SAARC ENERGY CENTRE
Islamabad

EVALUATING ENERGY CONSERVATION POTENTIAL OF BRICK KILNS IN SAARC COUNTRIES

December 2012

Disclaimer:

This study is conducted by Techno Green Associates with support from the South Asian Association for Regional Cooperation (SAARC) through SAARC Energy Centre, Islamabad. The contents of this report are the responsibility of Techno Green Associates - Pakistan, and do not necessarily reflect the views of SAARC or any of its member countries.

Pakistan

Efficiency Leads to Sustainability

ACKNOWLEDGMENT

This study is compiled from sets of interventions made by the professionals of Techno Green Associates, in quest of improving the brick sector in Pakistan.

Encouraged by the patronage received from SAARC Energy Centre Islamabad, the author has strived to gather energy conservation literature available from regional and national experiences. Deliberate effort was made to remain focused on the scientific and practically achieved results with a view to evaluating the data held, facilitating to unfold energy conservation potential in the brick sector of Pakistan.

However the views expressed in this study are solely those of the author and do not necessarily represent the views of the SAARC Energy Centre or Techno Green Associates.

The magnanimous technical and financial support extended by SAARC Energy Centre Islamabad is gratefully acknowledged with the expectations that short comings in the study will be ignored with a view to capitalize the vision already conceived at the centre, treading a way forward to improve upon the energy efficiency of the brick sector and transforming the livelihood of kiln workers providing decent work environments in Southeast Asia.

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Acronyms/Abbreviations

AERC	Applied Socio-Economic Research Center
AJK	Azad Jammu and Kashmir
BISP	Benazir Income Support Program
BTK	Bull's Trench Kiln
CNICs	Computerized National Identity Card
CRCs	Child Rights Committees
DVCs	District Vigilance Committees
EEBP	Energy Efficient Bricks Production Programme
EFA	Education for All
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
FBS	Federal Bureau of Statistics
GHGs	Green House Gases
GoP	Government of Pakistan
HRCP	Human Rights Commission of Pakistan
IEE	Initial Environmental Examination
ILO	International Labour Organization
IPR	Intellectual Proprietary Rights
KPK	Khyber Pakhtunkhwa-Province of Pakistan
NEQS	National Environmental Quality Standards
NGO	Non Governmental Organization
NIC	National Identity Card
PAHs	Poly aromatic hydrocarbons
PILER	Pakistan Institute of Labour Education and Research
PPM	Parts per million
PRSP	Punjab Rural Support Program
RSPN	Rural Support Program Network
SDC	Swiss Agency for Development and Cooperation
SDPI	Sustainable Development Policy Institute
SKAT	Swiss Resource Centre and Consultancies for Development
SPARC	Society for the Protection of the Rights of the Child
T.B	Tuberculosis
ToR	Terms of Reference
TGA	Techno Green Associates
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund

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Executive Summary

The energy security is imperative for sustained progress and growth of any country especially for the emerging and developing economies in the South Asian region where the natural resources are scarce and fast depleting against the yawning energy demand. Four out of eight SAARC countries are highly populous and so is their energy needs. Bangladesh, India, Nepal and Pakistan share

many common facets of culture, traditions and needs based upon the regional similarities, yet present a canvas displaying different colors and shades of population, economic growth and the geographical areas. Each one of these four countries is striving hard towards sustainable growth to become an honorable member amongst the comity of nations providing better life standards for their people. The economic growth is dependent upon the availability of energy which is mostly imported amongst these countries, in the shape of fossil fuel. The spiraling prices of fossil fuel are the biggest challenge to the growth rate, resultantly the energy conservation and renewable energy becomes the focus areas within the region. The SAARC Energy Centre, Islamabad has aptly recognized the challenge and taken up a study on, "Evaluating Energy Conservation Potential of Brick Production in SAARC Countries". This report is based upon the data collected from Pakistani brick kilns as such is Pakistan specific, like other three countries are preparing their own reports, which all will be mutually exchanged to evolve a regional approach on energy conservation for the brick sectors.

The objective of this study is to contribute and further understanding of the energy efficient techniques in order to reduce the cost of production, foster efficient utilization of fuel and in the region, as a result, assisting in the development and expansion of the market through the implementation of the recommendations made in the report, which will be published and disseminated to all SAARC members states.

Brick making is a centuries old practice which is popularly followed for producing affordable and durable construction material. Our part of the world is the home of the famous Indus Valley civilization that is well known to have 'invented' baked bricks by using firewood that in turn caused extensive deforestation, quoted, as one of the causes of the decline of the Indus Valley civilization. In Pakistan the volume of the brick industry has been estimated through market sources according to which there are about 12000 brick kilns which are operational throughout Pakistan, these include Clamps, Moveable Chimney Bulls Trench Kilns (MCBTK) and predominantly the Bull's Trench Kiln (BTK), all of these types are energy intensive as compared to the alternate kiln technologies offered as Hoffman Kiln (only one reported), Vertical Shaft Brick Kilns (VSBK, only three are reported) and Modified Bull's Trench Kiln (Mod BTK, Indian version, only one reported). The geographical spread of these assorted kilns is, 4500 in central-upper Punjab, 3500 in rest of the Punjab, 3000 in Sindh and Baluchistan (combined) and around 1000 in Khyber Pakhtunkhwa. In Pakistan, it is estimated that 59 billion fired bricks are yearly produced through different types of kilns, using different kinds of fuels and fuel mix like indigenously produced lignite coal, rice husk and other agro waste, beside rubber tires, plastics and varied industrial waste, producing highly toxic gases. It is estimated that brick kiln sector consume almost 40% of the total extraction/mining of around four million tons of locally produced coal, i.e. 1.6 Million tons per annum.

Techno Green Associates having single largest database on brick kilns has utilized it, compensating for the meager resources allocated for the study. Earlier TGA had monitored about one hundred and ten kilns and its results such as coal consumption, the firing techniques adopted, the interrelation between type of coal and soil etc were analyzed to find the energy conservation potential in Pakistani Brick Sector. It is envisaged that by simply adopting the better and disciplined firing drills, administering appropriate quantity of coal reduced to the right size and allowing needed flow of air

for proper combustion can conserve about 30% of coal. Introduction of firing technologies alternate to traditional kilns such as BTK and Clamps have potential of yet another saving of 30% to 40% of coal.

These potential savings can be materialized through institutionalizing the sector, providing organized and skilled training to the kiln workers, introducing construction bye-laws for the kiln “designed structure”, enforcing emission standards specific to the brick kilns. These challenges can be met through creating awareness amongst masses, inducing a political will and awarding incentives to the forth-coming entrepreneurs.

Energy conservation and pollution control are interrelated -- the key to controlling combustion related pollution in brick industry lies in increasing the efficiency of fuel use in brick kilns. The combination of energy saving and reduction in pollution is a win-win situation, in which industry benefits because of savings in energy costs, better working conditions; and the country and society gain due to reduction in pollution as well as savings of precious natural resource available in the form of natural fuel.

The study has provided a deeper and focused look into the brick sector of the Pakistan with a renewed vision to analyze the current situation of the brick industry, evaluating the un-explored potential on energy conservation in kiln sector The need to adopt the energy conserving firing techniques, using alternate energy efficient technologies and studying the kiln emissions in order to propose guidelines for bringing energy efficiency in the sector, is now the call of the day.

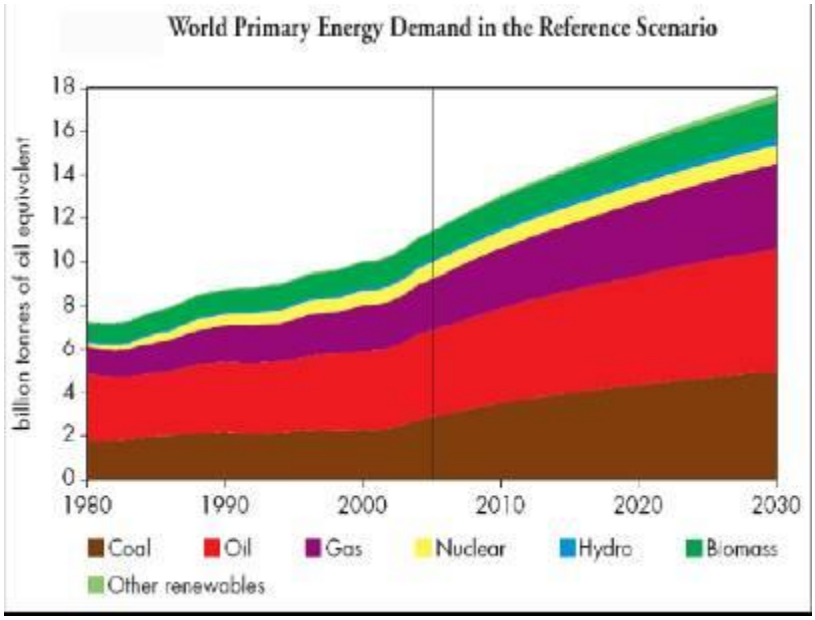
The study also perceives potential for in-depth technical specific energy audits and foot printing research work of the various types of traditional brick kilns to quantify the energy losses and recommend energy efficient methods and technologies for local adaptation.

1.0 Introduction and Background

The fast depleting, fixed reserves of fossil fuel and the ever increasing energy demand has generated the concept of energy security for the globe wherein the countries in the north have evolved a strategy to explore sources of alternate energy and simultaneously remain on the constant lookout to develop ways and means to efficiently implement their energy security plans through innovative building designs, home appliances, introducing new building materials, adopting procedures and techniques in the processes thus conserving energy. These all efforts are strengthened by framing regulatory frame work.

The global energy crisis is posing an economic and security threat to almost all countries of the world unifying the comity of nations to cooperate and evolve a strategy to meet the challenge by exploring renewable energy resources and also to adopt technology options which are energy efficient. SAARC member states are no exception these challenges and are also facing energy crisis. The increasing gap between availability of resources versus energy demand call for timely and adequate actions.

Fig no.1.1



Amongst all the energy sources, coal dominates the energy mix in most of the developing countries, and its continued use is expected to increase dramatically in the coming years. Brick industry within the SAARC region is considered as third largest consumer of coal after power plants and steel industry. The SAARC Energy Centre Islamabad has aptly identified the sector and correctly taken a timely step of undertaking the study, “Evaluating the Energy Conservation Potential of Brick Kilns” in four of the SAARC countries.

This study was conceptualized by SAARC Energy Center (SEC) to be undertaken by four SAARC countries to explore the energy conservation potential of brick sector. M/S Techno Green Associates, Islamabad Pakistan was entrusted to conduct the study specific to energy conservation potential of brick sector in Pakistan. Similar studies are being carried out simultaneously in three other major SAARC member countries, namely, Bangladesh, India and Nepal.

Bricks are the basic building units found throughout the SAARC region and used in various shapes and types for making shelters. Brick Production through firing in a kiln arrangement is centuries old

technique, in the history known to mankind. The modern day brick production has been advanced yet the primitive types of brick production practices are still observed in the SAARC region. The study is based on a thorough research on the brick kilns and the various technologies used for production of bricks in Pakistan. The current study is aimed at presenting an overview of the brick kilns in Pakistan to help identify the gaps by evaluating the brick sector and frame recommendations to capitalize the energy conservation potential, improving the working environment through adopting better production practices and safeguarding the environment. Interestingly the energy mix in Pakistan is no different to the world primary energy, as shown in Table-1.2

Table 1.1: Consumption of coal by sectors

Year	Household		Power		Brick Kilns		Cement		Total (000 metric tons)
	(000 metric tons)	Share (%)	(000 metric tons)	Share (%)	(000 metric tons)	Share (%)	(000 metric tons)	Share (%)	
2001-02	1	0.0	249	5.7	2,578	58.5	1,581	35.9	4,409
2002-03	1	0.0	204	4.2	2,607	53.3	2,078	42.5	4,890
2003-04	1	0.0	185	3.0	2,589	42.7	3,289	54.2	6,065
2004-05	–	–	180	2.3	3,907	49.5	3,807	48.2	7,894
2005-06	–	–	149	1.9	4,222	54.7	3,343	43.3	7,714
2006-07	1	0.0	164	2.1	3,278	41.5	4,451	56.4	7,894
2007-08	1	0.0	162	1.6	3,761	37.2	6,187	61.2	10,111
2008-09	1	0.0	113	1.3	3,275	39.0	5,002	59.6	8,390
2009-10	–	–	126	1.5	3,005	36.9	5,008	61.5	8,139
2010-	–	–	97	1.3	3,004	38.9	4,617	59.8	7,717
Avg. 10 years		0.0		2.5		45.2		52.3	

Source: Ministry of Petroleum Natural Resource & Hydrocarbon Development Institute of Pakistan

Brick usage is a function of the development stage and can be safely vouched as one of the indicators of development in Pakistan's context. Respected anthropologist Leslie White's theory of assessing cultural development through energy usage and trend towards energy conservation and efficiency is quite applicable in the context of brick making. He outlined a theory that the measurement of energy consumption of a society is an indication of a society's advancement through the formula C=ET where E is a measure of energy consumed per capita per year, T is the measure of efficiency of technical factors utilizing the energy and C represents the degree of cultural development.

Pakistan is also the home of the famous Indus Valley civilization that is well known to have 'invented' baked bricks by using firewood that in turn caused extensive deforestation. There are references that quote deforestation (or environmental degradation) due to extensive brick making as one of the causes of the decline of the Indus Valley civilization.

Energy is the life line of present day world. The natural non-renewable energy resources are the main source of energy to maintain this life line. They are available in abundance, are cheap, can be

used immediately and readily as such present soft sources of energy retrieval and thus are depleting fast. Renewable sources are less explored being expensive besides many other challenges. Almost 90% of the world's energy needs are met by the non-renewable sources like coal and natural gas.

Amongst the wide variety of technologies under development that might become available in the future, the focus remains on energy efficiency and conservation methods which could be adapted immediately for accelerated deployment at existing energy systems. The most affordable energy is the energy we can sequester and can be achieved by adopting energy efficient techniques within a system.

The under-developed and developing countries, alike, therefore have an opportunity to benefit by adopting energy conservation measures and saving their energy resources as well as exploring the opportunity to earn Carbon credits in the international market. It is estimated the Indian brick industry, alone consumes about 20 million tons per year followed by Pakistan which consumes approximately 2.0 million tons of coal. Technological advancements in the brick industry vary in the SAARC countries, India being the leader, followed by Nepal and Bangladesh. Pakistan and Afghanistan are at the bottom of the list, having poorest brick production conditions.

The current study would help identify the energy losses within the brick production systems in Pakistan and would provide recommendations to conserve the energy within the existing technologies as well as introduce newer and more energy efficient models for local adaptation.

