VSBK. MCBTK was effectively banned in the Kathmandu Valley since 2004 and out of the Valley effective 2012.

8.1 Overview of the Prevalent Technologies in Nepal

Clamp Kiln

This is a traditional brick firing technology, generally in operation in many parts of the country, especially in hilly areas, where bricks are popular building materials but other brick firing technologies are not available. It is a kind of *intermittent kilns*, where the green bricks are stacked and fired in a location either inside a kiln or in open condition. The fire is allowed to die out and the bricks to cool after they have been fired. The kiln must be emptied, refilled and a new fire started for each load of bricks.



The annual production capacity of clamp kilns is below one million bricks, which is considered as very low. The quality of brick produced is below average with maximum breakage. The fuel consumption is very high due to high heat loss. The fuel used is generally coal, biomass, firewood, rice husk, cow dung, etc.

This is the easiest type of kiln that required negligible amount of investment. But it is an obsolete technology due to its poor quality and high energy consumption. There are no government criteria to register to start up business with this type of kiln and hence the data is not available. As per the baseline study report by CEN, 2009, 7% of brick kilns are of Clamp Kilns.

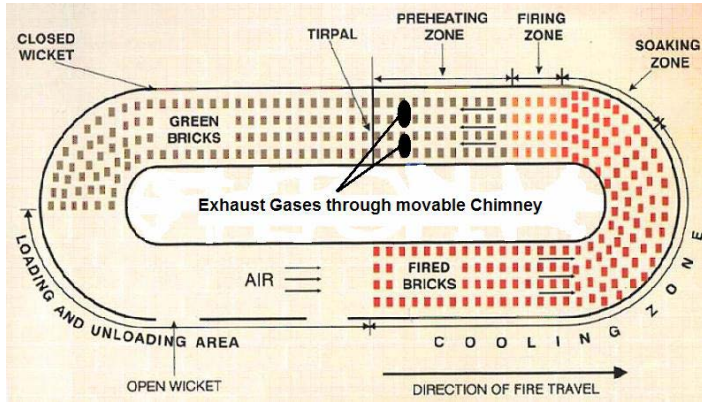
Movable Chimney Bull's Trench Kiln (MCBTK)

It is a type of *continuous kiln* in which once the firing has started, the fire keeps on moving unless it is stopped. As its name implies, the kiln consists of a trench dug into the ground with a crude structure built over it that serves as an enclosure in which the bricks are burnt. The green bricks are stacked inside the trench with necessary stacking pattern in such a way



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that fuel can be fed inside and sufficient flow of air through the setting. On top of the bricks, two layers of bricks, covered with ash or brick dust, seal the setting. A large piece of canvas, paper or metal sheet is placed vertically across the brick setting to block air from entering from the wrong side of the chimneys. Chimneys, 6 - 10 m high, made of sheet metal, are placed on top of the brick setting which are moved around as the firing progresses. Hence this type of kiln is named Movable Chimney Bull's Trench Kiln.



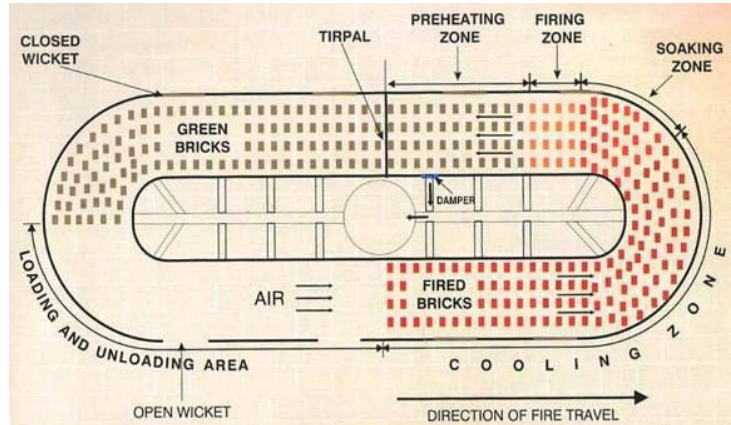
The firing is continuous where as green bricks are loaded and fired bricks are drawn all the time. The fuel saving is partly achieved by reusing part of the energy but the surface heat loss are significant making this technology energy inefficient and very polluting.

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fuel saving is partly achieved by reusing part of the energy but the surface heat loss are significant making this technology energy inefficient and very polluting.

Fixed Chimney Bull's Trench Kiln (FCBTK)

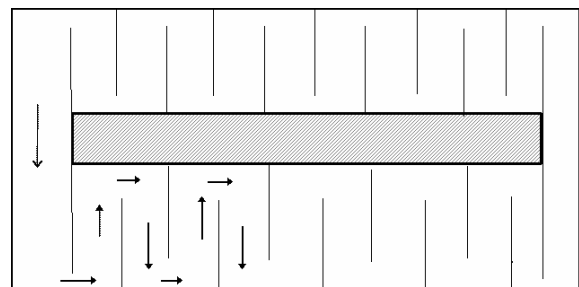
The firing pattern, movement of fire and kiln's trench structure is same as MCBTK. The only difference between MCBTK and FCBTK is the chimney which is permanent and fixed at the centre of the kiln with its height about 100-120 ft tall. In addition of the chimney the flue is passed through the ducts constructed inside the centre of kiln (refer drawing below).



Fixed chimney has further classification based on the draught system and brick stacking pattern:

- Forced Draught FCBTK
 - Straight line
 - Zig-Zag
- Natural Draught FCBTK
 - Straight line
 - Zig-Zag

Zig-Zag:

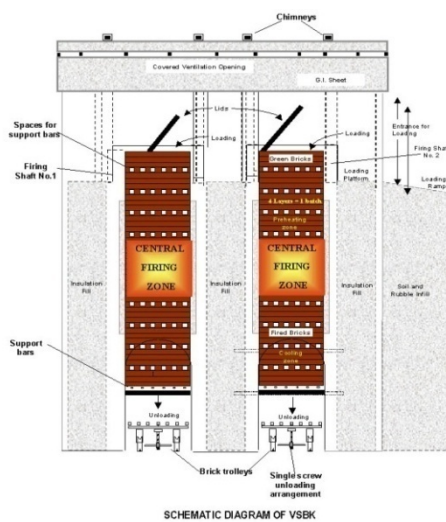




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It is a type of FCBTK where brick are stacked in such a way that the fired follows Zig-Zag pattern. In these types of kilns, the length of the kiln gallery is increased by zig-zagging the chambers and the fire follows a zig-zag path instead of a straight path. The zig-zag kilns are mostly found as forced draught but some of the kilns are of natural draught as well. The environmental performance and energy efficiency in this type is higher than other type of FCBTKs.

Vertical Shaft Brick Kiln (VSBK)



Vertical Shaft Brick Kiln (VSBK) technology is an energy-efficient and environment friendly brick making technology which was invented in China in 60s and reached to the acceptable conditions in terms of energy-efficiency and occupational health and safety by the time it is transferred to Nepal in 2003. VSBK has achieved a 30% reduction in energy consumption and around 80% reduction in emission parameters. VSBK consists of vertical shaft in which bricks are stacked and fired inside where the fired bricks are produced within 24 hours. It has a short cycle of firing hence operation and management of this technology is critical to achieve the quality production.

The flow of air and brick are opposite to each other. The air flows from bottom of shafts passing through the cooling zone, firing zone and preheating zone. The cold air take up the heat from hot bricks gradually pass out from the shaft from preheating zone transferring the heat to the bricks in that zone. The natural laws of convection that hot air always flow upward. This is one reason which makes the VSBK energy efficient.

Hoffmann kiln

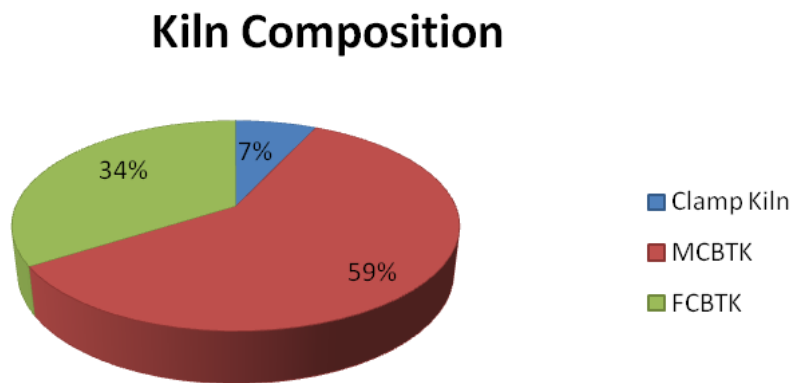


The Hoffman kiln looks like huge fixed chimney BTK with its large chimney with closed massive structure which takes the form of two parallel tunnels built side by side, connected by curved tunnels at either end. Due to its closed structure, round the year production is possible if quantity of green bricks is available.

8.2 Market of the Prevalent Technologies

A report on the baseline study conducted by CEN, 2009 with sample of 100 brick kilns showed that MCBTK is the major prevalent technology in Nepal, particularly out of the Valley. Based on the report of CEN-2009 after incorporating VSBK and Hoffman kiln in the baseline report, MCBTK constitute 57% of the market share, followed by FCBTK with 33%, clamp kiln 6.7 VSBK 3.6 and Hoffman 0.3%. The technological composition and market share of technology-wise brick production is illustrated by the charts below:

Chart 1 – Technology-wise brick kiln composition



Source: Baseline Study of Brick Kilns of Nepal, CEN, 2009

Chart 2 – Technology-wise kiln composition with inclusion of VSBK and Hoffman

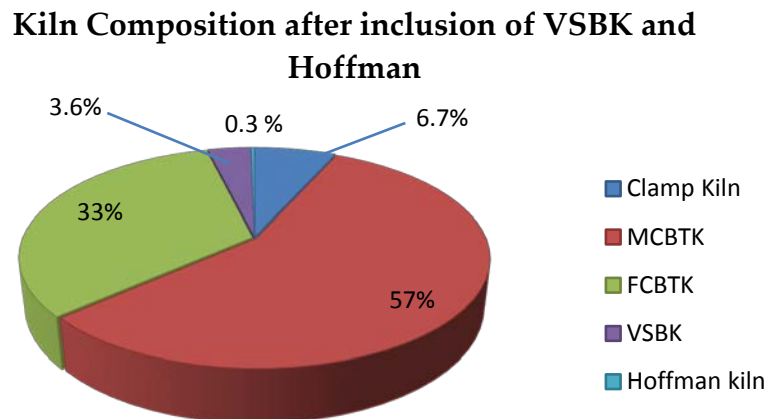


Chart on the basis of CEN, 2009 with inclusion of VSBK units and Hoffman's kilns (total 728 kilns)

8.3 Technology-wise Production Capacity

The production capacity of brick kilns vary according to the technology being used for brick firing. Though there is discrepancy between published and estimated data, there is uniformity in that Hoffman kiln has the highest production capacity while its investment requirement is also high. Since VSBK is a modular technology, the production capacity of VSBK varies with number of shafts and subsequently the investment cost. As seen in the following table, the investment requirement is proportional to the annual production capacity.

Most of the brick kilns are under-utilized in terms of production capacity since the green brick (moulded raw bricks before firing) making and firing operations are done during the dry season and that makes this the brick making as a seasonal business. Hence, there is potential of increasing production capacity of brick kilns but with the consequences on higher energy consumptions and higher investment. The following table gives an overview on the production capacity and investment requirement of the various technologies.

Table 6: Estimated Annual Production Capacity

S. No.	Kiln Type	Annual Production Capacity ^a	Estimated Per Unit Annual Production Capacity ^b	Per Unit Fixed Investment Requirement (USD) ^c	Operational Cycle
1	Clamp Kiln	Below 1 million	344,000	NA	Seasonal
2	MCBTK	2- 5 millions	4,000,000	35,000	Seasonal
3	FCBTK	4-10 millions	8,100,000	70,000	Seasonal
4	VSBK (per shaft)	1.5- 10 millions ^d	5000-7000	71,500	Year round
5	Hoffman kiln	above 10 millions	17,500,000	715,000	Year round

a. Information collected by various brick entrepreneurs

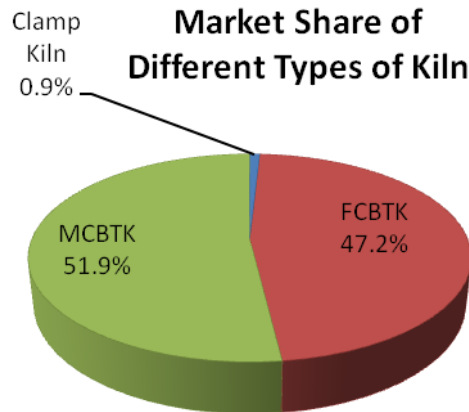
b. Estimated for the purpose of this study (refer to Table 2 for bases of estimation)

c. In reference to Table 3

d. The production capacity of VSBK depends upon the number shafts, the production capacity of one shaft is 5000-7000 bricks per day

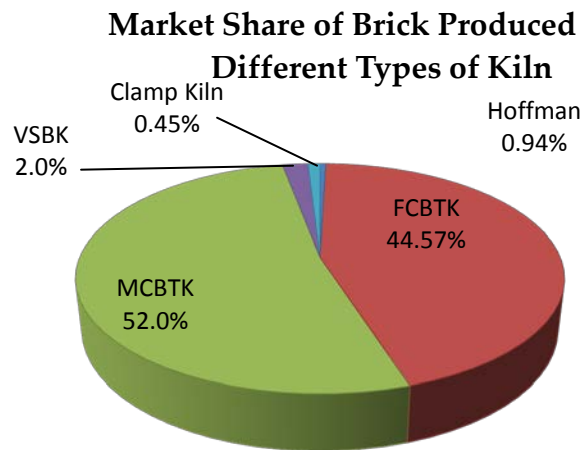
Bricks produced from FCBTK are higher though the number of MCBTK operating are higher number (as seen in the following chart) confirming that the bigger brick market is within the Kathmandu Valley as larger number of FCBTKs are concentrated in the Valley.

Chart 3 – Market share of bricks produced by different technologies



Source: Baseline Study of Brick Kilns of Nepal, CEN, 2009

Chart 4 – Market share covered by different types of kilns in terms of brick production



Note: The chart derived from total production capacity of various kilns (refer Table 2)

8.4 Technology-wise Energy and Environment Performances

The energy consumption of VSBK is the least, as demonstrated by specific energy consumption in terms of Mega Joule per kg of fire bricks in the following table, compare to other prevalent technologies. The SEC of VSBK is 28.5% and 33.6% less compare to FCBTK and MCBTK respectively. The improved FCBTK with Forced Draught Zigzag stacking pattern shows higher energy efficiency compare to other techniques within FCBTK and MCBTK.

The environmental performance of VSBK is superior to all other technologies. The Suspended Particulate Matter (SPM) of VSBK is 28.5 % less compare to FCBTK and 33.6%



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less compared to MCBTK respectively. Similarly, the toxic gas Sulphur Dioxide (SO_2) emission is 84.2 % less for VSBK compared to FCBTK. The environmental performance of Forced Draught Zigzag Stacking of FCBTK is better compare to other FCBTK technologies. The energy and environment performance of the prevalent technologies are as given in the table below:



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Table7: Energy Consumption and Emissions from Brick Kilns in Kathmandu Valley

S. No	Kiln Type	SEC (MJ/kg of fired bricks)	SPM Emission (mg/Nm ³)	SO ₂ Emission (mg/Nm ³)	Coal Consumption (gram) ^c	CO ₂ Emission per brick (gram) ^d
1	Clamp Kiln	2.36 ^b	NA	NA	191	471
2	MCBTK ^a	1.25	840	NA	101	249
3	FCBTK					
	Forced Draught, Zigzag Stacking	0.91	116	145	74	182
	Forced Draught, Straight Line	0.92	125	170	74	182
	Natural Draught, Straight Line	1.16	238	228	94	232
4	VSBK ^e	0.83	101	36	67	166

Sources: IEM (2003); IEM (2005); TERI (2002)

- a. Data for MCBTK is from TERI, 2002, report but not specific for Kathmandu or Nepal*
- b. External Review of Clean Building Technologies For Nepal VSBK-CESEF Project 2008-2011, Premchander et al., (2011)*
- c. Calculated value based on following assumption*
 - ✓ Brick weight is 2.03 Kg (Brick weight for KTM)
 - ✓ CV of coal is 6500 kcal/kg
- d. 1 kg of coal burning emits 2.465 kg of CO₂ (PREGA, 2006)*
- e. The SEC and subsequently coal consumption data provided in Table 5 is not used in this table though it is the most recent published data as it does not have other environmental data. Hence, the old data of IEM has been taken in this table.*

9 Social and Environmental Impacts

This chapter describes the social and environmental impacts caused by the brick kilns.

9.1 Health and Social Impact

Air pollution is considered as a major cause for higher health cost in urban cities of Nepal. The World Bank has estimated the economic cost of urban air pollution in Nepal at US\$ 21 million or 0.29 percent of GDP (World Bank, 2007). The same report showed that urban air pollution in Nepal is estimated to have caused nearly 7,000 premature deaths in 2005 and about 2,106 new cases of chronic bronchitis (ibid). The former Ministry of Environment, Science and Technology estimated that the PM₁₀ emission in the Kathmandu Valley is responsible for 1600 premature deaths per year (MoEST, 2005). The following table on health cost gives an overview of health cost due to urban air pollution in Nepal.



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Table 8: Estimated Health Costs Due to Urban Air Pollution in Nepal

Type of cost	Estimated Cost (US\$)
Costs of premature mortality from particulate matter (PM2.5)	15,186,923
Costs of morbidity endpoints ^a from particulate matter (PM10)	3,903,578
Costs of illness (medical costs + lost productivity costs)	2,012,000
Total costs attributed to urban air pollution	21,074,932
Total costs as % of GDP	0.29%

Source: World Bank, 2007

a. Includes chronic bronchitis, hospital admissions, emergency room visits, restricted activity days, lower respiratory illness in children, and respiratory symptoms.

It can be concluded that brick kilns are major contributors to these health costs since brick kilns are identified as second largest polluter in the Kathmandu Valley. The following study findings also support to this conclusion that brick kilns contribute to health costs.

In another study, it is found that the pollution level in areas with brick kilns was about three times higher than in control areas (Tuladhar and Raut, 2002). The children studying in a school near brick kilns in suffered more from respiratory problems than similar children from a control area (ibid).

Another study also concluded with the similar statement that “the concentration of various air pollutants was higher during the operation of brick kilns” (Joshi and Dudani, 2008, pg 3). The health status of the school children attending the school close to the vicinity of the brick kilns was worse compared to the students attending the school away from the brick kilns.

There has hardly any study been done exclusively to analyse the health impact on the labourers working in the brick kiln premises. However, a relative analysis can be made based on the comparative study made by Clean Energy Nepal (CEN) in June 2002 on health impacts of Kathmandu’s brick kilns on school children. The study findings showed that the abnormalities, particularly of upper and lower respiratory tract, are way higher in the school children near brick kilns compare to school children without brick kilns in the near vicinity. With this finding it can be concluded that the health situations of brick workers are as bad as the school children of nearby neighbourhoods (CEN, 2002).