2.0 Scope of Work

The detailed Scope of the Study is given in the Terms of References (ToRs) issued by SAARC Energy Centre, also provided in Anneuxure-1 to this report. Briefly the study is meant to provide detailed information on the following aspects of the brick kilns in Pakistan:-.

a. Economic & industrial condition
b. Social & Environmental Impacts
c. Identification of relevant institution, activities for capacity building for promotion of energy efficiency in the sector
d. Mapping of active stakeholders in the market, covering financiers/investors, technology providers
e. Identify and Analyze Barriers of the Private Sector for investment
f. National Coal Policy & present situation of coal industry
g. Environment Policy for Brick Kiln (if any)
h. Experiences, expertise and best available practices for sharing with other member states
i. Economic & Cost benefit Analysis
j. Recommendations

3.0 The Methodology

To explore the energy conservative potential of the brick kilns, it is considered imperative to first assess the present performance of the most popular brick baking system, the BTK technology which predominates the entire brick sector. Not withstanding with the other types of fuels being used at BTK, for tangible comparison, the study evaluated the single recommended source of energy i.e. indigenously produced coal. Present energy performance of BTK was easily examined from the data already held with TGA, which was collected earlier from 110 brick kilns spread over three provinces, namely Sindh, Punjab and Khyber Pakhtoon Khawa (KPK). The challenges to energy conservation as identified are enumerated as below:-

a. BTK is the most popular brick firing technology out of all traditional firing practices, besides the fact that it is highly inefficient on energy, a coal guzzler consuming 120 grams of coal per brick.
b. Poor quality of green bricks consumes more energy due to manual moulding inherited with large number of pours which pose hindrance in heat conduction thus producing inconsistent quality.
c. The managerial staff and the entrepreneurs neither have technical knowhow on energy conservation, nor have the inclined orientation.
d. Brick sector as whole is unregistered and undocumented facet of our industrial economy thus is introvert, isolated and ignorant of modern day innovations and improvements.
e. Institutional framework supporting brick industry for its development is yet not in place.
f. Brick kiln designs and construction is non-engineered and depends exclusively on masons (mistries) resulting in cracks and heat leakages.
g. Legislation, on kiln designs, quality standards for bricks, emission standards specific to brick kilns are nonexistent.

3.1 Approach Adopted

Focusing upon the objective of the study, to evaluate the energy conservation potential of the brick sector in Pakistan, it was envisaged to first analyze the type and amount of energy being consumed at the kilns, the methods / practices which are followed and identify the potential areas of improvement. The ever rising demand of energy coupled with its increasing cost renders energy conservation a momentous country need. Therefore to achieve the objective two prongs methodology is adopted as following:-

a. **Part-A**; Conduct an overview of the brick sector in Pakistan to recommend instant measures to be adopted.

b. **Part-B**; Evaluate the contemporary energy efficient brick kiln technologies leading towards sustainable energy conservation practices.

c. **Part-**C; Comments on renewable sources which can be integrated to reduce pressure on the natural resources. Cross cutting areas

3.2 Methodology

a. Primary Data Collection

This effort being the Pakistan specific, reliance is made on the primary information held which was collected by TGA over a period of time through key informant interviews

conducted with EPA, Punjab Small Industrial Corporation, Environment Protection Department Punjab, All Pakistan Brick Kiln Owners Association, Pakistan Medical Research Center (PMRC), Islamabad and an NGO named Society for the Protection of the Rights of Child (SPARC). The primary data collected from one hundred and ten kilns, spread over three provinces, already held with TGA was also utilized for the purpose.

b. Secondary Data collection

Secondary and tertiary information available from literature on similar studies and/or environmental studies conducted in the region was accessed. In addition the literature available with Techno Green Associates (TGA) from its former Energy Efficient Brick Production (EEBP 2008-2011) Project, the case histories and documented guide lines were validated through practiced tests conducted on ground at two brick kiln fields of Tarlai and Tarnol, respectively around the twin cities of Rawalpindi-Islamabad, Pakistan and recommendation for energy conservations were framed for prudent application.

Conduct of the Study

4.0 Part A - Overview of the Brick Sector in Pakistan.

Brick making in South Asia date backs to ancient times and has a history of almost four thousand years and so are the brick making practices adopted, with a little or no change to date. Green brick making and brick firing are the two distinct processes, each requiring specific parameters for quality production. Natural heat from sun is the main source of energy used to dry the green bricks and the process appears to be independent of energy issues yet the soil composition and quality of green bricks do affects the energy consumption indirectly. The process of brick firing is done utilizing fuels of varied kind, under assorted types of kiln technologies. In subsequent paragraphs, both processes are discussed in detail to explore the potential areas for fastest, cheapest and most environment friendly means to conserve energy within the Pakistani brick sector.

4.1 Green Brick Making

a. Manual Moulding

The sun being the primary source of energy is free and available in abundance, thus is used to dry bricks, as the practice. The primary data held reveals that about 99% of the brick kilns are producing green bricks through hand moulding, wherein the labour is engaged in family groups, involving children, women and male members. The moulding techniques are learnt by just watching the family elders, having no formal methodological concepts or training to produce the quality bricks with minimum of effort and fuel resources. The quality of a green brick is simply gauged from its geometric correctness. The fact remains validated that correct soil composition, its grain size and type do help in achieving the vitrification with optimal quantity of energy, the high percentage of lime and excessive moisture contents need additional energy to

decompose the calcium contents and evaporate the water content, respectively. Seasoned soil which is properly mixed and adequately matured before moulding will produce a denser brick which provide a good medium for uniform heat conduction. All these factors once combined together produce a denser, cohesive mass allowing quick and uniform heat conduction within the brick and are significant enough to be considered for conserving the energy.

Photos: Manual moulding of bricks using steel moulds

b. Machine Made Green Bricks

The primary information collected indicates that very few brick factories, less than even one percent (1%) tried to produce bricks through mechanical means like extruder or mechanical presses but remained unsuccessful due to different reasons, primarily the lack of holistic approach to adopt mechanization. Mechanically produced green bricks are denser, uniform in quality, have less wastage yet are not being impressed upon in this study because the energy slippage through machine operations may counter the energy conserved through denser and better quality green bricks

Photos: Locally manufactured extruder at on work

c. Internal Fuel Green Bricks (IFGB)

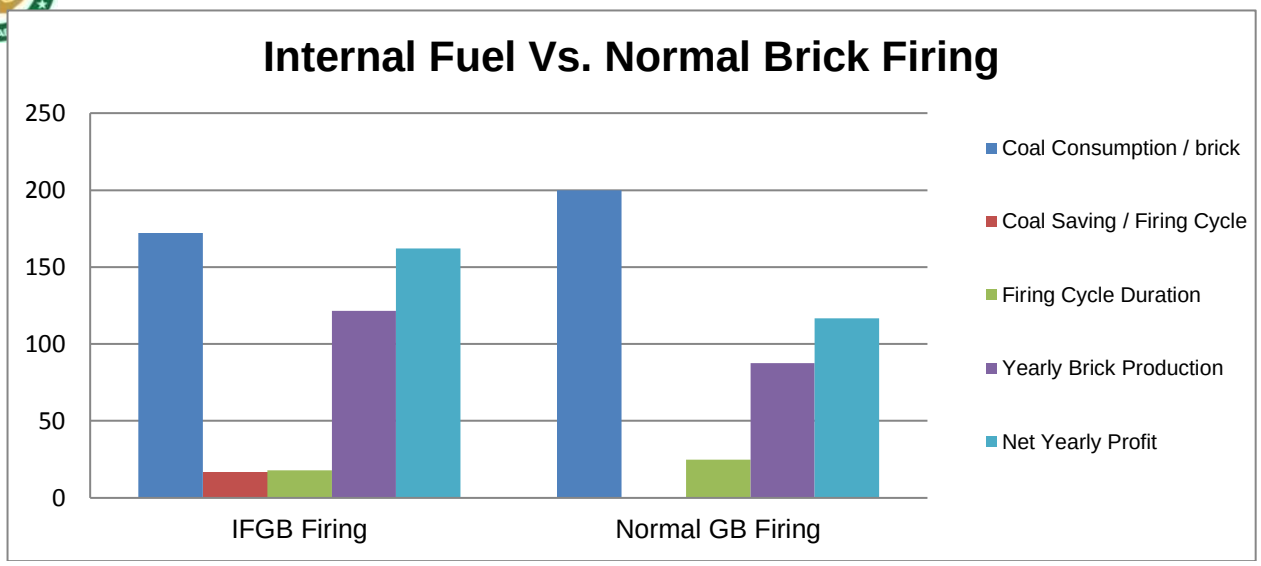
The secondary information available reveals that if fuel (coal) is reduced to a size of one millimeter or less and mixed with the soil, before moulding the bricks, it will help uniform sintering thus utilizes optimal fuel, making IFGB practice as a major source of energy conservation. This practice is widely followed in many countries especially in Vietnam and South Africa. However, the primary data collected from 110 brick kilns in Pakistan indicated that none of these even knew about IFGB technique. TGA decided to experiment and validate the practice before advocating and disseminating this technique to the national kiln owners. TGA conducted this practice at Punjab-Sarhad Brick kiln successfully, augmented with introducing better firing techniques; approximately 18% saving was achieved.

Techno Green Association (TGA) considered this technology for technical evaluation and potential improvement since any improvement within the existing BTK system, conserving energy and saving cost of fuel is readily accepted by the BTK owners, it was aptly considered that a small improvement could yield immediate and substantial environmental benefits keeping in view its economy of scale. However it remains as an interim measure till the time a better technology alternate to BTK is finally accepted on popular terms. A new technique on mixing the coal (fossil fuel) internally within the green bricks (IFGB) prior to firing in a kiln and developing firing drills ensuring optimal combustion was evolved as standard operating procedures for kiln workers, gave promising results in terms of coal savings and pollution reduction.

Table no. 4.1 Preliminary Results of IFGBs and Normal Brick Firing in BTK

BTK Firing	Coal Consumption / brick	Coal Saving / Firing Cycle	Firing Cycle Duration	Yearly Brick Production	Net Yearly Profit
IFGBs Firing	172 gm / Brick	16.8 Tons OR Approx. Pak Rs. 150,000	18 days	12.16 Million	16.21 Million
Normal GB Firing	200 gm / Brick	None	25 days	8.76 Million	11.67 Million

Fig 4.1 Comparison of Normal Green Bricks vs Internally Mixed Fuel Bricks



The trial production conducted by TGA was duly monitored by Environmental Protection

Recommended Soil Composition Chart						
Chemical				Grain Size		
SiO_2	Al_2O_3	Fe_2O_3	CaO	Clay	Silt	Sand

Department Punjab Pakistan and was found within the pollution limits set by the department. The existing practices in vogue at BTKs are yielding emissions much higher than the limits prescribed for the BTKs operating in the country. Coal was saved up to 18%, mitigating the emissions falling within National Environmental Quality Standards (NEQS) in addition the brick production of BTK increased by 40%. It is envisaged that this innovative technique will be accepted by the kiln owners, readily and immediately

d. <u>The Constituents of Soil</u>

Sort with high time contents needs higher temperatures i.e. more than 1000 C0 where as the soil having lime contents within the range of 1% produce good quality A- grade bricks at temperatures between 850 C0 to 950 C0. Similarly the tiny pebbles and stones disintegrate/ explode at vitrification temperature destroying brick structure wasting all the effort and energy consumed till that point.

Table no. 4.2 Recommended Soil Constituents of Soil for Brick Making

50-60%	**>20%**	**>3%**	**<1%**	**20-35%**	**25-45%**	**20-45%**

Photos: Anomalies like pebbles burst open the bricks

e. Moisture Content

Not a single kiln was reported where bricks were being inspected to to check the moisture content before these were placed inside the kiln. Higher moisture content need extra energy to evaporate the excessive moisture, this energy can be saved if bricks are dried to minimum moisture content using free energy from the sun. A maximum of 3% of moisture by weight can be allowed, which is achievable under natural sun.

Photo : Weighing bricks for moisture contents

4.2 Kiln Firing Techniques

a. Coal Stoking. Kiln firing, identifying the temperature range and maintaining the temperature with minimum possible fuel is the area which needs careful intervention for energy conservation. The brick making season falls in summer to utilize the freely available energy, under the scorching sun. The work environments are non-conducive due to very high temperature prevailing in the workplace. The fire men are neither knowledgeable nor trained to utilize fuel in an efficient manner. The prevailing practice of coal stoking employs a pair of firemen at a time, having larger scoop i.e. size of one kg more. The pair tends to over stoke the charging holes with a view to extending the time interval in between stoking periods. The natural, high speed draught of air containing oxygen is neither sufficient enough,

nor allows the time needed for coal to burn properly, supporting 100 % combustion. The system gets suffocated and jet black smoke, the un-burnt carbon is bellowed out of the chimney wasting the precious energy. The practice need to be revamped, the continuous stoking of small quantities of coal having size reduced to 2 cm will allow maximum combustion within the firing chamber.

Photos:. Using small scoop, “the Quetta bailcha”

b. Temperature Monitoring and Control. The optimal use of coal, conserving energy, can only be ensured if firemen establishes the required temperature and maintains it for the specified length of time so that vitrification of soil is completed. The compound obtained through two raw materials, the soil and the coal, need specific temperature range as per their chemical composition. Correctness of temperature is the fireman / fire master guess, who with his experience examines the colour of the fire, seen through the coal charging holes, determines the quantity and charging intervals. This judgment of the fire master, for any given kiln, soil and coal is established after wasting few hundred tons of coal and yet there appear many slips due to other variables. Any variation in the coal or soil quarry makes the established judgment vulnerable to disaster and this happens quite often, from chakkar to chakkar.

Soil and coal both items need to be tested for their needed physical and chemical properties, temperature range suitable for the compound is worked out, fire temperature is established and maintained, utilizing temperature gun and thermometer fixed at the chimney to administer coal charging.

Photo: Temperature gauge installed at chimney

Photo:. Temp gun recording stoking holes

c. Coal Supply Chain**.** Only indigenously produced coal by the brick sector in Pakistan having large reserves. The coal supply chain is a phenomenon by itself always

providing inconsistent quality. The coal after extraction is brought o sale dumps where it is blended with inferior coal at ratios varying during each mix, therefore the quality of coal even from the same mine differs with each supply load. Besides wastages and operational difficulties the high cost of transportation is significant enough to safeguard against these malpractices conserving energy and time.