A study on occupational health and safety of brick industry in the Kathmandu Valley concluded following results that help to interpret the health impact from different brick firing technologies (Krishnamurthy et al., 2006). The study indicated that among the number of workers who had health problems, gastrointestinal tract, skin related illnesses, respiratory complaints and genitourinary tract problems were more prevalent among FCBTK workers compared to VSBK workers. All these problems, however, cannot be attributable to brick technology. Following were the major findings of the study in relation to the occupational health hazards.



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- **Dust pollution:** The dust and heat pollution was found to be higher at FCBTK compared to VSBK brick firing technology. The major findings with respect to work environment monitoring was that the respirable particulate pollution was a problem in and is a serious one with respect to both green brick loaders as well as red brick loaders at FCBTK factories.
- **Gas pollution:** The sulfur dioxide (SO₂) gas monitoring indicated that VSBK factories were associated with higher SO₂ levels; the average levels were within prescribed threshold limit value. However, there is a scope to reduce gaseous pollution at green brick loading area of VSBK factories.
- **Heat Stress:** The thermal stress (radiant heat) prevalent in FCBTK fireplaces was higher compared to the fireplace work at VSBK technology. The difference was statistically highly significant suggesting that FCBTK brick making technology exerts a higher thermal stress on the fire-masters. The study indicated level of thermal stress prevalent at FCBTK technology was considerable to induce health disorders to the FCBTK firemasters who are exposed on a chronic scale.

The other social impacts due to brick kiln are mostly on neighbouring communities. The major complaints the community have are due to air pollution, destruction of road access by brick trucks, sharing of scarce drinking water resources and open defecation by large number of migrant workers in brick kilns. Often there are reported incidences of conflicts between neighbouring community and brick kilns and their workers. Other social issues such as conflicts among workers and with local community after excessive alcohol consumption are also reported.

9.2 Environmental Impact

In 2001, brick kilns were found to be second largest polluter contributing 31% of TSP and 23% of PM₁₀¹ of the Kathmandu Valley (MOPE, 2003). In 2005, brick kilns were the third largest contributor (after Vehicular emission and road dust re-suspension in the emission of Total SPM and PM₁₀) in the Kathmandu Valley (Gautam, 2006). It is estimated that in 2005, brick kilns in the Valley emitted 1850 tons of TSP, which is 9.6 percent of the total TSP in Kathmandu. Similarly brick kilns emitted 1437 tons of PM₁₀ particles which is 11 % of total emission (Gautam, 2006). Although the concentration of SO₂ in Kathmandu Valley's ambient air is not a major problem, it is generally higher in areas around brick kilns. Monitoring of SO₂ in 2003 indicated that the highest level of SO₂ level (50 µg/m³ at all times and once exceeded the national standard of 70 µg/m³) was recorded in Bhaktapur, which has many brick kilns. (CEN/ENPHO, 2003).

The reason for brick kilns' position being improved could be contributed to the effective ban of MCBTK in 2003, closing down of a cement factory and increased number of vehicles in the Kathmandu Valley. The following table gives an overview of trends of pollutants and its

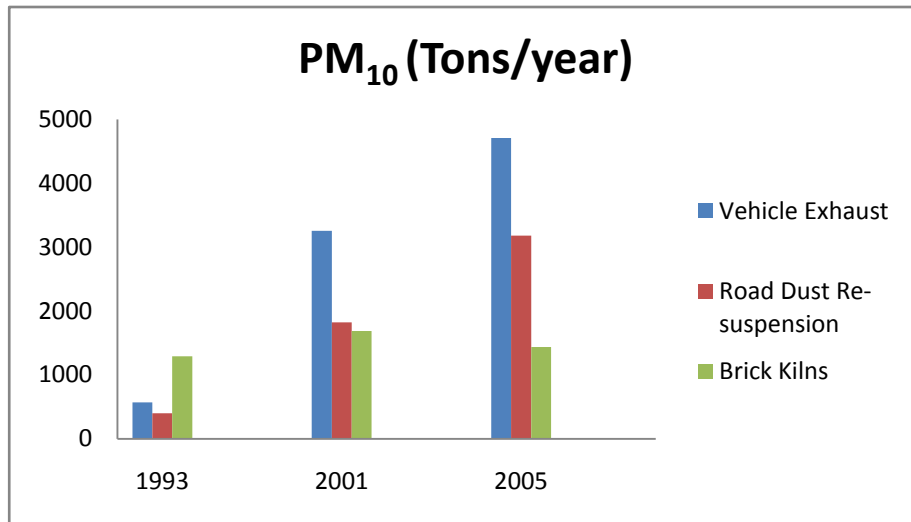
¹ PM10 is particulate matter of less than 10 microns diameter



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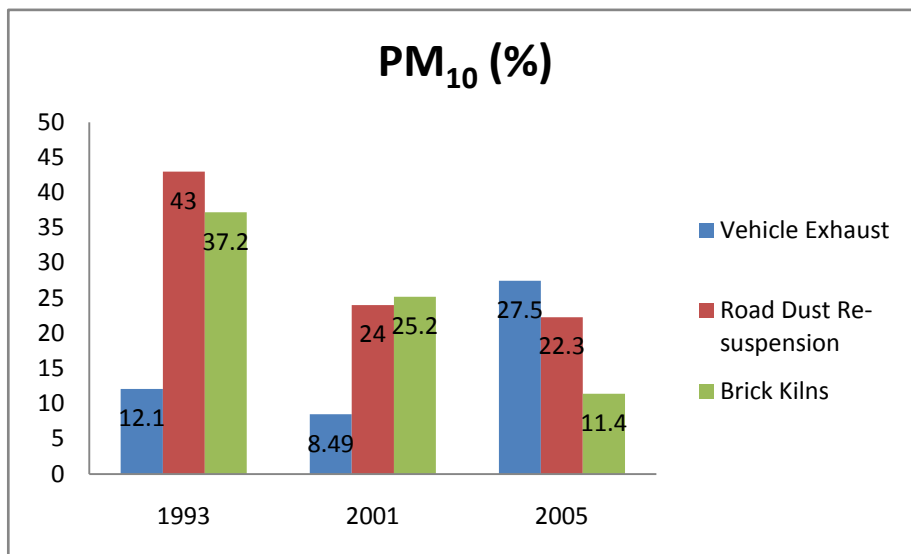
sources. The environmental effect by brick kilns in Kathmandu valley in various time period is shown in graphical representation and a table below

Chart 5 - Total PM₁₀ in various years



Source: Shah and Nagpal, 1997; MOPE/ESPS, 2003; Gautam, 2006; MoEST 2005

Chart 6 - Percentage of PM₁₀ in various years



Source: Shah and Nagpal, 1997; MOPE/ESPS, 2003; Gautam, 2006; MoEST 2005



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Table 9. Comparison of Emission Inventory in 1993, 2001 and 2005

SOURCES	TSP ² (Tons per year)						PM ₁₀ (TONS/YR)					
	1993	%	2001	%	2005	%	1993	%	2001	%	2005	%
<i>Mobile Sources</i>												
Vehicle Exhaust	570	3.44	1971	9.86	2450	12.7	570	12.1	3259	43.0	4708	37.2
Road Dust Re-suspension	1530	9.23	7008	35.1	12239	63.6	400	8.49	1822	24.0	3182	25.2
<i>Stationary Sources</i>												
Brick Kilns	5180	31.3	6676	33.4	1850	9.61	1295	27.5	1688	22.3	1437	11.4
Himal Cement	6000		3612		0		800		455		0	

Shah and Nagpal, 1997; MOPE 2003; Gautam, 2006

An estimation done for the purpose of this study showed that 1,107,667 tons per annum of CO₂ is emitted by brick kilns in Nepal. The basis for estimation is calculated utilizing secondary data and information as follows:

Table 10: Estimation of CO₂ Emission by Brick Kilns in Nepal

S. No.	Kiln Type	Total brick production ^a	Coal Consumed (tons) ^b	CO ₂ (tons) ^c
1	Clamp Kiln	16,856,000	4,378	10791
2	MCBTK	1,652,000,000	272,699	672,202
3	FCBTK			
	FCBTK inside Kathmandu Valley	834,300,000	84,411	208,074
	FCBTK outside Kathmandu Valley	569,835,000	78,386	193,222
4	VSBK	75,000,000	5,943	14,648
5	Hoffman kiln	35,000,000	3,541	8,729
Total				1,107,667

a. Refer Table 2 of this report

b. Refer Table 5 of this report

c. Refer Table 7 of this report

² TSPM is Total Suspended Particulate Matter

10 National Coal Policy and Present Situation of Coal Industry

10.1 Coal in Nepal

Nepal does not have specific policy related to coal. Nepal is dependent in India for coal which is imported from Assam and Bihar State of India. Domestic coal production amounts to around 5 percent of total coal import. Ten thousand tons of lignitic coal, extracted through open pit mining in Dang district of Nepal, is generally used for brick manufacturing (WECS, 2010). Its heating value is found to be low and the local brick entrepreneurs of Dang use the local coal by mixing with imported coal in approximate ratio of 50- 50%. The brick entrepreneurs are generally found unaware of quality and grade of coal that they import and use for brick firing. Almost all the FCBTK and MCBTK use coal from Assam, locally called Assam Coal.

Recently, the Assam state government of India has enforced a new policy allowing containers to ferry only 15 tons of coal at a time, which is just one-third of what they used to ferry in the past³. This new policy has direct implication on the price rise of coal in Nepal.

10.2 Nepal Coal Limited and Private Sector Coal Importers

Till 1992, the Nepal Coal Limited (NCL) established as a public corporation with exclusive right for import of coal from India was the only agency engaged in necessary coal supplies through agreement with the Coal India Limited (CIL). In 1993, twelve private enterprises were emerged to share hands in coal import business. The new arrangement provides the individual private enterprises the right to make own agreement and fix price with Coal India Limited. NCL is dissolved by decision of the Government of Nepal. Currently the private sector is engaged in import and distribution of coal throughout the country. The Nepal Coal Limited was dissolved in view of providing a competitive forum totally for the private enterprises (<http://www.sari-energy.org/Publications/eia/Nepal.pdf>). Currently most of the brick entrepreneurs are purchasing coal from these existing suppliers where as few entrepreneurs import coal directly from India.