Table no. 4.3. Standard Characteristics of Coal

Characteristics	**Moisture (%)**	**Volatile Matter (%)**	**Fixed Carbon (%)**	**Ash (%)**	**Sulphur (%)**	**Calorific Value Btu/lb**
Coal Specifications (VSBK)	1-2	15-20	35-45	25-40	1-2	8100-9900

Coal be selected from mines having deeper seams, specified coal characteristics needed for kiln firing, preferably located at the nearest distance to save upon the energy spent upon transportation. Overview of coal mines available in Pakistan, reflecting coal characteristics is given at Annexure "A"

Annexure A

Overview of Pakistani Coal Fields

Province/Coal Field	Seam Thickness (metres)	Reserves (million			Status	Coal Quality Proximate Analyses (in					Rank ASTM Classification	Heating Value (mmmf) Btu/l	Average Annual
		Total	Measured	Minable		Moisture	Volatile Matter	Fixed Carbon	Ash	Total Sulphur			
SINDH													
Lakhra	0.3-3.3	1,3	24		Develope	9.7-	18.3-	9.8-	4.3-	1.2-	ligB to	5,503	1,112,
Sonda-Thatta	0.3.-1.5	3,7	6	36	Non-	22.6-	16.1-	8.9-	2.7-	0.2-	SubC to	8,878-	-
Jherruk	0.3-6.2	1,8	10	64	Non-						SubC to	8,800-	-
Ongar	0.3-1.5	3	1	11	Non-	} 9.0-	20.0-	15.0-	5.0-	0.4-	LigB to	5,219-	-
Indus East	0.3-2.5	1,7	5	31	Non-		44.2	58.8	39.0	7.7	LigA to	7,782	-
Meting-Jhumpir	0.3-1.0	1	1	6	Develope	26.6-	25.2-	24.1-	8.2-	2.9-	LigA to	7,734	-
Badin	0.55-3.1	16	3	2	Non-						SubA to	11,415-	-
Thar	0.2-22.8	175,5	2,70	1	Non-	29.6-	23.1-	14.2-	2.9-	0.4-	LigB to	6,244-	-
BALOCHISTAN													
Khost-Shahrig-Harnai	0.3-2.3	76	13	8	Developed	1.7-11.2	9.3-45.3	25.5-43.8	9.3-34.0	3.5-9.55	SubB to hvAb	9,637-	227,784
Sor Range-Deghari	0.3-1.3	50	15	9	Developed	3.9-18.9	20.7-37.5	41.0-50.8	4.9-17.2	0.6-5.5	SubA to hvBb	11,245-	279,564
Duki	0.2-2.3	50	1	8	Develope	3.5-	32.0-	28.0-	5.0-	4.0-	SubB to	10,131	278,51
Mach Abegum	0.6-1.3	23	9	5	Develope	7.1-	34.2-	32.4-	9.6-	3.2-	SubA to	11,110	317,00
Pir Ismail Ziarat	0.4-0.7	2	2		Develope	6.3-	34.6-	19.3-	10.3-	4.0-	SubA to	10,786	384,10
Chamalong-Bala Dhaka	0.3-2.0	1	1		Developed	1.1-2.9	24.9-43.5	19.4-478.1	9.1-36.5	3.0-8.5	hvCb to hvAb	12,500-	NA
PUNJAB													

Salt Range	0.15-1.2	2	5	30	Develope	3.2-	21.5-	25.7-	12.3-	2.6-	SubC to	9,472	221,96
Makarwal	0.3-2.0	-	5	3	Develope	2.8-	31.5-	34.9-	6.4-	2.8-	SubA to	10,688	47,928
Khyber P. K													
Hangu/Orakzai	1	82	1		Develope	0.2-	16.2-	21.8-	5.3-	1.5-	SubA to	10,500	77,000
Cherat/Gulla Khel	0.3-1.2	9	0.		Develope	0.1-	14.0-	37.0-	6.1-	1.1-	SibC to hvAb	9,388-	36,060
AJK													
Kotli	0.25-1.0	8	1	-	Develope	0.2-	5.1-	26.3-	3.3-	0.3-	ligA to	7,336	-
TOTAL		185,1	3,30	1									2,982,

The kiln owner needs to develop his own procedure to obtain the quality coal. The kiln specific fuel needs to be designed for consistent quality and utilization of bio-waste, available in abundance, crop after crop, as renewable energy.

Table no.4.4 Bio-fuel Analysis Report

Ser	Fuel Type	Analysis Report					Calorific Value Gross
		Moisture	Ash	Volatile Matters	Sulphur	Carbon	
		%	%	%	%	%	%
1	Poultry litter	14.15	22.3	59.18	0.6	Nil	5745
2	Rice husk	Nil	Nil	Nil	Nil	Nil	6205
3	Bagasse	Nil	Nil	Nil	Nil	Nil	7130
4	Sugar Mill Mud	Nil	Nil	Nil	Nil	Nil	5475
5	VSBK Standard	1-2%	25-40	15-20	<1	35-45	8100-9900

d. Non-engineered Structure and Regular Maintenance**.** Leakage of temperature is common in BTKs from the firing zone, the top of firing bays and from the chimney cracks which are developed due to the fact that all of these kilns structures are non-engineered, built on turnkey basis by the masons/ brick layers, as kiln specialist. The concept of gravity settling chambers, baffle walls, the quantity and velocity of air within the system, the temperature of flue gases escaping the system, the required height of the chimney, the bearing capacity of the soil for compatible design etc are not known to the constructor and the owners alike which results in poor energy performance of the kiln which already is known for it higher coal consumption even all these parameters are looked after.

Photo: EPA monitoring stack emissions

Photo: Leakage cracks in chimney

The standard kiln designs need to be developed by qualified engineers, keeping in mind the geotechnical analysis, site layout, route in & out, drainage etc and with due considerations towards its thermal efficiency and structural safety.

4.3 Validation of Energy Conservation Potential in Existing System

Punjab – Sarhad rick Company located at Islamabad Expressway was selected to test run the composite model of brick making based upon the recommendations made above, to validate the energy conservation potential available in the existing system. The selection criterion for kiln was easy access for visibility, willing entrepreneur, and availability of utilities to experiment. One MoU was agreed upon to apportion the risk sharing components and IPR for TGA. Following factors were applied and results were recorded by a third party i.e. Environment Protection Department Government of Punjab:-

a. Green Brick Making. Soil was selected having suitable constituents as recommended; already quarried and seasoned soil was obtained. After mixing the internal fuel at given ratio, water was added and the mix was matured for two days, wrapped in polythene sheets. Moulders were trained on the technique for preparing soil lumps free of sand folds. Steel moulds for single brick were used. Sun dried bricks were weighed for moisture contents before stacking into the firing bays.

b. Coal Stoking. Coal lumps were reduced to a size less than two centimeters for complete burning by the time it reaches at the bottom layers. Smaller scoops for administering 750 grams of coal were used by “single fireman drill” for continuous feeding at shorter intervals.

c. Temperature Monitoring and Control. Temperature gauges and temperature gun were used to monitor the temperature for comparison with the one calculated as suitable for the soil and coal as being used followed by the visual inspection of the fire master. Temperature for each hole was recorded at three intervals, start of the stoking, in the middle and when recommended temperature was obtained, as per the table format given at Annex-B. The quantity of coal used was also recorded. Temperature of flue gases escaping from the chimney was also recorded for heat recovery potential.

“Annexure B”

Punjab Sarhad Brick Factory
Temperature and Quality Log

Met Conditions: Wind___ Humidity ___

Date	Line No		Charging Hole Nos.												Coal/ line (Kg)	Reading Time
			1	2	3	4	5	6	7	8	9	10	11	12		
27 June, 2012	Temperature	I	713			812				717				619	567 kg	6:10 am
		M	938			986				931				814		7:15 am

	1		**F**	997			1031				1044				1003		9:00 am
		Ring		M			M				M				M		
		Color		Y			Y				Y				Y		

Ring : (1) M- Metallic Sound (2) D- Dull Sound ; **Color** : (1) R- Red (2) Y - Yellow
Temperature: I – Initial; M – Middle; F- Final

d. Energy Audit**.** The potential could only be assessed if the baseline parameters are established for the prevailing technology and the practices. An "Energy Audit Performa" was developed to record and compare the results obtained after the intervention keeping raw materials identical, only refined techniques and drills were applied under scientific parameters. Energy Audit Performa is at Annexure C.

e. Recommendations. The Energy Audit conducted under above mentioned case study confirms that the one traditional BTK system has the energy conservation potential of 4.221 TJ per year, in terms of coal saving it is transformed as 184.2 tons of coal per kiln per year. This potential is recommended to be capitalized through introduction of above mentioned techniques, only the soft component. These are recommended for immediate adoption having high chances of success due to the fact that structural changes are not required, investment is negligible, training of green brick moulders and fire master can be arranged at site.

These recommended techniques are the fastest to adopt, least expensive offering most environment friendly solutions to meet the energy conservation challenges faced by the brick sector

ENERGY AUDIT at BTK

Name of the Unit: Sarhad - Punjab Brick, Lohe Bher, Islamabad

Start Date: **25 June 2012** **Completion Date: July 1, 2011**

GENERAL

TYPE of KILN	Green Brick Making		Brick Qualit 84		Average Produ
	Manual	✔	Class A	12	Daily
	Mechine		Class B	4	Cycle
	Mix		Class C		Yearly

SOIL

Test Re 10.94		Vitrification Type ✔		Moisture Content (MC)		Total Weight o
Calcium % 5.97		High Temp >1000C		Avge Wet Wt Kg:	3.0	Avge Brick Dry Wt:
Ferous O %		Med Temp 950-1000		Avge Dry Wt Kg:	2.85	Total No of Bricks:
Grain Size 64%		Low Temp <950C		Total MC Kg:	0.15	Total Dry Wt Kg:
a. Clay 21%		*The temp at which top of the*				***Here word wt is tak***
b. Silt 15%		*cone (base 15mm, ht 70 mm*				
c. Sand		*bends, on incline in oven.*				

FUEL

Test Results		Energy Used		Specific Firing energy-Case1		Specific Firing ene
GC V KJ/Kg:	23202	Wt of Fuel: Kg (Int+Ext)	35300	Wt of **a** Fired Brk:	2.75	Wt of **a** Fired Brk:
V M %:	41.76	Total Energy: KJ	819030600	No of Fired Brks	200,000	No of Fired Brks
Fix Carbon%:	32.15	Specific Drying Engy:	2,591	Wt of Total Frd Bks	550000	Wt of Total Frd Bks
Moisture%	4.85	Drying enrgy:	77730000	**Spsfic Firng Enrgy-1**	1347.8193	**Spsfic Firng Enrgy-2**
Sulfur%	2.38	Firing enrgy:	741300600			

5.0 Part B – Evaluation of Contemporary Kiln Technologies

The ever increasing prices of energy lead towards concept of smart technologies which are needed for instant adoption. The technology transfer process is not formidable yet is a time dependent challenge because of various factors such as non existence of energy oriented legislation, non compliance of the quality standards, ineffective governance and above all very strong inertia, apathy to change and replace old, outdated and underdeveloped infrastructure. The paradigm shift towards new and energy efficient technologies is possible only when there is political will and this concept becomes the key theme of national energy security plan and policies. Recognizing these grave and momentous impediments it is prudent to evaluate the contemporary energy efficient and smart kiln technologies and identify those which are compatible to the national socio-economic scenario and the local needs for ready acceptance by the stake holders in general and the kiln entrepreneurs in particular.

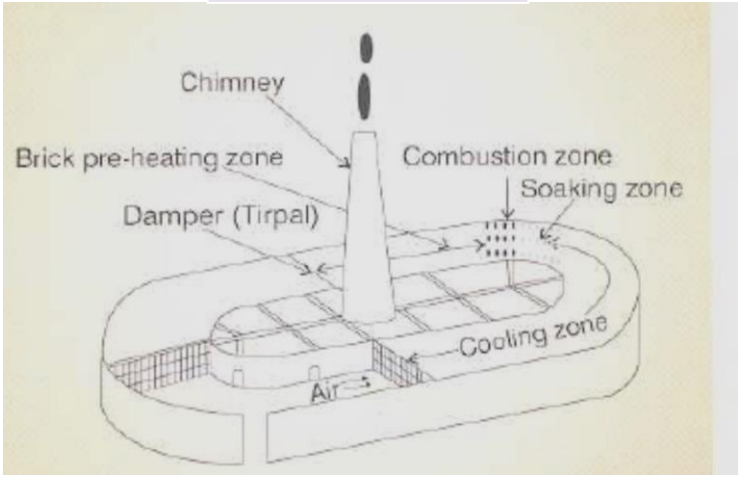
Brick sector predominantly uses only two raw materials namely fuel and soil. Despite the fact that varied type of fuel is used for brick baking yet the study is focused on one type of fuel which is recommended and legitimately allowed for use i.e. coal. Green bricks made of raw soil needs to be heated between 850^0C to 1000^0C in a kiln, the temperature at which the vitrification of soil takes place. The needed temperature range is decided as per the constituents of the soil. This process of vitrification is completed at the required temperature achieved through different kiln firing technologies which is classified in to two categories, the intermittent kilns and the continuous firing kilns. The “Intermittent Kiln” is made operational for each single load i.e. bricks are filled in, a new fire is set, bricks are baked, fire is forced to die out, once cooled the bricks are un loaded. A new cycle, with fresh bricks and new fire is started and for each new cycle additional energy is wasted to heat up the infrastructure. Hot flue gases escaping in to the atmosphere remain unutilized.

The “Continuous Kilns” are more energy efficient because of the continuous fire, the kiln structure is heated up only once, the heat available in different parts of the kiln is utilized efficiently before it escapes into the atmospheres. The hot flue gas are utilized to heat up the green bricks, on the other hand the heat available in freshly vitrified bricks is utilized to heat the air passing through these before entering in to the firing chamber helping the combustion and conserving energy. All contemporary kiln technologies are continuous type being energy efficient so will be discussed in subsequent paragraphs for evaluating their energy conservation potential, upfront cost, payback period and ease of handling with a view to recommending the most suitable technology within the Pakistani context.

5.1 The Bull's Trench Kilns (BTK)

During 19th century, one British engineer by the name of W. Bull, modified the Hoffman kiln for cheaper version where instead of constructing a supper structure for brick baking, a trench in the earth was dug, lined and stacked with green unbaked bricks which after the first firing cycle become a permanent trench. This technology still enjoys the status of most popular type of brick kiln in present day practice of brick making and called as the **Bull's Trench Kiln** (BTK). An oval trench is dug, 20–30 feet wide, 5- 6 feet deep, and 200–350 feet in circumference. A tall exhaust chimney with a height of 50 – 60 feet is constructed in the centre. Half or more of the trench is filled with "green" (unfired) bricks which are stacked in an open lattice pattern to allow airflow. The lattice is capped with a roofing layer of finished bricks and soil.

Fig.5.1: Sketch of BTK



In operation, new green bricks, along with roofing bricks, are stacked at one end of the brick pile; cooled finished bricks are removed from the other end for transport to their destinations. In the middle, the brick workers create a firing zone by dropping fuel (coal, wood, oil, debris, garbage, used tires, plastic etc.) through access holes in the roof above the trench. Sheet metal or boards are used to route the airflow through the brick lattice so that fresh air flows first through the recently burned bricks using the heat available, raising its temperature then entering in to the active burning zone thus conserving upon the energy. The air continues through the green brick zone (pre-heating and drying the bricks), and finally out the chimney, where the rising gases create suction which pulls air through the system. The reuse of heated air yields savings in fuel cost.

The BTK process is based upon continuous firing technology. Half a dozen labourers working around the clock can fire approximately 14,000–25,000 bricks a day. The BTK process allows the fire to move around the bricks which remain stationary since after loading inside the trench.

Fig.5.2:: Zones in BTK

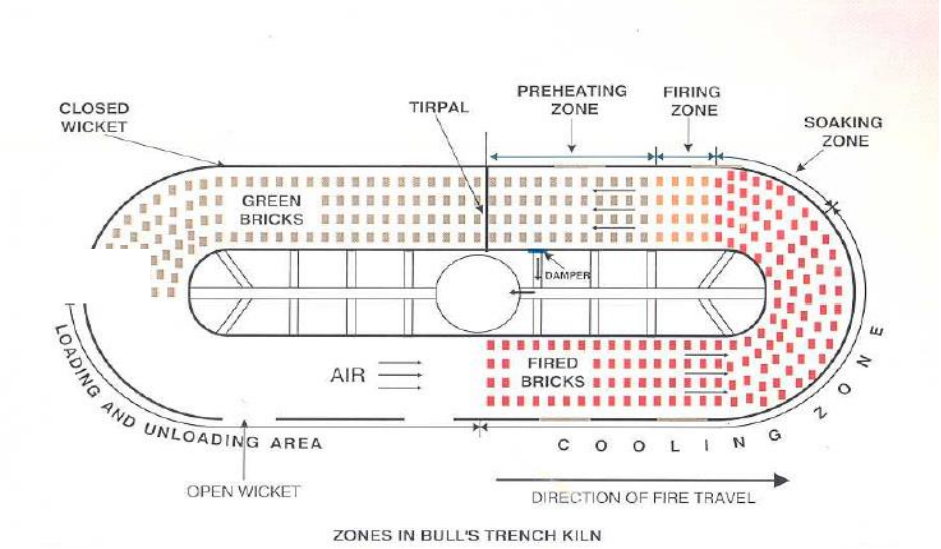


Table 5.1 Types of Brick Kilns in Pakistan

Size of Kiln	Average Production per day/ (Chakkar)	Type of Kiln	Fuel Used	Remarks
Small	5000 (1,25,000)	Clamps, Scove	Rice Husk, Bios waste, saw dust	Rarely used
Medium	14000 (3,50,000)	Clamps, MCBTK BTK	Wood, coal, tires plastic etc.	About 5%
Large	20000 to 25000 (500000 to 650000)	BTK, MBTK	Coal, tires	95%

BTK is the popular technology and so is thriving without any improvement; however the clamps and Mobile Chimney BTKs have already been phased out to negligible number. Besides it its easy operations the technology is resilient having following characteristics.