11 Environment Policy for Brick Kiln

This chapter outlines general and specific environmental policies for brick kilns. Government of Nepal has put forward set of policies especially for the brick sector.

11.1 National Regulations

Various national regulations such as Environment Protection Act 1997, Environment Protection Regulation 1997, Industrial Enterprises Act 2049, and Industrial Policy 2067 govern the industrial operation including that of brick kilns. These regulations have general

³ (Source: http://archives.myrepublica.com/portal/index.php?action=news_details&news_id=24467)

provisions to promote cleaner technology and energy efficiency which also apply to brick sector. The legal requirements for the brick kilns are listed as follows:

- Industrial Promotion Board, GoN, decided in 2009 to replace the MCBTK all over Nepal within two years. The options given are VSBK, FCBTK or Tunnel Kiln. Some districts have been granted a one year extension to comply with this directive (FNBI, 2012).
- There is no regulation imposed for registration of clamp kilns.
- Environmental Impact Assessment (EIA) for industries producing more than 20 million bricks per year and Initial Environmental Examination (IEE) for industries producing less than 20 million is a mandatory process for registration.
- The forest distance for VSBK has been removed on the basis that wood cannot be used as fuel; and 1 km has been set for other technologies.
- Minimum area of land that entrepreneur need to own/acquire for establishment of new brick kiln must be at least 100 ft radius for VSBK and 200 ft radius for other technologies. The leased agreement details at least for five years have to be submitted in case of leased land.
- The soil cutting and reclamation plan should be submitted along with the registration documents
- Firewood, rubber, tire, plastic should not be used as fuel for brick production. Coal is only valid fuel for brick production.
- The kiln must be at least 1 km far from the dense human settlement and distance while 500 m for VSBK.
- The permissible emission standard and chimney height are as follow:

Table 11: Regulations for different technologies

Technology	Maximum Limit for SPM (mg/Nm ³)	Minimum Chimney Height (meter)	Distance from settlement	Minimum Land Requirement	Distance to Forest
FCBTK natural draught	700	30 m	1 km	200 ft Radius	1 km
FCBTK forced draught	600	17 m	1 km	200 ft Radius	1 km
VSBK	400	15 m	500 m	100 ft Radius	Not applicable

Source: Environment Protection Regulation 1997

Note:

- Value of suspended particulate matter shall be calculated considering reference oxygen concentration at 10%
- Chimney height shall be measured from ground level:

The less emission standard for VSBK in fact gives a notion that environmental policy for cleaner technology is more stringent.



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11.2 Environment Policy for brick kilns

The government has taken various environmental policy decisions for brick kilns under different acts and at different times.

Table 12: Government Decisions Regarding Cleaner Technology in the Brick Sector

Government Decision	Description
The Industrial Enterprises Act 2049 (1992) Section 15:Sub-section K	Permission shall be granted for a reduction of up to 50 percent from the taxable income for the investment of any industry on process or equipment, which has the objective of controlling pollution or which any have a minimum effect on the environment. Such remission may be deducted on a lump-sum or on an instalment basis within a period of three years.
The Industrial Enterprises Act 2049 (1992) Section 15:Sub section N	After an industry comes into operation, 10 percent of the gross profit shall be allowed as a deduction against taxable income on account of expenses related with technology, product development and efficiency improvement.
The Industrial Enterprises Act 2049 (1992) Section 16:Sub-section D	On the recommendation of and with the decision of the Council of Ministers, and by notification published in the Nepal Gazette, additional facilities may be granted to any National Priority Industry or any industry established in Nepal by the way of invention therein.
Industrial Policy, 2067	Those industries who adopt environment friendly technology and save energy themselves will be provided technical and financial support
Local Self Governance Act, 2055 (1999)	<ul style="list-style-type: none"> - Section 28.h.3 authorizes VDC to make various programmes on environment protection and to carry out or cause to be carried out the same. - Section 28.j.2 authorizes VDC to act as a motivator for carrying out cottage industries in the village development area. - Section 96.c.4 authorizes Municipality to control and prevent, or cause to be controlled and prevented the possible river-cutting, floods and soil erosion in the Municipality area. - Section 96.i.1 authorizes Municipality to act or cause o act as a motivator to the promotion of cottage, small and medium industries in the Municipality area. - Section 189.m authorizes DDC to maintain records of the cottage industries to be establish within the district development area, and to identify and develop an industrial zone in the district.
VAT Act 2052	It mentions that there exists a threshold limit for compulsory registration under VAT Act for the industries with the turnover of Rs. 2,000,000 over last 12 months or turnover of Rs. 200,000 in any month. All the brick industries basically have turnover of more than Rs. 2,000,000 annually. The existing rate for VAT is 13%.
Excise Act, 2058, Schedule in accordance to section 3, (s. no. 25)	It is mandatory for the brick industry to pay excise duty; as the brick (produced with in the country or imported) is listed as the excisable goods under this section.
Excise Duty Regulation, 2059, Schedule 2, (3, G, 2)	The excise duty is waived for the brick kiln producing bricks using the modern technology and emitting under the Nepal emission standard.



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Excise Rule (10th Amendment), 2066 (2009 /10), Schedule 2, 3,G	Declared NRs.150,000 per kiln as excise duty for the brick industry, and for the brick kilns out of the valley there is 25% deduction in this amount
Excise Duty Regulation,(10th Amendment),2009/10, Schedule 2, (explanation) 5	Brick kilns those registered for VAT do not need to pay excise license fee amount. However, if the brick kiln pays VAT amount less than the amount of excise duty then the brick kiln should pay the remaining amount as excise duty. (e.g. If a brick kiln pays NRs. 75000 as VAT now, the brick kiln should pay remaining NRs. 75000 as excise duty)
Fiscal Year Budget, 2008/9, 268, E	GON shall provide 50 percent exemption in license fee with the recommendation of Ministry of Environment, Science and Technology to those brick industries that emit less than 50 percent of the emission standard set by the Ministry of Environment, Science and Technology.
Fiscal Year Budget 2007/08, 195	For the purpose of providing relief to the brick industries being affected due to unusual situation in the past, exemption shall be provided on arrears including interest, penalty and late fee up to mid July 2006, if they pay all excise duty arrears before mid January 2008.
Fiscal Year Budget 2003/04, 219	Excise license fee will be waived to industries, which adopt modern technology and meet the environmental standard. Excise duty on brick factories, which do not meet environmental standard and pollute the atmosphere, has been doubled from Rs. 100,000 to Rs. 200,000.
Fiscal Year Budget 2002/03, 85	To enable the industries produce pure products, conserve energy, install equipment for treatment of polluted water, and to control air pollution of Kathmandu Valley, Rs 456.5 million has been earmarked for environment sector support programme.
Industrial Promotion Board meeting 15/12/2009, 183 minutes, decision no. 1	Decide to replace the MBTK within 2 years by VSBK/Fixed Chimney/Tunnel Kiln. Mandatory to use the VSBK/Fixed Chimney/Tunnel Kiln for new registration, compulsory EIA for industries producing more than 20 million bricks per year and IEE mandatory for industries producing less than 20 million. The Forest Distance for VSBK has been removed.

Source: Winrock (2011)

12 Mapping of active stakeholders and relevant institutions

This chapter explains the activities being carried out by important stakeholders and relevant institutions in the sector. The major stakeholders in the sector are brick consumers, brick entrepreneurs and their associations, government agencies, donor-funded projects and technology providers.

12.1 History of Efforts on Energy-Efficiency in the Sector

Due to increasing brick demand, widely-used traditional clamp kilns were largely displaced by MCBTK technology which was transferred from India through informal channel of skilled human resources in early 1950s.

As part of a GTZ/GATE project in 1991, VSBK technology was introduced in two cities with the achievement of reduced energy consumption of 1 MJ per kg of fired bricks by two

demonstration VSBK units. However, both VSBKs faced technical problems that the entrepreneurs could not resolve on their own without access to reliable technical support and were eventually closed down (VSBK Nepal, 2012).

From 1999 to 2005, DANIDA with the Government of Nepal and under its Environment Sector Programme Support (ESPS) supported the switch from MCBTK to FCBTK. The technical assistance and some financial incentives were provided through the Institute of Environmental Management (IEM, 2005). During this period, most of the MCBTKs were transferred to FCBTKs in the Kathmandu Valley.

Swiss Agency for Development and Cooperation (SDC), under the bilateral agreement, supported the VSBK Technology Transfer Programme to Nepal. The VSBK Project/Nepal was implemented in three phases by SKAT Switzerland with Department of cottage and Small Industry (DCSI) between 2003 and end of 2011. The project supported the construction of 26 VSBKs with 58 shafts. The project faced and overcome difficulties such as inferior brick quality and high breakage due to sensitivity of the technology to soil, improper green brick making, lack of entrepreneurs' capacity to manage the technology, all these led to low demand for the technology. The project gained momentum and built 20 VSBKs between 2008 to end of 2011 with a subsidy of NRs 400,000 in addition to free technical assistance and the favourable policy of "zero distance to forest" for VSBK.

12.2 Brick Consumers

The major brick consumers are household and petty contractors constituting 80% of the market. This category of consumers are sensitive to price and less concerned with brick quality. However, the consumers out of the Kathmandu Valley, especially in *terai* (the southern plain of Nepal) are conscious about the brick quality, where there is a culture of categorising bricks as class A, B and C. There are some instances that larger contractors are concerned about brick quality and its impact on construction costs. The perceptions about good brick quality are related to cherry red colour, metallic ring, shape and size. As per Nepal Standard Brick Masonry (N: 1/2035), the brick quality requirement is defined in terms of water absorption of 15% of weight and minimum compressive strength of 75kg/cm².