Table 5.2 Comparison of Energy Consumption between Clamp, MCBTK and Traditional BTK

Type of Kiln	Energy Consumption (MJ/Kg)	Chimney Height (ft)	Coal used Grams/ brick	Remarks
Clamp, Scove	1.2 – 1.75	-	-	Bio fuel only
Mobile Chimney BTK	1.2 – 1.75	12 - 20	250 -270	Bio fuel & coal
BTK	1.2 – 1.4	55 - 65	200-210	Coal

5.2 Modified BTK

Photo: Mod BTK of Dr. Sultan

The brick kiln owners do recognize the need and benefits of an energy efficient technology which may be an alternate to the existing traditional BTK but in absence of regulatory provisions, the unforeseen challenges and the risk involved in adoption of new technology, their initiatives are not forthcoming. One Pakistani entrepreneur by the name of Dr. Sultan has ventured in to the brick business introducing the modified design of BTK, developed by Priya Bricks India, in which the energy efficiency is achieved by controlling the air flow, improving upon the combustion and even distribution of the available heat. The structural design incorporates baffle walls, gravity settling chamber and increased chimney height as compared to traditional kin. The modified design also helps improving the fire travel rate from 16 ft per day to 20ft per day thus increasing the daily production. Since surface heat losses are time dependent, this helps in reducing the heat losses also. TGA also experimented the brick firing at Mod BTK constructed by Dr. Sultan near Burhan, Rawalpindi but could not accurately ascertain the energy efficiency, this being the first ever firing cycle at this Modified BTK.

However the data collected by TERI India, after monitoring the performance of two fixed chimney brick kilns, one of traditional BTK design and the other being the design developed and modified by Priya Kiln shows considerable energy saving as reflected in the table.

Table 5.3 Comparison of Performance of Two Fixed Chimney Brick Kilns by TERI India

	Traditional Kilns with traditional operation	Modified BTK with improved operation
Excess Air		
During Coal Feeding	No access air	100-150%
During Non Feeding	100-150%	200-300%
Daily Production	20000 bricks/ day	27000 bricks /day
Specific Fuel Consumption	24-25 tons/lakh bricks	18-20 tons/lakh bricks
Specific energy Consumption	1.35 MJ/Kg	1.1 MJ/Kg

Courtesy TERI; India

Mod BTK helps conserving about 5 tons of coal energy for one hundred thousands of bricks; the saving is substantial when it is converted into yearly profits. For a large size kiln, producing about 600,000 bricks in one cycle, about 30 tons of coal is saved, which also yields an added profit to the entrepreneur. The reduction in coal usage and improved operations reduce the emissions considerably, which will bring the Mod BTK within the limits of National Emission Quality standards as prescribed by Environment Protection Agency of Pakistan.

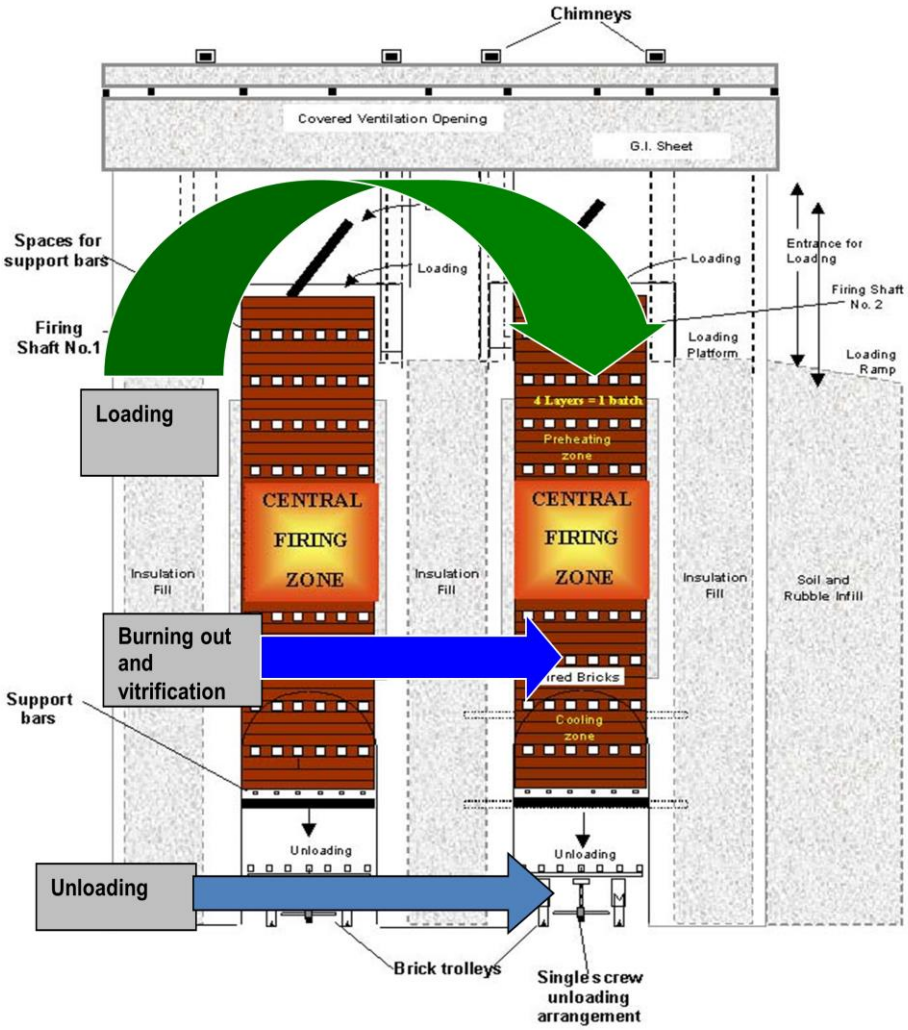
Photo: Iron shunt at Mod BTK

5.3 Vertical Shaft Brick Kiln (VSBK)

A Vertical Shaft Brick Kiln (VSBK) is an energy efficient technology to fire the clay brick. This technology originated in China and three, first generation VSBK were introduced in Pakistan by GTZ during early 90s, unfortunately the experience was not successful due to many reasons, later during year 2008 Swiss Development Corporation (SDC) launched the third generation VSBKs in Islamabad region. Third generation VSBK is an improved version having screw jacks as an unloading mechanism instead of chain & block arrangement, similarly the additional features such as, flue ducts, chimney, lid cover and thermocouples etc facilitates the operation and controls. It essentially consists of two rectangular, vertical shafts within the kiln structure. Rectangular arrays of dried green bricks and coal crushed to small size (2cm approx) are carefully stacked into batches, which are loaded into the shaft from the top and finally batches of fired clay bricks are removed from the bottom end. During this process, the batches of bricks pass through the preheating, firing and cooling zones before they reach the shaft exit within a period of 24 hours. This technology relies on the principle of counter heat exchanger in order to achieve high thermal efficiency. The entire kiln functions as a chimney when the shaft lid is in its closed position. The heating cycle for the green bricks is between 22-24 hours. A kiln with 2 shaft of 1.25m x 2m - produce upto 8000 bricks in a day, which equals to the annual brick production of around 2.5 million for 312 working days.

The VSBK technology considerably economizes on fuel consumption, with savings of between 30 to 50% when compared with other common firing technologies such as clamps or Bull's Trench Kilns. Pollution levels are extremely reduced compared to other prevalent methods of brick firing.

Fig.5.3: Schematic diagram of VSBK



SCHEMATIC DIAGRAM OF VSBK

VSBK bricks are suitable for all fired brick applications. Well-designed loading and unloading mechanism ensure uniform size, sharp edges and corners and less breakage during the production. These qualities make these bricks more suitable for exposed brick masonry and high strength load bearing applications. Wire cut extruded VSBK bricks with compressive strength upto 300 kg/cm^2 are ideal for such applications.

Requires less land for kiln construction unlike the horizontally spread in the BTK, VSBK requires vertical firing concept thus reduces the land requirement considerably

The batch type firing system gives an unmatched flexibility in production. It allows you to plan a precise production schedule with exact amount of bricks to be produced, depending upon the market demand. More than 90% of the bricks produced belong to 1st grade; where as in a BTK 2nd and 3rd grade brick are produced in significant quantity. Well designed loading and unloading system controls the breakage within 2-3% of the production.

5.4 Habla Zig-Zag Kiln

Alois Habla a German engineer invented the Habla Zig Zag Kiln. Its main characteristic is the long firing zone which is forced to move in zig-zag pattern through the stationary bricks, the draft is induced with the help of an axial flow fan. The technology allows even the most inferior fuels due to the long zig-zag firing zones. The heat available in the freshly burnt bricks is reclaimed and used to dry the green bricks before these are subject to firing zone. The low emission burning process helps mitigating the emission of green house gases.

The induced draft eliminates the need of chimney structure, which is quite expensive to built, thus the technology requires far less capital investment. Overall energy requirement for this type of kiln is very low, using less fuel for brick baking and almost negligible mechanical energy to operate the kiln. The kiln is capable of continuous operations for round the year. The flexible design can meet the requirements of small as well as medium enterprises.

For quality construction and load bearing walls the bricks need to have adequate load bearing and crushing strength which is usually difficult to achieve through short firing cycle, less cooling period as offered by VSBK and Tunnel.

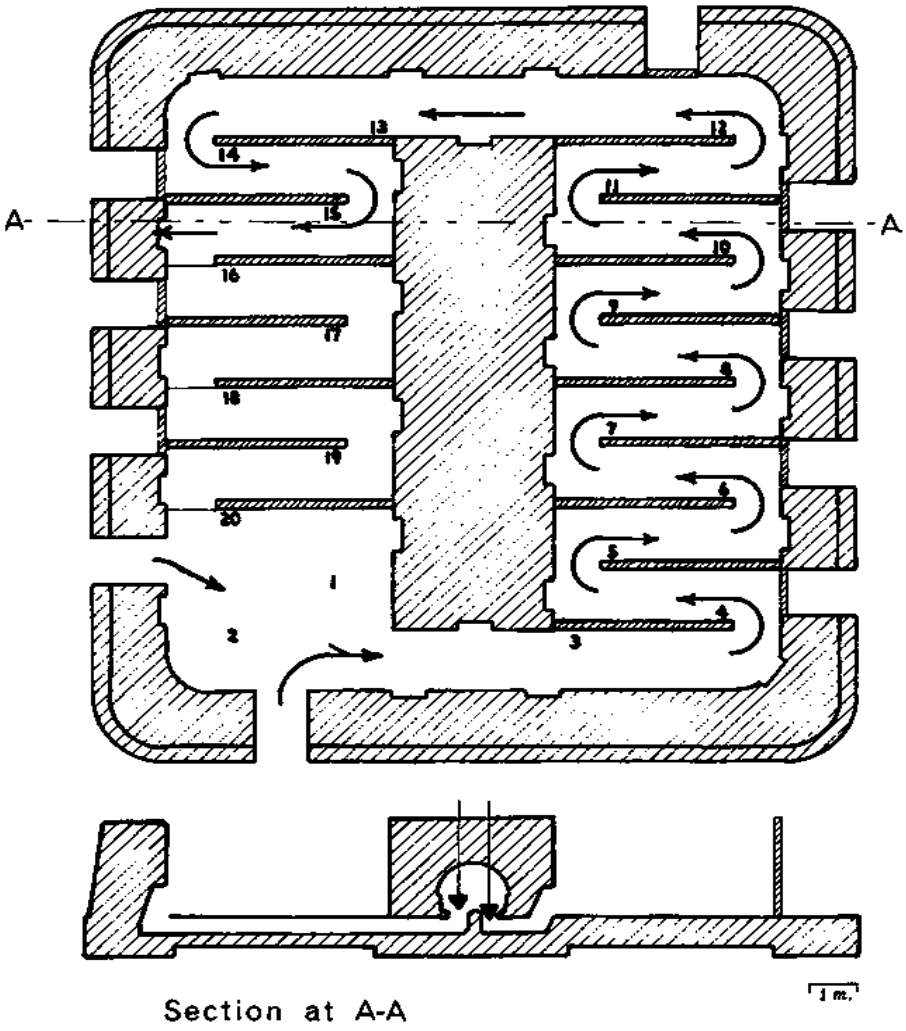


Fig 5.4: Schematic air flow in a Habla Zig-zag kiln

The initial investment for Habla Kiln is lower than its cotemporary technologies, kiln maintenance requirements are almost negligible, operation can be opted from semi- continuous to continuous with varying production sizes and above all its adoptability to cheaper inferior fuels while still retaining efficiency and low pollution grade this kiln as most suitable to Pakistani context.

The technology also offers good working and health conditions which can be significantly improved under cleaner working environments. The curse of bonded labour, for which brick sector is notorious, can be addressed to a certain degree because the employment is maintained and extended with the use of the roof in the monsoonal season during which kiln labour will not be dependent upon the extensive borrowing from the kiln owners.

Habla Kiln having, versatile nature to varied adopt production sizes, easy to maintain, flexible and low initial investment and above all, is reported as the most energy efficient technology can conserve energy if adopted in Pakistan. The technology has yet not been introduced in Pakistan.

5.5 Hoffman Kiln

Mr. Friedrich Hoffmann, a German, is the inventor of this continuous fire kiln, for producing building bricks which can also bake other ceramic products. It was also used lime kiln.

The classical Hoffmann kiln design consists of a main fire passage surrounded on each side by several small rooms each containing a pallet of bricks. In the main fire passage there is a fire wagon that holds the fire that burns continuously but in a room the fire is kept for a specific time, until the bricks are vitrified properly and thereafter the fire wagon is rolled to the next room to be fired. These rooms are connected to each other by a passageway carrying hot gases from the fire. In this way, the hottest gases are directed into the room containing the fire at that time. Then the gases pass into the adjacent room that is scheduled to be fired next. There the gases preheat the brick. As the gases pass through the kiln circuit, they gradually cool as they transfer heat to the brick as it is preheated and dried. This is essentially a counter-current heat exchanger, which makes for a very efficient use of heat and fuel. The dimensions of a typical Hoffmann kiln are completely variable, but in average about 5 m (height) x 15 m (width) x 150 m (length). This efficiency is a principal advantage of the Hoffmann kiln, and is one of the reasons for its original development and continued use throughout history. In addition to the inner opening to the fire passage, each room also has an outside door, through which recently-fired brick is removed, and replaced with wet brick to be dried and then fired in the next firing cycle.

Photo: Inside view of a Hoffman

Hybrid Hoffman Kiln is the improved version of traditional design, which stately consumes 50% less energy as compared to the traditional BTK wherein the technique of internal fuel green bricks is coupled with the energy efficient and improved heat chamber lined with refractory bricks, plastered with refractory material reduces the heat leakage considerably. Coal duly pulverized or in granular form is stoked through roof chambers. The infrastructure improvements alone contribute about 25% saving in coal.

Reportedly there were three attempts made to introduce Hoffman Kiln in Pakistan. Presently one, owned by Mr. Raheel, is operational near Rawalpindi but is unable to yield results as are quoted, primarily it is due to the inadequate supply of quality bricks. The initial capital investment is quoted as Rs70 million, working capital as Rs.60 million over an area of 10 acres. Indigenously produced lignite coal quantity 8-10 tons per 100000 bricks is being used.

5.6 Tunnel Kiln in Pakistan

Tunnel Kiln is a modern, state of the art kiln, which is yet to be introduced in Pakistan for mass scale production of clay brick which constitute the basic building material

A tunnel kiln is a long rectangular structure in which only the central portion is directly heated. From the entrance, bricks at atmospheric temperature, are slowly transported through the kiln, and its temperature is increased steadily as it approaches the central, hottest part of the kiln.

From there, its transportation continues and the temperature is reduced until it exits the kiln at near room temperature. A continuous tunnel kiln is the most energy-efficient, because heat given off during cooling is recycled to pre-heat the incoming bricks.

These kilns are designed to utilize electricity and more refined fuels, including natural gas and propane. The majority of large, industrial brick kilns now use natural gas, as it is generally clean, efficient and easy to control. Modern kilns can be fitted with computerized controls, allowing for refined adjustments during the firing cycle. A user may choose to control the rate of temperature climb or *ramp*, *hold* or *soak* the temperature at any given point, or control the rate of cooling.

Pakistan is having about 12000 brick kilns and unfortunately none is a tunnel kiln, almost all of these are the traditional Bull's Trench Kilns (BTK). Pakistan being committed to MDGs is cognizant of its polluting intensity; energy inefficiency intends to adopt an alternate technology replacing these polluting BTKs. Amongst various options one is considered to be as "Tunnel Kiln" which needs to be evaluated for its suitability and acceptability by the BTK owners. This study intends to find whether Tunnel Kiln is suitable and economically viable or not, as an alternate to BTK technology in Pakistan.
The detail investigations on equipment needed, its power rating required, the elaborate arrangements on green brick making under properly designed sheds and the construction of tunnel kiln with computerized process controls, all combined together sum up to a huge upfront cost besides the enormous working capital needed. A highly skilled and professional team dedicated for uninterrupted operations round the years is also essential to keep the kiln project economically viable. The analysis indicates that in Pakistan, the electric power supply system, non bankability of brick business and above all the lack of awareness and the "political will" to change, the time for tunnel kiln is yet not ripe and kiln owners will not accept it being not economically viable due to uncertain and non-conducive environments.

5.6.1 The Systematized Technology

The tunnel kiln project has two distinct portions like any other brick plant, one, is the green brick making segment and the second is the firing of bricks, both once combined together form a composite and holistic brick manufacturing process. Green brick making is equally important for which investment is required rather larger than the tunnel kiln itself.

Processing of green bricks involve soil quarrying, grinding, coal grinding, collection in box feeder and mixing through pug mills and finally the extrusion of

Photo: Bricks loaded on a fire wagon

required size cakes to be cut into proper length which are to be dried under a shed saving highly compressed green bricks from direct heat of the sun avoiding cracks and deformation.

Firing of clay bricks is done through kiln designed as a tunnel having firing zone and provides a continuous baking process at a temperature fixed keeping in view the nature of soil mix, but usually at a temperature not less than 950 ^{0}C…

The tunnel kilns which are operative in Pakistan are used for manufacturing of fire or refractory bricks and not for production of standard construction bricks. The raw material is brought in from the areas of Attock, Mianwali and Haripur. The brick making process and kiln operation requires a team of only ten persons to carry on the operations. Out of these ten, there is only one technical person who operates the kiln. The remaining persons are semiskilled, trained to perform the functions of green brick making and supporting the "kiln fire master" during the kiln operation. Bricks with rectangular shape are made on mechanical press and the hollow-circular bricks are made by hand die. The green bricks are dried in a shed, which also uses the heat recovered from kiln to dry and to some extent preheat the bricks. Green bricks are loaded on the trolleys by hand. Trolleys are pushed by hand on rails and after turning the trolleys in the kiln direction, they are pushed into the tunnel by a "pusher mechanism". The pusher mechanism is operated in a manner that trolley takes about three-four days to enter the tunnel kiln. This requirement is based on (i) time required for the bricks' firing, (ii) sudden push or a jerk may cause the green bricks to slip / fall down and get damaged.

Photo: Bricks loaded on a fire wagon

The kiln is gas Operated, takes about four days time to reach the desired temperature (approximately 1300 degree centigrade) in four days. Tunnel kiln, technically is not affected by weather conditions and can be operational throughout the year. The existing supply of natural gas is inadequate to operate the kilns to their full capacity because the gas would be supplied only for duration of six months in a calendar year. Therefore in this case the total number of days available is 180, making the project highly uneconomical. The kiln is fired from sides and therefore bricks are stacked on trolleys that allow hot air to pass through the brick layers in a direction perpendicular to the rail direction.

5.6.1.1 Process Flow

For commercial production of clay bricks as a building material the steps involved in processing clay fired bricks are given in Figure No.5.5 below;

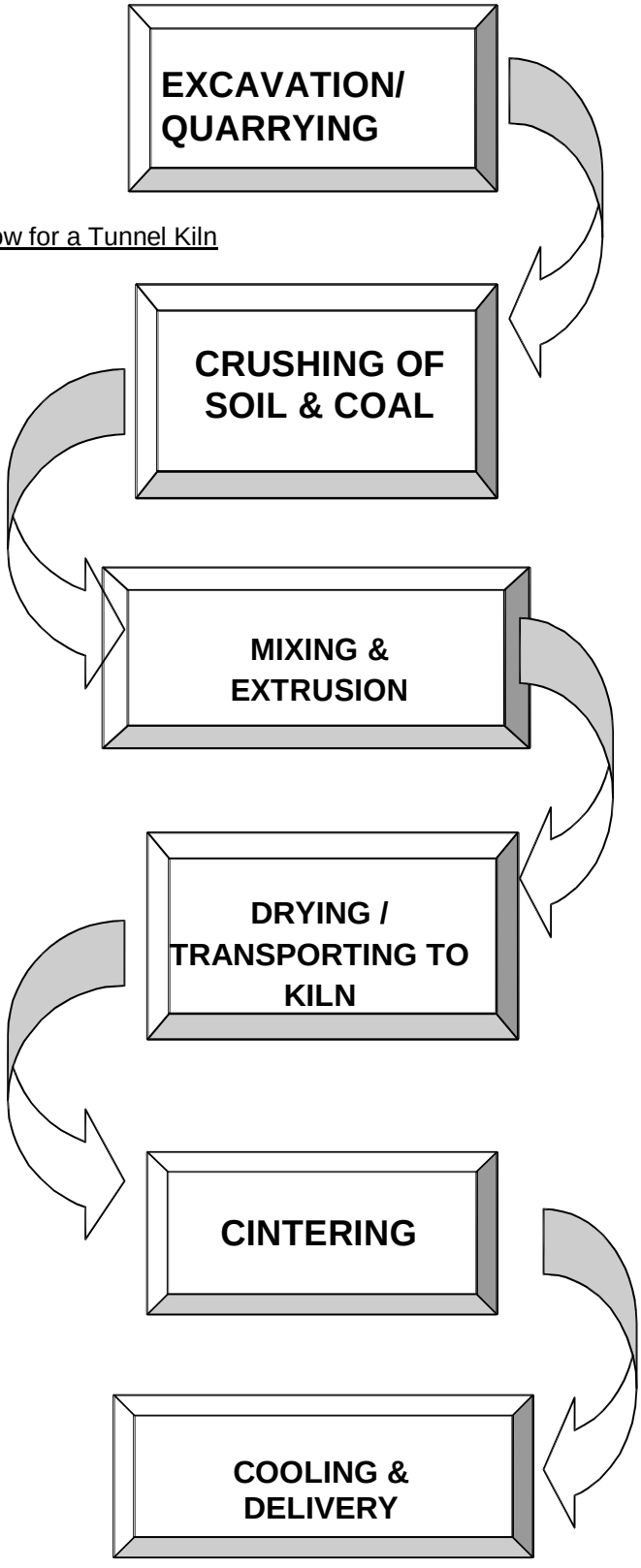


Figure No.5.5 Process Flow for a Tunnel Kiln

5.6.1.2 Green Brick Making Process

a. Soil Quarrying, Seasoning and Storage

Right kind of soil is quarried almost one season in advance so proper seasoning is allowed. The production capacity of the kiln dictates the quantity of clay needed to be quarried and stored in advance.

Photo: Seasoning of quarried soil

Photo: Seasoning of quarried soil

b. Soil Processing, Crushing Coal Mixing

Coal and soil both are crushed to grain size less than 1mm for homogeneous mixing and conveyed to a box feeder through conveyor belts having electric sensors which control the designed weights of each delivered to the box feeder.

Photo: Soil processing crushing

Photo: Soil mixing in a box

c. Extrusion of Clay Cakes and Brick Cutting

Soil after processed through the crushers, mixed with fixed quantities of water and coal is properly pugged and fed in to the extruder fitted with de-airing unit which extrudes out densely compacted clay beam and passed through a mechanical cutter for the required predesigned bricks.

Photo: Mechanical green brick making

Photo: Green brick extruder

d. Loading the Tunnel Kiln

Green bricks are placed on kiln trolleys are further dried with the help of hot flue gases being emitted from the kiln exhaust and after being completely dried the brick loaded trolleys are moved inside the tunnel kiln for sintering to take place.

e. Sintering Process

Soils once subject to high temperatures which is adequate enough to fuse the constitu nts make a crystalline structure which after cooling retains its hard structure. This process is called as sintering or vitrification of soil. Irrespective of the technology this process needs to be done but the technology controls the energy efficiency and environment friendliness of the process.

f. Cooling and Delivery

Bricks after gradual cooling are delivered to the customers

Photos: Fired bricks ready for delivery

5.6.2 Financial Analysis & Key Assumptions

The project cost estimates for the proposed "Tunnel Kiln" have been formulated on the basis of discussions held at Vietnam with industry stakeholders and experts. The projections cover the cost of land, machinery and equipment including office equipment, fixtures etc. Assumptions regarding machinery have been provided, however, the specific assumptions relating to individual cost components are given as under:

5.6.3 Machinery and Equipment Required:

Plant & Machinery	Quantity	Approx Cost	Accumulated Cost
Excavators	2	10,000,000	10,000,000
Soil and Coal Crushers	2	2,000,000	12,000,000
Box feeder and Pug mill	2	30,00000	42,000,000
Extruder & Wire Cake Cutter	1	40,000000	82,000,000
Misc Trolleys, wheel barrows etc,	-	500000	82,5000,000
Total			82,500,000

5.6.4 Summary of Land and Building Requirements:

Details	Size/Area (Sq. Ft.)	Civil Works /Construction Cost/Sq. Ft.	Total Construction Cost
Green Brick Production Area	120,000	250	30,000,000
Tunnel Kiln Area	2500	15000	37,500,000
Office & Staff facilities	2000	1000	2,000,000
Storage Area (Sand/Crush)	Not limited	-	0
Water Tank	8000	200	1,600,000
Other Services (water plant, tool shop	500	300	150,000
Total Covered Area			**85,650,000**

5.6.5 Human Resource Requirement

Construction and allied industry is a labor intensive industry; therefore, a total 23 persons will be required on permanent basis to handle the production operations:

(Pak. Rs.)

Staff Title	No of Persons	Monthly Salary	Annual Salary
1.Owner (Business Unit Manager)			
Production Staff (Quarry/Excavation Site)			
2. Operator Excavator	1	8,000	96,000
3. Dumper/Truck Driver	1	8,000	96,000
4. Helper/Labourer	2	8,000	192,000
Production Staff			
5. Green Brick Production In charge / Plant Operator	2	10,000	240,000
6. Assistant Production Plant Operator	4	8,000	4,80,000
7. Production Labourers	10	8000	9,60,000
Total Production Staff	**20**	-	**20,64,000852,0**
General Administration/ Selling Staff			
8. Office Assistant	1	5,000	60,000
9. Security Staff	2	10,000	120,000
Total G A /S Staff	**3**	**15,000**	**180,000**
TOTAL	23	-	**22,44,000**

5.6.6 Experience Requirement for the Staff

One to two year of experience on mechanized bricks making and tunnel kiln operation, would be necessary for the employees. It is also envisaged that preference should be given to literate persons so that they could understand the mechanical operations and significance of undertaking health and safety measures.

Table 5.4 Tunnel Kiln at a Glance

Sr. No.	Parameter	Criteria	Tunnel Kiln	
			Local	Remarks
1	Investment (Pak. Rs. Million) – all values estimated max.	Chimney	Pak. Rs. 450 million for a proper tunnel kiln.	The tunnel kiln visited in Vietnam is used for assorted production of clay items and therefore exact cost cannot be adapted towards a Pakistani model
		Other		
		total		
2	Production	Per day	150,000	
		Available days	270	
		Total Production	40,500,000	
		Grade “A” Bricks	90%	
		Saving in Grade “A” bricks	40%	
		Ready for sale (production cycle)	7 days	
		Time saving	23 days	
3	fuel	Coal quantity / 100,000 bricks	The kiln is coal fired and average consumption is 150 grams per brick.	
		Coal cost / 100,000 bricks (coal @ Rs. 4,500/ton)		
		Saving in coal cost		
		Energy Efficiency		
4	Labour	Technical	1	
		Support	9	
		Total	10	
		Training	minor	
5	Environment	Space / Land requirements	Horizontal – thereby more space required	
		Comparative Area Requirements for Actual Kiln	5 Acres	
		SPM	N.A.	
		CO2 emission per brick (kg CO2 per 1000 brick)	-	
6	Working conditions	Exposure to high temperatures	Nil	

The upfront huge cost, the annual expenditures on training and human resource development, once shared with brick kiln owners and market demand was discussed, it was evident that neither the market is ready to adopt such highly mechanized and high production factory. The fact remains that Tunnel Kiln is the need of the day having highest energy conservation potential, but neither the Pakistani market nor the public sector is ready to adopt this technology.

5.7 Comparative State of Kiln Technologies under Study

After having gone through the technologies and evaluating their advantages and characteristics a comparison in tabular form is appended below:-

Table 5.5: Comparative State of Contemporary Kiln Technologies

Traditional FCBTK	Modified FCBTK	Hoffman	VSBK	Habla / Zig-Zag	Tunnel Kiln
1. Expertise available in local market 2. Less capital intensive 3. Bricks may be of lower quality but acceptable in the market 4. No training required 5. Employment for more un-skilled labourers 6. Requires lesser number of technical persons 7. Training is not required	1. More production rate 2. Higher percentage of "A" grade bricks as compared to traditional FCBTK 3. Cycle completion-bricks ready for sale in 15 days which is 15 days less than traditional FCBTK 4. Can be developed locally 5. Environmental friendly – SPM and CO2 emissions are less than traditional FCBTB by using high Chimney 6. Workers less exposed to heat / adverse working conditions as compared to traditional FCBTK 7. Training is not required 8. High yield of "A" grade bricks as compared to traditional FCBTK	1. Supply of bricks is continuous and regular 2. Pre-heating of the bricks are done by hot gases before they escape into the atmosphere 3. Fuel consumption and stack emission is low 4. Bricks are burnt evenly and the quality of bricks is good 5. Height of the chimney control emissions of particulates and flue gases 6. Kiln is operational throughout the year. 7. High yield of "A" grade bricks as compared to traditional FCBTK 8. Operational through out the year	1. Deployment as CDM project 2. Less fuel requirement per 100,000 bricks 3. Less space requirement as compared to other types of kilns – six shaft VSBK requires 13% less space as compared to BTK of same capacity [E] 4. Not affected by weather conditions 5. Bricks ready for sale in shorter duration 6. Variable capacity: can be increased by adding more shafts 7. Least SPM emissions 8. Workers are not exposed to adverse conditions 9. Least payback period 10. Maximum time / year for firing – can be operational throughout the year 11. High yield of "A" grade bricks	1. Wastage less than traditional FCBTK 2. Less capital intensive as compared to Hoffman Kiln 3. More available days for brick firing as compared to traditional FCBTK	1. Firing temperature control is easy 2. Thermo-couple arrangement in the kiln visited automatically controls the temperature 3. Technically the kiln can be operated throughout the year – no weather effects 4. Least manpower requirement – labor problems minimal 5. Environment-friendly 6. Bricks of various sizes and shapes can be made.