12.3 Financial Institutions and Investors

Brick kilns in Nepal are generally small scale operations and considered as informal sector. The financial institutions and banks in Nepal do not yet consider brick kiln as a formal industry and hence difficult for brick kilns to access capital. This is also confirmed with the findings of the survey (done for one hundred brick kilns) that 54% of registered kilns were found to be single proprietorships, with the remainder equally distributed among private companies and partnerships (CEN, 2009). The brick kiln operators are found to be accessing bank finances based on private collateral, equity and demonstrated track record of individuals. Hence it can be concluded that brick entrepreneurs have limited access to bank financing or commercial loans to invest for upgradation or transformation of their kilns to improve energy-efficiency. However, commercial banks are currently liquid and looking for investment opportunities. Banks are willing to finance cleaner technologies under the

conditions that the banks' lending requirements are fulfilled. Recently, efforts are being made (e.g. EU-funded SCP project, NEEP) to ease the process on bank financing for cleaner technologies and energy efficiency. It is reported that Clean Energy Development Bank (CEDB) has provided loan to VSBK entrepreneurs.

12.4 Technology Providers and Local Initiatives

The brick sector in Nepal is operating in informal conditions. There is no such formally established entity as technology provider in the sector. However, as a strategy of the SDC supported VSBK project to locally anchor the VSBK technology, MinErgy has been evolved with the initiatives of the ex-project staff as an organization to work in the sector. It is involved in promotion of energy-efficiency measures (such as internal fuel green brick making, coal substitution) in different types of prevalent brick firing technologies. It is also active in providing technology services for construction and operation of different types of brick kilns including skill training of human resources.

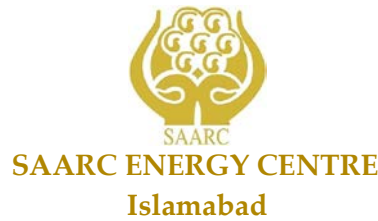
The EU-funded SCP project has a strategy to capacitate and utilize supply chain actors to provide technology services to VSBK entrepreneurs. According to SCP, so far two technical persons (one civil overseer and one civil engineer) have been developed as supply chain actors to construct the VSBK units.

An organization called PACE Nepal Pvt. Ltd. is being operated in the field of industrial energy efficiency, productivity, energy auditing and environmental monitoring. It has done a baseline of different industries for NEEP among which brick kiln is one of the industrial sectors.

MCBTK and FCBTK entrepreneurs heavily rely on kiln supervisors, masons and firemasters (mainly coming from India) to construct and operate their kilns. These technology providers usually gain skills through experiences and skill transfer from the experienced ones than the formal training. Often the skill transfer and experiences are not copied correctly resulting into higher energy consumption and often a major contributor to a failure of establishment.

An organization called Innovative Machineries has recently manufactured a green brick moulding machine for the first time in Nepal. With few adjustments, it also has a potential to produce hollow bricks and introduce internal fuel practices during green brick making process. Internal fuel is a technique in which dust fuel (coal or waste having energy value) is mixed in soil during green brick moulding. This technique has the proven results of 16% less fuel consumption (Prajapati, 2009). This company has a plan to carry out applied R&D on semi-mechanization for controlled coal feeding (fuel injection) to increase energy-efficiency and improve occupational health conditions in fixed chimneys. The study result showed that incomplete combustion in BTK is responsible for 5 to 10% energy loss (TERI, 2001). This incomplete combustion in BTK can be tackled through mechanized controlled coal feeding and can also contribute to reduced occupational health hazards (which is a major concern for BTK).

BrickClean Network (BCN) is an informal network of NGOs working in the brick sector, particularly within the brick kilns, in different disciplinary areas such as on child labour,



living and working conditions, health and hygiene, work-place security, discrimination and violence, energy and environmental performance and animal welfare. BCN is particularly active in consumer awareness and policy advocacy aiming to make brick kilns more socially responsible.

12.5 Donor Supported Projects and Programmes

An overview of activities being implemented by different projects, programmes and organizations for promotion of energy efficiency in brick kilns are given in this chapter.

Within the framework of bilateral development cooperation between Nepal and the Federal Republic of Germany, “Nepal Energy Efficiency Programme” is being implemented since 2009 jointly by the Water and Energy Commission Secretariat (WECS) and German Technical Cooperation (GIZ). Under the industrial energy-efficiency improvement, one of its three components, NEEP supported the establishment of Energy Efficiency Centre (EEC) under the umbrella of the Federation of Nepalese Chambers of Commerce and Industry (FNCCI). The main areas of activities are awareness raising for Nepalese industries (including brick sector), facilitate energy-efficiency services through training of energy auditors and financing through financial institutions.

With support from the of Renewable Energy Nepal Programme (RENPN), managed by Kathmandu University and financed by NORAD, a local organization called MinErgy is promoting coal substitution in brick kilns by charcoal produced from forest waste. Apart from the fuel substitution, MinErgy is planning to promote internal fuel in all the brick kilns based on the positive results obtained in VSBKs in Nepal and FCBTKs in India and Bangladesh. It intends to carry out demonstration in show-case brick kilns as well as create awareness for wider dissemination. This is possible given the fact that majority of brick kilns in the Kathmandu Valley operate semi-mechanized pug-mill to prepare soil for green brick moulding.

European Union, under the Switch Asia Programme, launched “VSBK and Other Sustainable Construction Practices - SCP” in 2012 which will last for three years. This project has the strategy to work through service providers in order to provide technical assistance to achieve the outputs of additional 35 VSBK units. It also has the mandate to capacitate service providers in order to achieve the outputs.

International Finance Corporation (IFC) are carrying out energy efficiency study, training and certification to energy auditors, and training to financial intermediaries. It is carrying these activities for general industries but not particularly on brick kilns.

The general awareness on needs and benefits of energy-efficiency has been created with many donor-supported projects and programmes. The technology transfer of VSBK and fixed chimney technologies in Nepal have been done through the donor supported programmes such as SDC supported VSBK Programme/Nepal and DANIDA supported ESPs.

12.6 Government Agencies

Government agencies are primarily responsible for setting and implementing the policies. The government institutions for governing and regulating the brick kilns are the Department of Cottage and Small Industries (DCSI) under the Ministry of Industry, Commerce and Supplies (MoICS) and Ministry of Environment (MoE).

Brick kilns in Nepal are mostly registered as cottage industries under the jurisdiction of DCSI of the MoICS. DCSI is responsible to verify and make decision on license application after verification of Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA)⁴ as per the requirement. A no objection letter from the village development committee (VDC), on the behalf of local community and local government administration, is required as a first step for license application. The monitoring of brick kilns in response to complaints of environmental impact is the responsibility of DCSI. DCSI also has a mandate to make recommendations to the Industrial Promotion Board (IPB), which is a decision making body to devise policy on investment and incentives for industries.

Ministry of Environment (MoE) is a regulatory body in relation to environment protection and pollution controls also for the brick sector. MoE is the authorizing agency to issue different pollution and emission standards and monitor accordingly to ensure the compliance of the standards. As set in Environment Protection Regulation – 1997 by GoN, the SPM emission standards in 10% oxygen reference condition, for prevailing technologies are as follows:

- For VSBK - 400mg/Nm³
- For FCBTK and MCBTK – 700mg/Nm³

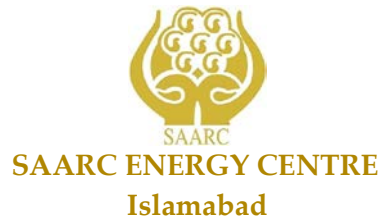
Industrial Energy Management Project (IEMP) under Government of Nepal (GoN) is carrying out energy audit training and awareness campaign for brick entrepreneurs to shift from MCBTKs to more environment friendly brick making technologies. VSBK, fixed chimney or tunnel kiln are the cleaner technology options approved by GoN.

There is no specific implementation programme being done by GoN except for the donor-supported programme in which GoN are the bi-lateral agreement partners.

12.7 Brick Entrepreneurs' Associations

Entrepreneurs in the sector have organized themselves into associations. The VSBK entrepreneurs are organized under the VSBK Entrepreneurs' Association while the registered FCBTK and MCBTK entrepreneurs under the district level Brick Entrepreneurs

⁴IEE required for brick industry with annual production capacity of 20 million units or less; EIA required for brick industry with annual production capacity above 20 million units



Association. The district associations are then federated in the Federation of Nepal Brick Industries (FNBI).

The VSBK Entrepreneurs' Association is carrying out VSBK technology promotion activities. The Federation of Nepal Brick Industries (FNBI) has recently formed a sub-unit called Technology Research and Development Committee (TRDC) to carry out different activities related to improved energy efficiency, reduced pollution and other pertinent issues of the brick sector.

13 Barriers of the Private Sector for Investment

This chapter describes on the barriers that private sector faced for investment on energy-efficient technologies. The analysis is based mainly on the perceptions of stakeholders from interviews and secondary information.

13.1 Investment Environment and Capacity

Normally higher investment is required for adoption of energy-efficient technology. Entrepreneurs are hesitant for higher investment and have concerns on favourable environment for investment security due to political instability. Due to unfavourable investment security environment, entrepreneurs are more inclined towards the investment where shorter pay back period is preferred compare to other financial and economic parameters. The higher initial investment and lower returns of VSBK compare to FCBTK has been one of the key factors for entrepreneurs in Nepal not to preferred VSBK despite of being energy-efficient, cleaner and economically profitable (Winrock, 2011). Similarly, the Hoffman Kiln, despite being introduced over forty years, could not be disseminated at larger scale due to high upfront investment. The financing constraint is likely to affect any efforts to introduce lower-emission, higher-efficiency kilns (e.g., Hybrid Hoffman Kiln-HHK and Tunnel Kilns) that cost 10 times or more than FCBTK (World Bank, 2011).

13.2 Enabling Policy for Investment

Even though the investment is high with longer pay back period, the return on investment (ROI) for VSBK is 40% showing that even running a VSBK is profitable. Hence, without stringent energy-efficiency and environmental emission policy and regulatory enforcement, it is obvious that the investment on efficient technology is less likely to happen when the ROI for MCBTK is 135% and for FCBTK 80% (Heierli and Maithel, 2008).

Most of the current policies on brick sector do not differentiate between energy-intensive and energy-efficient technologies. The policy incentives to encourage investment on energy-efficient technologies are often lacking. Even when there is such favourable policy, the access to such incentives are cumbersome and the mechanism to implement such policy is not yet in place. One of the practical issues often raised in implementation of such policy are weak coordination among different government institutions since different government agencies have different roles and responsibilities. Absence of regular monitoring by Ministry of Environment (MoE) is another issue that impede proper implementation of favourable

policies. Such as brick entrepreneurs who perform better in terms of energy-efficiency could not enjoy the benefits of 50% exemption in license fee, as promulgated by the budget of fiscal year 2008/9, in absence of certified monitoring results.

13.3 Financing

The financial institutions and banks do not consider brick kiln as an industry and hence do not provide commercial or industrial loan with competitive interest rate. Most of the entrepreneurs have ownership on limited areas of the land, mainly for the kiln structure, and they tend to lease land for other requirements such as for green brick moulding, stacking and storing. In the case of kilns established on rented land, entrepreneurs cannot use land as collateral to access commercial loans to invest in efficient technologies. Hence, most of the brick entrepreneurs have to access private lending and investment which do not encourage for higher investment on energy-efficient technologies.

13.4 Confidence and Capacity for Technology Operation

The sensitive operational practices required for VSBK compare to FCBTK has been another factor for many entrepreneurs, mainly the existing BTKs, not to take VSBK as a viable option. Preference of FCBTK over VSBK after banning of MCBTK is also due to the fact that the operational practices for these two technologies are of similar nature. The complexity in operation and requirement for totally different operational practice would hamper the speed of change in technology.

The confidence of entrepreneurs for investment on efficient technologies is also determined by success of demonstration kilns in the initial technology transfer phase. This is experienced in the case of VSBK technology as lot of efforts were put together to overcome the perception of VSBK bricks as inferior quality perceived at initial stage.

The availability of and access to capable service providers also plays an important role in investment on efficient technologies. One of the reasons for success of VSBK at later stage is continuous supply of technical assistance and coaching along with capacity building in the production line. This is crucial while introducing changes in new technology as well as in the operational practices.

14 Experiences, Expertise and Best Practices

14.1 Key Successes and Lessons Learnt

The key successes and adhered lessons learnt in relation to activities on capacity building and promotion of energy efficiency are described as follows.

A number of effective implementation of favouring policies has contributed to promotion of cleaner technologies.

- The ban on MCBTK has come to an effect in 2003 in Kathmandu Valley and proposed FCBTK, VSBK and Tunnel Kilns as an alternative environmental friendly and energy

efficient technology. Almost all MCBTK operating in Kathmandu Valley converted to FCBTK after the government effectively enforced the ban on MCBTK. The effective banning of MCBTK can be considered as a key factor to improve air pollution in the Kathmandu Valley (brick kiln being 2nd largest polluter to 3rd largest polluter). The GoN calling for a ban on the MCBTK technology all over the country by end of 2011 and proposed FCBTK, VSBK and Tunnel Kilns as options will contribute substantially, if this is implemented and monitored effectively. The banning of MCBTK has been announced, however there has been no monitoring done to verify that this ban has been effective outside the Kathmandu Valley.

- GoN recognized VSBK technology is a non-wood based technology, therefore not requiring certification of forest distance. This is a step towards promoting efficient and cleaner technologies.

The technical support, financed through external funding agencies, has been instrumental in promotion of energy-efficient technologies.

- The technical support provided by ESPS/DANIDA as early as in 2002 has set a trend to discuss and transfer feasible technological options through professionals and experts.
- The energy-efficient and environment friendly VSBK technology has been successfully introduced, though faced lot of technical difficulties in initial phases, with establishment of 26 units till 2011 with the funding support of SDC.
- Due to a number of donor-supported projects and programmes, local technical and managerial expertise has been developed and many of them are active in the sector. The certain level of expertise has been gained by local expertise on energy-efficiency and cleaner technologies thereby having a space for easier entry for other new efficient and cleaner technologies. Local initiatives have been evolved for applied R&D in introducing smaller initiatives but having bigger impact of energy-efficiency and reduced emission.

The increased awareness level and local level lobbying against pollution has positive impact on change in technologies.

- Many local NGOs are creating awareness on hazards and impacts from pollutants emitted from brick kilns including other social and environmental issues. Lot of community pressures are created against pollution of brick kilns creating favourable environment for adoption of efficient and cleaner technologies.
- Because of pressures from different dimensions, including that of international influence to reduce local pollution, brick entrepreneurs are also looking for viable alternatives though with limited interests.

14.2 Key Issues and Lessons Learnt

Though there has been some success in attaining the energy-efficiency in brick sector, the desired pace has not taken place. Following are some of the key issues discussed pertaining to effective dissemination and adaptation of energy-efficiency in the brick sector. This chapter is based more on perceptions expressed during interviews and the analysis made in previous chapters.

Policy, Investment Environment and Investment Capacity

- Ineffective implementation of favourable policies (as listed in Table 12 under chapter 11.2 of this report) has been an important issue that does not encourage adoption of efficient and cleaner technologies. Many policies are in place that favours efficient and cleaner technologies, however few of them have been implemented effectively. The less effective example is a 50% exemption in license based on emission which is linked to the effective monitoring of brick kilns. Some of the impediments and barriers are discussed under chapter 13.2 of this report.
- Since the Department of Cottage and Small Industries (DCSI) under the Ministry of Industry, Commerce and Supplies (MOICS) is responsible to implement policies and promote industries, it is a strategic institution to promote energy-efficiency policies as well.
- Brick entrepreneurs have difficult access to commercial lending and have weak capacity to organize capital investment. Some efforts are being made these days to ease financing mechanism linked up with energy-efficiency and environmental performance such as accessing financing through Clean Development Mechanism (CDM). However, these efforts are still in early stage with lot of complexity and have not been able to gain confidence of entrepreneurs as viable upfront financing mechanism.

Long-Term and Phase-Wise Plan and Strategy

- Government does not allocate enough financing resources on technology development for improved energy-efficiency and environmental performance. The resources for such initiatives are depending largely on external funding sources. Hence, the government should play a key role in strategizing and effectively utilizing these supports for sector improvement by achieving improved energy-efficiency and environmental performance. This is particularly more important that entrepreneurs' representatives have limited access to participate and take ownership in designing the programmes hence resulting in less ownership of the main stakeholder investing on the change.
- Even though MoE has issued emission standards, the regular monitoring has not been done. The discussions related to pollution and emission in brick kilns are being correlated to energy-efficiency. There are number of efforts being put to make this sector more energy-efficient also in the light of energy crisis and rising energy cost. In this perspective, the long-term and phase-wise sectoral plan along with arrays of technological options and emission standards is lacking in Nepal. The emission standards need to be reviewed in light of the growing concerns over energy and environment. Any initiatives taken without giving long-term perspectives, which is most likely to happen in absence of long-term sectoral plan, create skepticism among entrepreneurs towards any change.
- In absence of proper planning and strategizing introduction of technology and phasing out of technological supports before the mastery on technology create mistrust towards technology and technology providers in the long run as well as putting the investments at risk.

Technology Services and Local initiatives

- Availability of capable technology service providers including capacity and interests of entrepreneurs to access these services has implications on the technology dissemination. The availability of skilled human resources to operate and manage new technology has been a key factor. This requirement is more crucial for adoption of operational practices as this contributes to huge energy savings apart from using efficient technology. There has been demonstrated results at the regional level (particularly in India and Bangladesh) that there are large variations in energy consumption and environmental emission within the operation same kind of technology. According to the report of Brick Kiln Energy Management Project in Bangladesh, 23% energy savings is achieved through different better firing practices in fixed chimneys (DA, 2009). Improved firing practices such as proper insulation in the kiln floor and surface, improved coal feeder cover, mixing of internal fuel in green brick contributed to this energy savings.
- Some of the good operational practices that have been regionally proven for improved energy-efficiency and environmental performance, particularly in India, are not yet tested and demonstrated in context of Nepal. However, attentions and resources are not given for demonstration and capacity building for smaller improvements in firing practices, either by government or by the projects supported by external funding agencies.
- While discussions are taking place around energy-efficiency and environmental performance in brick sector, little has been done on the ground level to demonstrate the solutions to the issues. This has created the tendency among entrepreneurs to defend their current practices, have become more skeptical of any initiatives to bring change. There has been less attention and efforts for the mitigation works at ground level.
- Brick entrepreneurs and local organizations are carrying out smaller applied R&D (such as mechanization for controlled coal feeding, coal substitution, internal fuel mixing) on their own initiatives to achieve energy-efficiency and reduce emissions. This is demonstrated by the fact that FNBI has established a sub-unit for this purpose and a private company is planning to carry out applied R&D on controlled coal feeding to achieve energy-efficiency. Furthermore, there are almost negligible resources allocated to encourage local level applied R&D geared towards improving operational practices and energy-efficiency. There is also lack of funding source and absence of mechanism to disseminate positive results achieved from applied R&D that could contribute to higher energy-efficiency at large.
- On the other hand, the culture of brick kiln entrepreneurs have not been developed to pay for professional services that will ultimately benefits them. There is also a tendency that entrepreneurs preferred to utilize cheaper technology providers to copy technology while failed to adjust/adapt to the local needs. Such practices are prevalent to copy the zigzag and forced draught techniques in FCBTK in absence of capable technical service provider. This has implications on higher energy-intensity and in some of cases the kilns were closed down due to technical problems putting the investment in risk. Hence, one

of the major obstacles for wider dissemination of new technologies is development and availability of capable technical service providers.