5.8 Recommendations

Having gone through the literature review of contemporary technologies and the field studies conducted by TGA, the technology gap assessment as evaluated gives a tangible picture of energy conservation potential available in the brick sector of Pakistan. The process of technology transfer and adaptation of new techniques is usually not welcome by the veteran and old hands, it is therefore envisaged that low investment proposals with a modular approach on energy conservation measures may present a high probability on acceptance.

Yearly savings in coal through adoption of different options on energy efficient technologies and measures against, one BTK are tabulated below:-

Serial	Energy Efficient Technology/ measure	Annual Coal Savings (tons)	Annual Energy Savings (Terajoules)	Amount saved (Rs in millions)
a.	Adoption of smart techniques and procedures	122.8	2.814	1.228
b.	Mod BTK (15%)	184.2	4.221	1.842
c.	VSBK (20%)	245.6	5.629	2.456
d.	Hoffman Kiln (15%)	184.2	4.221	1.842
e.	Tunnel Kiln (30%)	368.4	8.443	3.684
f.	Habla Kiln	Data NA	Data NA	Data NA

To ascertain energy potential of brick kilns, basic constants are assumed that the type of coal, the soil and the annual output remains unchanged, wherein the traditional BTK which is the most popular technology is taken as base line. Average BTK has yearly output of around 585000 bricks per annum; consuming 210 grams of coal, the average cost of coal is taken as Rs.10000 per ton. Hypothetically, just adopting the smart, energy efficient techniques and procedures Pakistan has the potential to save around 1.47 million tons of coal, another tranche of 2.21 million tons can be saved by replacing traditional BTK with any other technology at a least count saving of 15%. National coal policy can work out a time frame to capitalize upon the potential spread over yearly phases.

6.0 Part C - Comments on Renewable Energy Sources

Beyond the scope of the study, it is envisaged that comments on renewable energy sources which can be integrated as fuel mix to reduce pressure on the natural resources, are inevitable. In Pakistan out of the total energy mix, 51.6% is the share of indigenously produced natural gas, 23.3% is imported oil and the share of coal is 6.2%. Country's natural gas reserve are fast depleting to the extent that gas rationing is already enforced. On the other hand the oil price in the international market is ever increasing. Both factors combined together have exerted pressure on indigenously produced coal and remaining forest cover which is 2.5% of the. There are approximately 12'000 brick kilns in the country producing an estimated quantity of 78 billion fired bricks per year and consuming two million tons of coal per annum. The current supply and demand equation has forced coal prices rise from Pak Rs. 6.0 to Pak Rs.11.50 per Kg which is almost double than previous years price. The supply chain of coal in the country is highly non reliable on quality and quantity because of the coal suppliers who obtain the supplies from mines and adulterate it with poor quality coal, the supply is further affected during harvesting season and Eid holidays. The brick sector already an unregulated and undocumented sector, is now looking toward other cheaper sources of energy such as tires, plastic, industrial waste and wood which is highly toxic and detrimental to environment. There is a yawning demand of kiln fuel which is

having the required calorific value and regular supply. There are two options to overcome the constraint:

a. Introduction and adoption of energy efficient technology and smart operating techniques.
b. Substitution of fossil fuel with bio fuels, based on agricultural residues.

TGA has also worked on introducing "Kiln Specific Bio-Fuel" prepared out of the agro waste readily available in all parts of the country crop after crop and throughout the year. The calorific value needed for the kiln process was achieved by adding coal in proportionate quantities. TGA was also successful in introducing internal fuel during the brick making process, which not only sequestered CO_2 but also helped reducing the coal consumption by 20 % to 30 %. The "Kiln Specific Bio-Fuel" is well received by the brick sector where the coal supply is neither regular nor its quality is assured. The monsoon season, non availability of miners during harvesting seasons and prolonged stay at homes after national holidays keep the supplies irregular. Most of the mines are having small yields as such are booked in advance by the coal brokers who invariably adulterate it with inferior coal and sell to the kiln owners. "Kiln Specific Bio-Fuel" once designed and prepared under strict quality control, using bio-waste will assure value for money, being quality product and if not cheaper at least at competitive rates. One biomass press machine can make bio fuel about 800 Kgs/hour to 1000 Kgs/ hours which is comparable any local lignite coal mine and can feed about two kilns on daily basis even during the peak demand period when labour is on holidays with assured quality and uninterrupted supplies. For first phase five such plants can be introduced making a small niche amongst coal supplier and induce a quality trend. High contents of sulphur and the resultant release of sulfurdioxide gas were considerably reduced due to direct reaction with chlorides and other chemical. EPA the regulator body acknowledged the practice for ready adoption by the traditional kiln till the time an alternate technology is well disseminated. Social uplift of kiln workers is embedded within these new interventions providing decent works opportunities and looking after the Child and bonded labour stigmas.

Techno Green Association (TGA), now confidently makes a case that Pakistani brick sector is ready for better environments if there exists a seamless continuity of efforts. The results achieved so far are well received by the public as well as the private sector, and if not a complete paradigm shift, at least sector re-orientation towards cleaner brick technologies has been made and stakeholders recognizing TGA as knowledge hub are now approaching it for technical support and are willing to pay the right price for right type of fuel.

7.0 Social & Environmental Impacts

For study purpose, a questionnaire was designed for gathering needed information from the various respondents as were available at the brick kilns. The summarized description of the social conditions found at the brick kilns is recorded in this section. The Copy of questionnaire is provided as Annex-2.

7.1 Social Conditions and Impact

a. Socio Economic Profile

Most of the kiln workers are migrants from other parts of the country. A majority (44.5%) hail from Punjab (mostly Central Punjab and some from Southern Punjab), followed by workers from the NWFP (29%) while AJK and Islamabad locals constitute 12% each. There were 2.4% Afghans in brick kilns as well.

b. Family Size

On average, there are 6.5 members per household. There were 12 respondents whose family were residing in their hometown, and were not included in the family roster. This has contributed to making the family size appear smaller than that observed. If we calculate average family size without these 12 respondents, then the average family size comes to 7.9 persons per family, which tallies with our observation.

c. Overall Poverty Ranking of Households

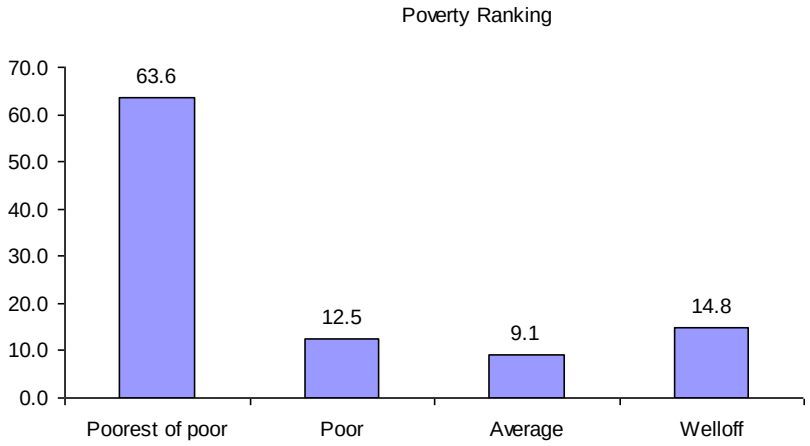


Fig 7.1 Overall Poverty Ranking of Households

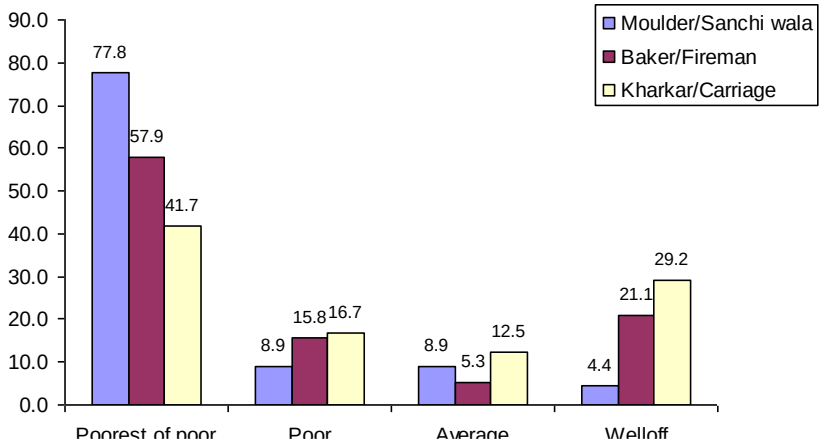


Fig 7.2 Overall Poverty Ranking of Households

Average family Size = 6.5
Poverty line = Rs.1100/month that makes less than US$ 2 per day, the poverty line.

Poverty Ranking Criteria

a. Poorest of poor = Less than Rs.800 Per capita income
b. Poor = Per capita Rs. 800 to Rs. 1100
c. Average = Per capita income Rs 1100 to Rs 1400
d. Well off = Rs 1400 to Rs 1700
e. Rich = Rs 1700 and above

d. Assets held by families

It is interesting to note that 77 % respondents own/have a fan in their house, leaving 23% households without even a basic facility like a fan. This was followed by cell phone owned by 44% respondents. 35% households have poultry, 26% have livestock (a goat or small animal). 20% respondents have a sewing machine at home while only 12% own a bicycle. 9% respondents, all kharkars, own donkeys or mules, used for transporting bricks.

e. Expenditure Trends of Households

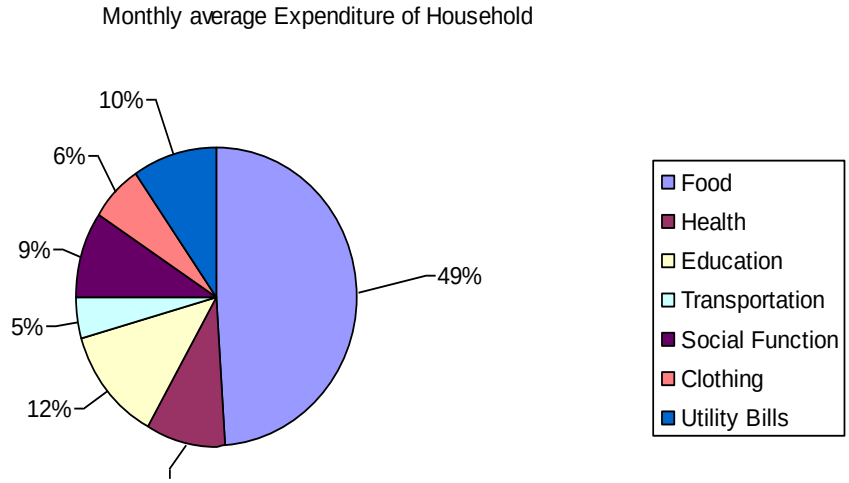


Fig 7.3 Expenditure Trends of Households

This chart indicates that food expense consumes almost half the respondents' earning, following by spending on education (12%), health (9%) and social functions (9%). There are no savings.

f. Housing Ownership

Only two respondents own their house; over 95% live in housing provided by the employer adjacent to the brick kiln.

g. Physical Infrastructure of Housing

78% live in a 'kutcha/pucca'[1] house while 19% live in a kutcha (mud) house and only 3% live in a pucca (brick) house. All accommodation is provided separately to families, unlike other countries where a big shared space is provided to multiple families.

h. Facilities Available in the House

Most houses lack latrine facilities; 61% use open fields while 24 % have access to a latrine outside their house and only 15% have a latrine inside their house. There is no proper drainage available in 85% houses. The employer provides access to water; usually there is a well outside the house (70%) or a hand pump (11%). Piped gas is unavailable for domestic use; everyone depends upon fuel wood for cooking purposes.

[1] Kutcha (mud) and Pucca (brick) implies a combination of the two. Usually the walls are made of brick but the roof is made of temporary materials.

i. Access to Social Services

Health

86 % respondents said that they access a health facility; everyone said that they rely upon private doctors rather than government services. It may be noted that 'private doctors' include dispensers, quacks and other doctors who charge a low fee. The public sector ill-equipped Basic Health Units (BHU) cannot deal with anything more than the common cold or fever and are open only, during the office hours, which often do not suit workers. Thus most prefer to go to private service providers.

Health related problems predominantly related to backache (56%), pain in legs (38%), pain in joints (36%) fever and cold (36%), high blood pressure (23%) and eye infections (19%). There is not a wide variation among these complaints from a gender perspective.

Education

58% respondents said their children attend school. Some of the respondents' families live in their hometowns so it is difficult to surmise how many children living on the kiln site have access to schooling but it can be safely asserted that the percentage would be lower than what is reported. Among those who attend school, 57% access private schools while 41% go public/government schools and the remaining 2% attend madrassas (religious schools). The distance from home to school for 92% children is one kilometer or less. In 29% cases, there are separate schools for girls but the majority (71%) does not have separate school facilities.

Adult literacy opportunities are available for very few (8%). However, the existence of the facility indicates that it can be useful and perhaps there can be a push for more adult literacy programs.

Social Protection

Only one respondent (a man) said that he is a beneficiary of zakat funds. All others have no access to any social welfare program such as Pakistan Bait ul Maal[2] or the Benazir Income Support Program (BISP) for poor women.[3] This may be related to the existence of a national identity card, which many workers lack.

National Identity Cards (NIC) and Voting Rights

Overall, only 57% respondents have an NIC and of these only 4% of women and 53% of the men have an NIC. No woman is a registered voter while only 20% of the men are registered voters indicating that less than half the number of those who hold an NIC have been registered for voting.

7.1.1 Work, Working Conditions, and Worker's Forums

a. Work and Remuneration

In most cases, the work is inter-generational as the following information clearly indicates.

[2] The Pakistan Bait ul Maal was set up in 1991 as an autonomous body under the Ministry of Social Welfare to provide social protection to the marginalized sections of society, especially destitute or those in need of social protection and financial aid.

[3] The BISP was launched by the government in December 2008 as a social welfare measure for the poor to protect them against the sudden price hike and inflation. Rs 1000 are distributed to poor women and widows each month.

b. Introduction to the Work
A majority of the workers (66%) said that they were introduced to the work by their parents or family; 21% said that they came to the work on their own while only 6.5% said that the Jamadar/ contractor introduced them to the work.

c. Length of Time/Experience
A majority of the workers (62.4%) have been involved in brick kiln work for more than ten years; among these workers, 41% have been involved in this work for over 15 years. Only 17% workers have joined this work during the last 1-5 years. This reconfirms that many workers join this work because their families are already engaged with it.

d. Opportunity to leave

An overwhelming majority (93.5%) said that if they could, they would leave work at brick kilns. Only 6.5 % said they would continue with the work.

e. Reasons for Joining Work
In response to the question about why they joined this work, the respondents listed poverty and support to the family as the predominant reasons.