15 Economics and Cost Benefit Analysis

The analysis in this chapter is mostly based on secondary data and also based on reports in Bangladeshi and Indian context. This chapter focused more on economics and cost-benefit analysis on technological transformation and changes. Later part of the chapter also provides an analysis on savings on of energy and major environmental parameters.

15.1 Energy Savings and Environmental Improvement Potentials

A report of SDC estimated that the total annual potential for CO₂ reduction in the 26 VSBKs is amounted to 12 – 15,000 CERs or VERs (Premchander et al., 2011). VSBK Project Nepal estimated that if BTKs in the Kathmandu Valley are transformed into VSBKs, the reduction in CO₂ emission will be 100,000 tons per annum only for the Kathmandu Valley http://www.vsbknepal.com/fact_sheet/fact_energy.php. A baseline report of NEEP estimated (citing the reports from ESP) the potential savings for electricity and thermal energy in brick sector of 0% and 22.6 % (5,600.5 Million Kilo Calorie (MKCal) respectively (PACE Nepal, 2012). In the same report, citing the calculations from IEMP, energy saving potentials of 14.37% is estimated (ibid).

A Project Design Document (PDD) for a VSBK Clean Development Mechanism (CDM) project activity in Nepal was drafted in 2006 by Winrock Nepal. This PDD estimated a total reduction of 143,506 tons of CO₂ equivalent over ten years from the operation of 72 VSBK shafts in the Kathmandu Valley. There is no further information about progress about the PDD and CDM. It is reported that a mission in Nepal of KfW was recently concluded for assessing the carbon trading potentials. The report has not been public yet.

Heierli et al. (2007), assuming national brick production of 4 billion bricks per year, calculate that 275,000 tons of coal per annum would be consumed if the entire production was done with VSBK; the corresponding coal consumption for FC-BTK, MC-BTK and Clamp kilns would be with 404,000 tons, 484,000 tons with MC-BTKs and 762,000 tons, respectively. The following table (excerpts from Heierli et al (2007) shows the potential national savings both in terms of coal consumption and CO₂ emissions with the utilization of each type of kiln technology found in Nepal today (with the exception of Hoffman Kilns). This does not account for the diesel saved by the reduced transportation of coal from India and the associated CO₂ emission savings, which could accrue to some 9,000 tons if over 200,000 tons of coal consumption is avoided as in the case of a switch from MC-BTK to VSBK.

Table 12: Total Coal Consumption, CO₂ Emissions and Savings from Brick Production in Nepal



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	VSBK	FC-BTK	MC-BTK	Clamps
Energy consumption: MJ/kg brick	0.72	1.25	1.50	2.36
Energy per brick: MJ/brick of 2.2 kg	1.58	2.75	3.30	5.19
Coal consumption per brick of 2.2 kg	0.069	0.101	0.121	0.191
CO ₂ emission per brick in kg	0.170	0.249	0.299	0.470
Coal consumption for 4 billion bricks in tons	275,119	404,115	484,938	762,968
CO ₂ emissions for 4 billion bricks in tons	678,169	996,143	1,195,371	1,880,717
Saving in % if FC-BTK is baseline	-31.92%	0.00%	20.00%	88.80%
Savings in % if MC-BTK is baseline	-51.92%	-20.00%	0.00%	68.80%
Saving in % if Clamp is baseline	-120.72%	-88.80%	-68.80%	0.00%
Savings in tons of coal if FC-BTK is baseline	-128,995.21	0.00	80,822.92	358,853.78
Savings in tons of coal if MC-BTK is baseline	-209,818.14	-80,822.92	0.00	278,030.86
Saving in tons of coal if Clamp is baseline	-487,849.00	-358,853.78	278,030.86	0.00
Savings in tons of CO ₂ if FC-BTK is baseline	-317,973.20	0.00	199,228.51	884,574.58
Savings in tons of CO ₂ if MC-BTK is baseline	-517,201.71	-199,228.51	0.00	685,346.07
Saving in tons of CO ₂ if Clamp is baseline	-1,202,547.78	-884,574.58	685,346.07	0.00

Source: Heierli et al. (2007)

Note: Production of 4 billion bricks assumed.

15.2 Investment, Energy and Environmental Benefits of Technology Transformation

As discussed in previous chapters that similar and simple operational practices, production capacity, and lesser investment with shorter pay back and easily available technology providers are some of the key factors for the entrepreneur to choose the technological options. Brick kiln entrepreneurs and operators have experience with MC-BTK and they therefore find it relatively easy to shift to FC-BTK, which has similar operational procedures (PREGA, 2006). The wide acceptance of FCBTKs is mainly due to the fact that this technology is similar to MCBTKs in infrastructure and in operation. Since this technology is widely popular in the neighbouring states of India as well, technical support, if required can be brought in cheaply from Indian FCBTK kilns. Entrepreneurs also see a scope of further improvements in its energy and environment conditions through retrofitting interventions such the zig-zag and natural/forced draught firing, usage of fuel as internal fuel, better insulation, controlled feeding, etc which have already been proven and is in practice in neighbouring India and Bangladesh. According to a study in Bangladesh, about 23% of fuel saving is possible in FCBTKs from these simple interventions. The technology is easily understandable and acceptable to entrepreneurs who had been previously operating MCBTKs, hence they can be convinced even by simple demonstrations and small technological supports. The following analysis on energy and environmental benefits against the investment are carried out. Information on newer technologies such as Hybrid Hoffman Kiln (HHK) and Tunnel Kiln are taken from the reports of Bangladesh and India.

Table 13: Analysis of Investment and Impacts of Technology Change in Brick Kilns



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Base Data	Cost (NPR millions)	Energy Consumption (MJ/kg of fired brick)	Environmental performances (g/kg of fired brick)					
			SPM	PM _{2.5}	SO ₂	CO	CO ₂	Black Carbon
FC-BTK	2	1.22	0.86	0.18	0.66	2.25	115.00	0.13

Technology Transfer (assuming equivalent production)	Cost (NPR millions)	Energy Saving (MJ/kg of fired brick)	Environmental performances (reduction in comparison with FCBTK) (g/kg of fired brick)					
			SPM	PM _{2.5}	SO ₂	CO	CO ₂	Black Carbon
FC-BTK to VSBK ^a	9	22.1%	87.2%	50.0%	18.2%	18.2%	39.1%	98.5%
FC-BTK to Zig-Zag	1	8.2%	69.8%	27.8%	51.5%	34.7%	10.4%	69.2%
FC-BTK to IFC-BTK ^b	0.65	23.0%	80.0%	NA	NA	NA	20.0%	NA
FC-BTK to Tunnel Kiln	80-160 ^c	-20.5%	63.9%	0.0%	-9.1%	-8.9%	-44.3%	~100 %
FC-BTK to HHK	40 -80 ^d	45.1%	70.9%	NA	NA	NA	26.1%	

- Data from GreenTech (2012), UNDP (2012), BKEMP (2009) and World Bank (2011)
- a - assuming equivalent production
- b "IFC-BTK" refers to Fixed Chimney Bull's Trench Kiln with efficiency improvements
- c including kiln, dryer, drying shed, extruder
- d including kiln, mechanical extrusion system and dry tunnel The probability of negative figures for tunnel kiln is mainly due to use of energy for drying green bricks and mechanical extrusion which otherwise are done through natural solar energy and hand moulding in case of other technologies.

16 Recommendations

Following recommendations are proposed based on suggestions provided through interviews and the analysis done in the previous chapters.

- The phase-wise long-term sectoral plan should be prepared in participation and consultation with the major stakeholders. As mentioned in the baseline report of NEEP, ESPS recommended payback period of three years as a criteria to determine feasible options of energy-efficiency (PACE Nepal, 2012). The strategy to use criteria, preferably in participation of major stakeholders, to decide on the feasible options for energy-efficiency could be an objective way of defining the phase-wise long-term sectoral plan.
- Support local level applied R&D gearing towards energy-efficiency and environmental performance such as control coal feeding. Similarly, promote mechanism that support capacity building of local technology service providers.
- Support promotion of hollow brick that has high potentials for energy savings and lesser emissions along with appropriate policy. The hollow brick has the potential of saving soil as well as the fuel for firing resulting in less emission. There has been no programme implemented so far for promotion of hollow bricks. As the hollow bricks are not commonly used, the consumer awareness should be included in the support programme for increasing use of hollow bricks in the market. The common practice of hand moulding can be a major barrier for its promotion as mechanized green brick production would be required for hollow brick moulding.



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Islamabad

- Support entrepreneurs to link with financial institutions to reduce entry barriers for higher investment on cleaner technologies.
- Support to simplify the favourable policy implementation mechanism in order to provide better access for entrepreneurs to policy incentives related to energy-efficiency and environmental performance.
- Create more favourable policy, particularly on financial and investment security, for the energy-efficient and cleaner technologies.
- Support demonstration projects as show-cases for wider dissemination, especially for the technologies that are successfully tested at the regional level.
- In addition to the cleaner technologies, support adoption of improvements in operational practices that have energy-saving and better environmental performance potentials. The improved FCBTK with best practices already has proved its potential in Bangladesh which saves up to 23 % energy (Brick Kiln Emission Management report) with a low investment and high energy efficiency.
- Apart from the operational and technological improvement, support wider dissemination of already proven coal-substitution and internal fuel mechanism. The opportunity can be utilized created by the directive from the Central Bank of Nepal (Nepal Rastra Bank) for commercial banks to keep ten percent of their loan portfolio in the renewable energy sector, which has been designated a priority sector by the Government of Nepal.
- Study on feasibility of advanced energy efficient technologies like HHK, Tunnel Kiln on Nepali context with modifications matching the need and demand of potential entrepreneurs.