7.1.2 The Advance System

A small percentage said they continue in this work due to the advance system. When asked their opinion about the advance system, most respondents from all categories said that they feel bound by the advance system and that they must work to pay off their loan to the employer. Very few (3%) indicated that they are paid less due to the advance system. However, 48% said that their remuneration has not increased over the last one year while 30% (majority of bakers and kharkars) said that their remuneration has increased once over the past one year. 20 % (a majority moulders and kharkars) said that their remuneration has increased more than once. It should be noted that the increase was not significant.

7.1.3 Contract: Terms and Conditions[4]

23% respondents, a majority of them moulders, said that they do not have a contract at all while 57% said that they have a verbal understanding. 21% said that the amount of minimum remuneration is settled and 11 percent said that they have leave with pay. The duration of working hours is not discussed; however, payment to moulders and kharkars is based upon the amount of work done, which is measured by the total number of bricks moulded/ transported/placed for baking. 80% said that they are paid on a piece rate basis while only 1-2 % said that they are paid on a daily basis and 17% on lump sum basis. Bakers/firemen receive a standard wage each month.

[4] Contracts in informal sector work are mostly verbal. This is a consequence of reliance upon oral traditions in societies where most people are illiterate; people's word carries weight while existing norms (regarding provision of facilities and conditions of work) are observed and respected. Hence the lack of a written contract does not indicate that workers are without rights but disadvantages set in when workers wish to resort to formal systems of justice where written documentation is critical. However, the informal systems of dispute resolution continue to work and are accessed by workers in such settings. These ultimately marginalize them and put them in a disadvantaged position even though workers do exercise some degree of agency in negotiating for leave, or extra advance in case of an emergency. Given these realities, we advocate for written contracts with assurance of labour rights.

7.1.4 Working Hours

All categories of respondents said they work between 11 and 13 hours. The work is performed mostly during the day but the bakers/firemen said that their work is evenly divided across the day and night while for kharkars it was approximately 3.5 hours at night. Moulders perform their work mostly in the day.

7.1.5 Disadvantages and Hazards at Work

This was an open-ended question therefore we received a variety of responses. We have categorized the responses into three broad categories related to health issues, work and remuneration and working conditions. The largest number of concerns were health related (52%) with most respondents complaining about the tough work; some pointed to specific ways in which they are affected ranging from eyesight problems to problems with mud and strong sun in their eyes. Many also complained of aches and pains and one respondent said that he had to sell his kidney in order to pay off his advances.

The second category relates to the disadvantages of working in the brick kiln sector. 22% respondents felt that they did not receive an adequate remuneration in keeping with the hard work they do for long hours.

The third category pertained to work conditions. 22% respondents said that the working conditions are poor; they pointed to the absence of safe drinking water, and shelter at the workplace. The harsh conditions also lead to deaths of animals in which case the owners (Kharkar) have to suffer heavy losses.

7.1.6 Facilities at Work Site

Besides drinking water at the worksite, there are barely any facilities available. Only 2% said they have access to a toilet and barely 1% indicated that a first aid box is available. Workers indicated that the employer does not provide them any shelter to shield from the strong sun in the summers. The absence of a toilet makes women feel uncomfortable; they indicated that they have to go to the nearby 'jungle.' For a majority, a toilet is not available at home either.

7.1.7 Negative Incidents and Harassment

In case there are negative incidents, 70% said that they can report these while 30% felt that they cannot. Most said that they could report these to the manager/munshi (52%) followed by employer (22%) and jamadar (21%). This indicates that there are conflict resolution systems that are being used by a majority of workers.

In response to specific harassment of women and children, 16% said that they face harassment. Of these, 9% said it is verbal while the others said that it is physical in the form of physical fights or beating of children. Sexual harassment was not reported. This is probably because women workers work besides their men folk and not all by themselves.

7.1.8 Other Seasonal Work

There were very few respondents who had not yet left for their hometowns as some brick kilns are seasonal. Of those who were interviewed, only 30% said that they work for remuneration when they go back, mostly on construction sites and few work as unskilled agricultural labourers.

7.1.9 Role of Manager/ Munshi

The dominant role of the munshi/manager appears to be to oversee the labourers and to pay advances on behalf of the employer. For the moulders, the munshi plays an important role in checking quality. There was a relatively unimportant role for the munshi in hiring and determining remuneration as the latter is generally decided by local market rates.

7.1.10 Monitoring of Work Conditions at the Workplace/Site

Working conditions are not monitored by any government agency or NGO said 72% respondents. Only 7% said that an NGO had visited them for this purpose and 2 % said that someone from the Environment Ministry had visited them. 67% said they were not satisfied with monitoring mechanisms in place.

7.1.11 Suggestions for Improvement

87% suggested that working conditions should be improved while 13% did not make any suggestions. This may indicate that they are either satisfied with what they have or that they do not have hope for improvement. Of those who made suggestions, 52.5% said that education facilities should be provided for children and 61% said that health facilities should be provided. There was a low demand for vocational training (1%) and adult literacy (8%).

7.1.12 Workers Forums and Organizing

92% workers said that they do not have a union or representative body where they can raise work related issues. Those who said such a forum is available explained that they approach the middleman to solve their problems. Usually these pertain to demand for advance, leave in case of illness or sometimes they wish to raise the issue of misbehavior of the munshi with the employers. However, most of the respondents had faith in the munshi and 62% relied upon him to solve their problems.

Thus it appears that there are no unions or formal forums that the workers access. The few persons who were aware of workers unions had a low opinion about union leadership, saying that they are mostly corrupt.

We can conclude that the relations between workers, managers and employers are highly personalized. There is a suspicion of formal organizations hence there is no initiative to contact the workers' organizations.

7.2 Environmental Impacts of Brick Kilns

7.2.1 Emissions from Pakistani Brick Kilns

There is no updated reliable scientific data for emissions from brick kilns or on their negative health impacts for Pakistan. However available data on regional countries has therefore been used to draw comparisons for this study. Government, NGO and donor reports emphasize the need for data collection and highlight the issues of emissions, health impacts and fossil fuel combustion. Another scientific study was conducted for kiln residues for Persistent Organic Pollutants (POPs) in 2006 by Arnika Toxics Czech

Republic[5]. All other studies made by Pak EPA for air quality monitoring in Islamabad were aimed towards vehicular emissions and none for brick kilns.

The Federal Bureau of Statistics (FBS) was contacted to find about data collection on brick kilns, it was found out that no data on brick kilns was ever collected; in fact the Bureau

collects data on the request of some agency provided funds are available, whereas no such request was ever received by the FBR.

7.2.2 Emissions Data

Extensive library and internet search reveals that no reliable data on brick kiln emissions is available for Pakistan, except for the data generated by the Pak-German Urban industrial Environment Protection (UIEP) Program 1999. According to this report the average SO^2 concentration in the exhaust of a typical Peshawar kiln are 3000 mg/m³ against the Pakistan National Environmental Quality Standard of 400mg/ m³, and the ambient air ranges from 0.2 to 5.75 mg/m³ while the WHO safe limit was 0.125 mg/m³. This project also found out that of the 1,000 patients examined in the EPA-UIEP medical camp 80% suffered from diseases related to air pollution. Other than this report, no brick kiln specific emission data for Pakistan is traceable in the libraries, offices and Green Library of the Environmental Protection Agency, CDA and the Punjab Provincial Environment District Office, Rawalpindi. Regional data was collected from TGA_EEBP records and some was accessed through internet.

7.2.3 Environmental Protection Agency Standards

The EPA has set no standards for brick kilns. The National Environmental Quality Standards (NEQS) are however available (SRO 549/1/2000 dated 8th August 2000) for industrial gaseous emissions, and ambient air quality standards are also provided therein. The nearest that could be valid for brick kilns are the standards for cement kilns; though the source of fuel for the cement industry is not the same as for BTKs in Pakistan. Another source perused are the NEQs for industries that use coal as a fuel though these cannot be applied to brick kilns since the latter use low quality coal. The NEQS for coal fired boilers are available; for particulate matter it is 500 mg/Nm³, the NEQs for emissions from any source (that also applies to brick kilns) for Carbon monoxide is 800 mg/Nm ³.

a. Smoke
According to the NEQS for Pakistan the smoke opacity for emission from source is 40% or 2 in the Ringlemann scale. Although the visible smoke from the brick kilns clearly indicates that the opacity is much higher, however, no published data on brick kiln opacity is available.

b. Particulate matter
The standards for SPM for brick kilns in Pakistan are not available. Therefore the WHO standards are referred invariably; however, standard for particulate matter is available which is 500 mg/Nm³ for coal fired furnaces. Nevertheless the SPM acceptable widely is 150 mg/Nm³ in accordance to WHO[6] standard for 24 hours

[5] Study Of Persistent Organic Pollutants Different Samples Of Hospital Waste And Brick Kiln Residues In Pakistan, Jindrich Petrlik, Arnika, Czech Republic and Mahmood A. Khwaja, SDPI, Pakistan, 2006

[6] World Health Organization Air Quality Guidelines for Particulate Matter, Ozone, nitrogen dioxide and Sulfur dioxide 2005

concentration while the standards for Suspended Particulate Matter (SPM) for Nepal is 600 mg/Nm3 (forced draught) and 700 mg/Nm3 (fixed draught) for BTK and 400 mg/ Nm3 for VSBK7.

c. Dust

Dust, a by-product of brick production, may cause serious health problems. Dust is most prevalent and dangerous when clay is extracted and finished bricks are transported following the firing process. Inhaling rock dust can lead to silicosis, a disease that affects lungs and breathing. Silicosis lowers the productivity of workers and can have long term and even fatal effects on the health of workers, owners and people who live close by (including the families of workers and owners)[8]. The available literature, however, does not provide any data on dust emissions at brick kilns in Pakistan.

d. Nitrogen oxide

The Pakistan NEQS for ambient nitrogen oxide in Pakistan is 100 ug/m³ (0.05 ppm) while the emission level for stationery source discharge is 300 ug/m³ while dilution of gaseous emission to bring them to NEQs through excess air mixing before emitting into the environment is not permissible. Available data for NOx emission at Tikathali Nepal is 39.49 µg/m3. Though not specifically studied for brick kilns in Pakistan, the NO_2 concentration studied by Pak-EPA indicate that the nitrous dioxide concentrations in the major cities are much below the WHO Guideline of 40 ug/m3.

e. Sulfur Dioxide (SO_2)

For sulfur dioxide the NEQS provide annual emissions for unpolluted source as <50 ug/m³ for and the NEQS state that no project with >100 ug/m³ shall be approved. The NEQS provide a maximum emission of 100 to 500 tons per day per plant. The Pak NEQS provide emission limit of 10 to 50 ug/m³ maximum allowable ground level increment to ambient SO_2. Available data for Nepal reveal that SO_2 Emissions range from 36 to 228 mg/ Nm³[9].

f. Carbon Monoxide (CO)

The NEQS for carbon monoxide emissions for Pakistan from any source of fossil fuel combustion is 800 mg/Nm ³ while the available literature for Nepal[10] shows that it ranges from 937ppm for Fixed Chimney and 2822 ppm for VSBK.

7.2.4 Health Impacts

SKAT, Switzerland studies in Afghanistan report that emissions in brick kilns consist mainly of coal fines, dust particles, organic matter and a small amount of acidic gases such as Sulfur dioxide, Nitrous oxide, Hydrogen sulfide, Carbon monoxide etc. accumulate black smoke that oozes out of kiln chimneys reaches the nearby residential areas[11]. SKAT also reports that continued present levels of pollution will lead to higher incidence of respiratory problems, especially those in downwind areas. This problem would logically be more serious for workmen and children who are continuously exposed to high levels of

7 TGA_EEBP Sources

8 EPA_Brick_guidelines_www.environment.gov.pkNWFP Environmental Protection Agency Environmental Assessment Checklists and Guidelines, 2004

9 Final Report, Stack & Energy Monitoring of Brick Kilns in Kathmandu Valley - NEPAL May 2005 Institute of Environmental Management, Nepal Project Report Reference No: [ES – 1 / 48 / 005]

10 Final Report, Stack & Energy Monitoring of Brick Kilns in Kathmandu Valley - NEPAL May 2005 Institute of Environmental Management, Nepal Project Report Reference No: [ES – 1 / 48 / 005]

11 page 21, Feasibility Study VSBK, Vertical Shaft Brick Kiln- Technology Afghanistan, SKAT 2006

dust and particulate matter while working at the kiln sites. The situation in Pakistan is also similar in nature though there is a lot of variation in different parts of the country; for example in the coastal areas of the country like Karachi cement blocks is the common building material instead of bricks. The district environment officer Rawalpindi, the federal EPA and the provincial EPA Peshawar contacted during the course of this study, however, report that since brick kilns do not fall under any category of projects that require environmental examination (EIA or IEE), therefore brick makers do not require environmental NOC nor are the emissions monitored. EPA Peshawar, however, takes legal action for those kilns that burn rubber tires that is a public health hazard. Otherwise brick making goes on unabated.

The literature survey reveals that brick kiln emissions cause many illnesses to the workers and the residents of the surrounding areas[12]. The diseases mentioned range from asthma, cancer, allergy, diarrhea, etc. However, there is a need to conduct an empirical study in this regard. The concerned health authorities contacted during this study are of the opinion that it is well understood from clinical practice that brick kiln emissions do cause many respiratory diseases. On the other hand they admitted that there is no empirical research done on this regard. They also informed that the Pakistan Medical Research Council (PMRC) is the right agency to initiate this research. The study also revealed that no agency has ever adopted any measures to mitigate the adverse effects of brick kiln emissions.

Results of key informant interviews conducted in the affected urban areas of Tarlai and Tarnol give an alarming picture. The residents report that the use of more detergents in the affected areas is due to heavy loads of soot and dust. The medical practitioners also report higher rates of respiratory disease due to the high number of brick kilns in the nearby area. The shopkeepers also report a higher rate of sale of non-prescription drugs for curing respiratory disorders in the affected area. Moreover, the residents are unaware of the existence of any environmental agency working to mitigate the adverse effects of brick kiln emissions.

The worsening air quality has drawn wide attention in view of the increasing incidences of respiratory diseases that are attributed to air pollution particularly in urban areas; the most serious issue being the excessive suspended particulate matter. Brick kiln emissions is one of the source in addition to vehicular and industrial emissions. Pak-EPA with the cooperation of JICA has established air quality monitoring systems in the major cities. Regular data is also being published. The studies show that SPM is 6.8 times higher than the WHO Guidelines. However, there is a need to undertake specific studies for monitoring brick kilns emissions so that the authorities become aware of the magnitude of the hazard.

8.0 Identification of relevant Institution, Activities for Capacity Building for Promotion of Energy Efficiency in the Sector

8.1 Institutions

As given under Chapter 7, all the identified stakeholders shall be taken on board with holistic approach for promotion of energy efficiency in the sector. The following actors however offer prior attention for capacity building measures and activities.

[12] Meeting Report 1999, Pak German Urban Industrial Environment Protection 9UIEP) Program NWFP and the MOE Plan of Action for Handling of Air Pollution Arising from Brick Kilns Around Islamabad and Rawalpindi NEAP SP, Ministry of Environment

Sr. No	Actor	Role
1	Kiln owners	Entrepreneurs and polluters
2	Kiln workers	Affected socially and sufferers
3	Residents in down-wind localities	Sufferers from pollutants
4	Civil Society	Silent spectators
5	Town Planners	Less understanding of environment friendly construction practices
6	Contractors and Builders	Application of Standard Quality bricks in Construction.