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PART C- Annexes

Annex-1

TERMS OF REFERENCE

PRG-34/2012/PETREN

“Consultancy Study on Evaluating Energy Conservation Potential of Brick Production in SAARC Countries”.

Project Background and Objectives

1. Background

The demand of energy around the world is growing in an immense pace. Increased energy demand for sustainable socio-economic development & increasing scarcity of resources, volatility of market and the awareness against the adverse affects of green house gases, has strongly influenced the World in general and South Asian region in particular to opt a strategy in all sector of economy. Energy Efficiency & Conservation is a least cost option to meet the increasing energy demands. Being energy deficient region it is imperative to set goals for use of energy & energy intensity to increase the resources and reduce cost of production, increasing affordability and minimize the effects on climate change.

2. Efficiency Leads to Sustainability.

SAARC Region security of supply as regards oil, coal and gas in particular has been weakened in the long term because domestic reserves in entire region are being exhausted, because the remaining reserves are concentrated in relatively few countries and regions, providing an additional market challenge. World is continuously becoming more energy efficient, but SAARC countries are relatively inefficient, which is evident through its high energy utilization per unit of Dollar GDP. Rapidly depleting natural resources and climate change awareness will result in tougher global legislation on how countries consume energy resources. With diminutive effort SAARC countries can also reduce emissions by increasing efficiency in day to day operations by using new energy efficient technologies. Brick industry within the SAARC region is the third largest consumer of coal after power plants and steel industry. It is estimated that the Indian brick industry alone consumes about 20 million tons/year of coal, consumes approximately 10 million tons of coal.

County	Estimated brick consumption / capita / year	Estimated annual production (billion bricks per year)	Estimated coal consumption for brick in million tons/year
India	100	100	15-12
Pakistan	100	15	10



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Bangladesh	50	6	2
Nepal	40	1.14	0.16

There is hardly any technological advancement in the brick industry in the SAARC Countries in spite of efforts to induce private sector participation by endorsing enabling policies across the region, the private sector has until recently not showed any strong interest in making energy efficient brick production through coal, due to a variety of market barriers or conditions that are not very transparent.

3. Consultancy Objective

The region is in the grip of a serious energy crisis that is affecting all sectors of the economy and various segments of the society. SAARC Energy Centre (SEC) is seeking an Energy Experts to support in developing and “Evaluating Energy Conservation Potential of Brick Production in SAARC Region”. The purpose of this assignment is to contribute & further understanding of the energy efficient techniques in order to reduce the cost of production, efficient utilization of fuel and market in the region, as a result assisting in the development and expansion of the market through the implementation of the report recommendations, which will be published and disseminated to all SAARC members states.

4. Term of Reference

The study will be carried out in major brick producing SAARC Member countries namely Bangladesh, India, Nepal and Pakistan. The Expert will develop strategy for efficient use of coal in brick industry; outline the objectives, priority areas, best practices, countries technologies, for improvement of the sustainable market. Specifically, the expert will carry out the following tasks:

- Executive Summary
- Introduction & Background
- Scope of Work
- Methodology
- Economic & industrial condition
- Social & Environmental Impacts
- Identification of relevant institution, activities for capacity building for promotion of energy efficiency in the sector
- Mapping of active stakeholders in the market, covering financiers/investors, technology providers
- Identify and Analyze Barriers of the Private Sector for investment
- National Coal Policy & present situation of coal industry
- Environment Policy for Brick Kiln (if any)
- Experiences, expertise and best available practices for sharing with other member states
- Economic & Cost benefit Analysis
- Recommendations



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- Any other information which member states may like to share for preparation for final report.

5. Methodology

SEC may engage short-term experts from region having far-reaching experience of industry. The experts may be selected by SEC as per technical requirements of the study. The study report will be reviewed by SEC as per technical requirements of the study. The study report will be reviewed by SEC professionals and suitable expert(s) from the region. Final report will be printed and circulated to all member states and it will be uploaded to SEC website for wider dissemination.

6. Time frame and Schedule

The consultant should be available from 20 July 2012 until after the completion of the report. Preliminary scheduling of a number of key milestones is listed below with the fixing of precise dates after each stage is implemented. Email would be the preferred mode of communication with SEC and all involved in the Study.

ACTIVITY	DATE
Announcement for selection of consultant in SEC website	20 July 2012
Appointment of consultant and signing contract with SEC	30 July 2012
Submission of draft Report	30 Sep 2012
First Peer Review of Report	20 Oct 2012
Second Peer Review of Report	20 Nov 2012
Printing & uploading of Report	20 Dec 2012

Note: the above is a preliminary estimation of the duration of the consultancy

List of Persons Interviewed

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Evaluating Energy Conservation Potential of Brick Production in SAARC Countries”

SAARC Energy Centre, Islamabad

Key Questions and Checklist for the Study

The following key questions are the checklist in line with the key tasks that the study has to complete. These questions are also the guidelines for the study team to fulfill the proposed study on “**Evaluating Energy Conservation Potential of Brick Production in Nepal**”.

Methodology

Given the time and budget constraints, the information collection and analysis will be done based on secondary sources (to the possible extent from published reports). Information derived from interviews and consultations with concerned government agencies, brick kiln entrepreneurs and their associations can also be utilized to substantiate the analysis. The set of information through interactions and interviews would be representative than of statistical significance. The likelihood of discrepancies in available secondary data from different sources is high. Hence, this limitation has to be considered in analysis.

Key stakeholders and actors to be consulted

- Government agencies responsible to govern brick kilns, environmental and energy issues
- Brick kiln entrepreneurs and their associations
- Projects and programmes supported by external funding sources such as bi-lateral organizations, international organizations etc.
- Technology and service providers

Following are the key questions and checklist under the broad heading to carry out the study:

Economic and Industrial Conditions

Share of the sector in the economy

- How many brick kilns are there in the country?
- How many bricks are produced annually?
- How many bricks are consumed annually?
- What is the share of the sector in GDP?
- What is the growth rate of the brick industries (sector)?
- What is the growth of the brick consumption?

Investment in the sector

- How much investment has been made in the sector?



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- How much cost is incurred in energy/fuel for brick production?
- How much cost is incurred in labour for brick production?
- What are the other major costs of production?
- What are the major economic issues in the sector?

Employment of the sector

- How many people are employed according to type of works?

Energy consumption in the sector

- What are the major energy issues in the sector?
- What is the annual coal consumption in the brick industries?
- What are major types of fuel used?

Technological status in the sector

- What are the major and prevalent technologies for brick firing?
- What are the economics and energy and environment performance of these prevalent technologies?
- What are the production capacities of these technologies?
- What is the status of prevalent technologies in terms of market shares in the sector?
- What is the dissemination status of different technologies?

Social and Environmental Impacts

Health and Social Impact

- What are the impact on health on workers and surrounding communities?
- How is the performance of different technologies on occupational health and safety aspects (such as Respiratory Particulate Matter-RSPM, heat stress)?
- What are the social issues prevalent within brick kilns? (e.g. child labour, seasonal migration, working conditions)?
- How is the working environment within brick kilns (basic facilities, water, sanitation, shelter)?
- Impact of social environment within brick kilns?

Environmental Impact

- What is the annual CO₂ emission from the brick industries?
- How much the brick kilns contribute to air pollution and environmental hazards, specifically, SPM (Suspended Particulate Matter), PM₁₀, SO₂, NO₂)?
- What is the share of brick industries in CO₂ emission in Nepal?

Policy Frameworks

Legal Procedures

- Who are the major government institutions for governing and regulating the brick kilns?
- What are legal procedures for establishing and operating brick kilns?

Environment Policy for Brick Kiln



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- What are the acts and policies in relation to environment issues in brick kilns?
- What are the specific policies, emission standards for brick kilns?
- What are the emission standards for brick kilns?
- What are the policy incentives for energy efficiency and better environment performance?

National Coal Policy and Present Situation of Coal Industry

- What are the major policies related to coal and coal supply?
- How many coal industry or coal suppliers are there?
- What are the issues related to coal industry and/or supply?

Actions for Improvement

Identification of relevant institution, activities for capacity building for promotion of energy efficiency in the sector

- Who are the current institutions involved in capacity building and promotion of energy efficiency?
- What are the current activities, projects and programmes being implemented for promotion of energy efficiency?

Mapping of active stakeholders in the market, covering financiers/ investors, technology providers

- Who are the active actors, stakeholders in this sector and what are the major roles they play in the sector?
 - Financial institutions, investors
 - Technology providers
 - Donors/Projects
 - Government agencies

Experiences, expertise and best available practices for sharing with other member states

- What are the key successes and issues in relation to activities on capacity building and promotion of energy efficiency?
- What has been done so far or what are the initiations taken so far in the sector for energy efficiency?
- What are the key lessons learnt and challenges of different initiations?
- What are the best available practices that can be replicated in the country and other countries in the region?

Barriers of the Private Sector for investment

- What are the key barriers for investment by private sector or brick kiln entrepreneurs on cleaner technologies?
- What are the key barriers in terms of investment, technology availability, know how, capacity and policy environment?
- How these barriers have been tackled so far and how it can be tackled in the given context?



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- What are the needs and interests of private sector on energy efficiency?

Economic and Cost Benefit Analysis

- What are the cost involved for technological changes for energy efficiency?
- What are other cost involved for changes towards energy efficiency?
- What are the environmental and social benefits of technological changes?

Future Recommendations

- What could be the effective strategy for efficient use of coal in brick industry with energy, environment and economic perspectives?
- What could be the objectives, priority areas, best practices, technologies for sector improvement for the sustainable market?