8.2 Activities

Various field visits to study the green brick making and brick baking / firing technology revealed the salient aspects of both the processes in Pakistan's perspective. Although, still to date, heavily dependent upon traditional methodologies, entrepreneurs are now turning towards latest technologies, including mechanized brick making and modern brick firing technologies like the M-FCBTK, Hoffman, Tunnel and VSBK Kilns. The major considerations for introduction of new technologies hinge around production capacity, operational time and yield / quality. Another factor, the importance of which can never be understated, is the labour factor, accompanied with typical issues. In many instances the single reason given by the kiln owners for adopting mechanized green brick making and non-traditional kilns was the labour issues. Above all, needless to mention, the environmental aspects are the most serious considerations at national level. However, there is still a wide gap between international best practices and the methodologies already being used and those being introduced.

A careful programme of introducing energy efficiency in the various steps of brick production in majority of the brick kilns in Pakistan shall be designed to bring energy efficiency and reduce wastage of fuel thus saving environment and natural resource base of the country.

9.0 Mapping of Active Stakeholders in the Market

9.1 Key Actors of the Brick Kiln Sector

During the process of this study, the following key actors have been identified with various roles as defined in the below table:

Sr. No	Actor	Role
a.	Pakistan Environmental Protection Agency	Emission standards for brick kilns and monitoring of kiln emissions
b.	Kiln owners	Entrepreneurs and polluters
c.	Kiln workers	Affected socially and sufferers
d.	Residents in down-wind localities	Sufferers from pollutants
e.	Urban Planning Authorities	Regulators
f.	Civil Aviation Authority	Sufferers from smoke haze
g.	Civil Society	Silent spectators
h.	Pakistan Medical Research Council	Responsibility to conduct studies on health impacts of brick kiln emissions
j..	NGOs	Social responsibility
k.	Ministry of Disaster Management	Same as above
l.	Pakistan Mineral Development Corporation	Exploration and development of Minerals including Coal Mines

m.	Housing colonies	Corporate Social Responsibility and Compliance to NEQs
n.	Universities and Research Institutions	Research on various aspects of brick kilns
o.	Federal Bureau of Statistics	Collection of statistical data
p.	Town Planners	Promotion of Standard Quality Bricks and advice to house builders on environment friendly produced bricks.
q.	Contractors and Builders	Application of Standard Quality bricks in Construction.
r.	Technology Developers	Mechanized Brick Making Plant Makers
s.	Labour and Business	All Pakistan Federation of Trade Unions Labour Unity Organization of Pakistan Khust-e-Awal Bhatta Labour Union Brick Labourers Unions at Town / District levels All Pakistan Brick Manufacturers Association
t.	Miscellaneous Orgs.	Pakistan Institute of Labour Education and Research Council for Housing and Works Research Construction Machinery Training Institute Ministry of Labour and Social Welfare ILO UNICEF

10.0 Identification and Analysis of Barriers to the Private Sector for investment

Private sector investment in brick industry is dependent on various aspects as seen by businessmen for any other business launching in Pakistan. Like other businesses, brick kilns sector also requires conducive market parameters for its growth including market push and pull factors, affordability of end users and general situation of the country. The lack or proportionate non-availability causes barrier for investment seen from overall turnover of a business in Pakistan.

10.1 Know-how of Stake-Holders

The stakeholders of construction industry like architects, consultants, builders and suppliers appears to be concentrating on building materials like steel bars, tiles, sanitary wares, pipes & fittings, marble, granite, glass, panels and doors, windows, etc to satisfy the clients and give little or no attention towards this basic building material i.e. brick therefore it is yet not in focus for quality and improvements. Consultants in public sector do specify the quality standards for bricks but usually overlook the specifications. In absence of complete knowledge about the specifications needed for bricks, the builders and end-users rely, to much extent, on the information and the products supplied by the producers and suppliers.

In case of bricks, architects and builders do specify about the specification like dimension, uniformity, color, water absorbency and crushing strength etc. The architects believe that the attributes of a good brick are as under:

Attribute	Benefits	Testing method
Red color	shows good quality of clay and right baking	Observation
Accurate dimensions, no broken edges and no de-shaping	Ensures good finish to walls and controlled quantity of mortar for masonry/plaster	Observation, manual measurement
No extra baking	Brittleness makes masonry difficult	Observation of shape and color, striking sound
No under baking	Softness reduces durability	Observation of shape and color, striking sound
Right strength / PSI	Ensures load-bearing and overall durability (PSI should be in the range of 2000-3000)	Striking/breaking, PSI lab test
Water absorbency	Ensures good quality of bricks (A brick should absorb water equal to 20% of its weight)	Manual water test

[Source: Builders/architects/dealers]

All these factors are judged by them through observation or manual tests like sound test, striking and breaking. There's no general practice of lab test in case of bricks. However, some projects require lab test for measuring strength. In such case Pound per Inch^2. (PSI) is conducted through UTS (Ultimate Tensile Strength) machine that is available at PCSIR, PSQC, Engineering universities and some private sector metal or ceramic industries. However, the widespread practice is just manual tests like observation, striking, sound testing, etc. The builders and masons are experienced enough to judge the quality of bricks through this practice.

Only a few brick producers have their printed material and websites that includes company profile and product catalogue. Such material contains only the images and dimension of products, while other specifications are not printed there.

11.0 National Coal Policy & Present Situation of Coal Industry

Pakistani coal reserves are quantified at a colossal 184 billion tons and which are estimated to last hundreds of years; again for producing thousands of mega-watts. Comparing the coal reserves with others, we see that these, according to some estimates, are equal to the oil reserves of both Saudi Arabia and Iran[13].

Pakistan does not have a full fledged national coal policy for its coal reserves in the country. The Government is formulating National Coal Policy to make Pakistan competitively attractive for investment in coal mining. The Ministry of Petroleum and Natural Resources stated that under this Policy government would offer an attractive package to foreign investors and yield close coordination between federal and provincial governments as well as concerned institutions.

According to official sources the feasibility study is being undertaken by Ministry of Petroleum and Natural Resources to ascertain techno-economic viability of Thar Coal gasification and extraction

[13] http://www.forexpk.com/economic-updates/exclusive-articles/thar-coal-and-national-policy.html

of chemicals is expected to be completed. It is expected that work to develop a mine yielding a quantity of 6 million tons per annum will also be started.

Production of coal during 2006-07 is 5.1 million tons per annum as compared to target of 5.2 million tons per annum showing 98 percent achievement. In addition, the feasibility study is also being undertaken by Sui Northern Gas Pipeline Limited (SNGPL) for setting up a pilot coal gasification plant at Bhakkar. The project "Feasibility Study on Gasification of Thar Coal District Tharparkar, Sindh" is under execution to ascertain viability of gasification of Thar Coal. The report of Phase I-A has been completed. The laboratory study has shown that Thar Coal is feasible for gasification. The next phase 1-B is expected to be completed in the first quarter of 2007-08.

The current coal mining techniques in the country are rudimentary; not even a single coalmine is mechanized. To enhance the share of coal in primary energy mix, Thar Coal Mining Company (TCMC) has been established. The prime objective of the company is to develop a coalmine yielding 5-6 million tons per annum at Thar Coal Field with the help of international well reputed firms/consultants.

Thar coalfield in the Sindh province has coal resources estimated at 175 billion tons. Due to high cost of imported energy, the government has decided to enhance the share of coal in the overall energy mix from 5 percent to 19 percent by 2030.

Energy Security Action Plan has set a target of generating 20,000 MW power from coal by 2030 and 50 percent by 2050. The total national coal production from operational coalmines increased by 6.5 percent, from 4.6 millions ton in 2005-06 to 4.9 million ton in 2006-07. Over 80 percent of coal was consumed by the brick kiln industry.
Approximately 80 percent of cement industry has also switched over to indigenous coal from furnace oil that has saved considerable foreign exchange being spent on the import of furnace oil.

The conversion of cement industry from furnace oil to coal has generated a demand for 2.5 - 3.0 million tons coal per annum[14].

11.1 Present Situation

The current figures on coal consumption from the Economic Survey of Pakistan 2011-12 reveals that the major users of coal in the country are the cement sector and brick kilns; about 60 percent of total coal is Consumed by cement while 39 percent is consumed by the brick kiln industry during current Year as compared to 62 percent consumption of coal in cement industry and 37 percent in Brick kiln industry last year[15].

About 56.5 percent of total coal extracted in the country has been consumed by the brick kilns industry whereas 42.7 percent by cement industry during the period July-March 2010-11.

The coal consumption shares of brick kilns decreased by 2.4 percent and that of cement industry increased by 3.1 percent. The percentage share of power sector declines by 1.24 percent during July-March 2010-11 compared against the same period last year (see Table 3).

Table 11.1: Consumption of Coal by Various Sectors *(Percentage Share)*[16]

Year	Household	Power	Brick Kilns	Cement
2001-02	0	5.7	58.5	35.9
2002-03	0	4.2	53.3	42.5
2003-04	0	3	42.7	54.2

[14] http://paktribune.com/business/news/National-coal-policy-in-the-offing-4272.html
[15] http://www.finance.gov.pk/survey/chapter_12/highlights.pdf
[16] http://www.infopak.gov.pk/EconomicSurvey/15-Energy.pdf

2004-05	-	2.3	49.5	48.2
2005-06	-	1.9	54.7	43.3
2006-07	0	2.1	41.5	56.4
2007-08	0	1.6	37.2	61.2
2008-09	0	1.3	39.0	45.3
2009-10	0	1.54	36.9	61.5
2010-11 (e)	0.0	0.76	56.5	42.7

- Not available *Source: Ministry of Petroleum Natural Resource*
e: Estimated *Hydrocarbon Development Institute of Pakistan*

It is expected that the coal consumption in the country would vary against the variations in demand for bricks and cement, being the primary consumers in Pakistan. With current surge for increasing housing demands at the aftermath of recent floods and growing population, it can be safely vouched that the coal mining sector would flourish however there is a strong need for formulating a national coal policy and sustainable exploration in order to not only cater for current energy needs but also environmental needs of future generations.

12.0 Environment Policy for Brick Kilns

12.1 Legal Framework

According to the Pakistan Environment Protection Agency (PEPA) 1997 in clause (xxiv) section 2, an Environmental Impact Assessment (EIA) shall precede all projects that may have an environmental impact. Since this is a socio-economic development project whose planned activities likely do not fall under the criteria of development projects which need EIA, therefore only an Environmental Assessment (EA) of project is required under the PEPA Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment Regulations, 2000.

There is a widespread belief that brick kilns, specially the emissions thereof, are a major cause of widespread respiratory and other diseases for the workers and residents of the areas within the reach of the smoke. This belief is also confirmed from the review of available literature, meetings with the experts and has surfaced again in the qualitative survey done by the team for this study. A most ostensible reason why no action has been taken to address this issue is the absence of brick kiln specific legislation and support from scientific research. Although the persons contacted in the residential areas of Tarnol and Tarlai are well aware of the hazards but they have never raised the issue at an appropriate level. A review of the EIA reports for the housing colonies of Lohi Bher, Islamabad also confirms that the issue of brick kiln smoke hazard was never considered.

The review of Environmental Law in Pakistan was undertaken during this study to find legal provisions regarding brick kiln emission hazards and mitigation.

12.2 Constitution of Pakistan

The constitution of Pakistan vests legislative powers with the National Assembly and Senate at the federal level and with the Provincial Assemblies in the four provinces. The subject of 'Environmental pollution and ecology' is included in the Concurrent List of the Constitution, thereby permitting both the federal and the provincial assemblies to enact laws on the subject. Only the federal government has so far enacted laws relating to the environment and the provincial governments derive their powers from the federal law.

12.3 Pakistan Environmental Protection Act, 1997

This Act provides for the protection, conservation, rehabilitation and improvement of the environment, prevention and control of pollution, and for promotion of sustainable development. It also aims to prevent any activity that has adverse environmental impact. Section 2 of this Act defines adverse environmental impact as impairment of or damage to the environment inclusive of impairment or damage to human health and safety or to biological diversity or property, pollution or any adverse environmental effect as may be specified in the regulations framed under this Act.

12.4 Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2000

This Regulation provides the basis, criteria and procedures for the preparation of environmental studies for all projects likely to impinge on the environment. It also specifies the procedure whereby environmental approval is granted by the federal or provincial agencies for such projects. Schedules I and II of the Regulation list the projects that require either an IEE of EIA.

However, none of the Schedules lists 'Brick Kiln' as a project worth undertaking of an IEE or EIA. Resultantly brick makers are free to construct any type of kilns anywhere they like without hindrance. The only known action taken by EPA against brick kilns is the Environmental Protection Order issued against two kilns near Khanna Bridge, Islamabad, and that too not on account of public health but due to haze that is inconvenient to aircrafts landing and taking off from the nearby airport. This case, however, remains un-decided as the brick makers have lodged appeals in the Environmental Tribunals under the PEPA 1997.

12.5 National Environmental Quality Standards 2000

These standards were promulgated under the PEPA 1997 and specify the parameters for maximum allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources and for power plants operating on oil or coal. The provisions relevant to this study include the maximum allowable emission of sulfur dioxide including maximum allowable increment in concentration in ambient air, maximum allowable emission of nitrogen oxides in ambient air and the maximum allowable discharges of vehicles and machinery used in

construction. Accordingly any project proponents are required to measure ambient air, noise and wastewater for conformity and report to the EPA.

Since the brick kilns have not been declared as an industry under any of the above mentioned regulations, no measurement of any liquid or gaseous emissions has been undertaken so far.

13.0 Experiences, Expertise and Best Available Practices for Sharing with other Member States

The TGA team documents an example of Internal Green Brick Making and Firing in traditional brick kilns as an energy efficient method of brick production which upon application and adaptation by the brick kilns in the country would save huge amounts of energy and operational costs apart from improvement in the production quality.

13.1 Introduction of Internal Fuel Green Brick (IFGB) Firing in Traditional Brick Kilns of Pakistan

Internal Fuel Brick Firing is an energy efficient technique of brick firing/ baking in a brick kiln. In this technique, the coal or fuel is pulverized through mechanical means if not available in powder form, weighed through a scale and an amount proportionate to the mass of the brick is mixed in

the clay used for making the bricks prior to its firing in the kiln. The technique is widely used in Vietnam, China and some parts of India and Nepal to achieve higher efficiency of the coal firing and achieve better quality bricks from a brick kiln. Pakistani entrepreneurs are yet to experiment and promote this efficient technique in their traditional way of brick making.

Energy Efficient Brick Production Project (2008-2011) of Swiss Agency for Development and Cooperation (SDC) and Techno Green Association (TGA) after gaining experience in Internal Fuel Technology at VSBK during the last years went on to introduce the technology in traditional Bull's Trench Kilns in Pakistan during the last year of the project. The experiment was the first of its kind

and had no previous examples in the South Asian region. Two successful trials on firing/baking of Internal Fuel Green Bricks (IFGBs) were conducted at two different BTKs around Rawalpindi/ Islamabad. The BTKs selection was made on the recommendation of the local brick kilns owners association. The first trial of firing 200,000 green bricks was conducted during the months of May-July 2011, while the second test of 300,000 bricks was made during Oct-Nov 2011. A capitalization workshop on the subject technology was organised in December 2011 in collaboration with local brick association.

The IFGBs is a lasting success in improving the traditional brick kilns' fuel efficiency viz-a-viz environment friendliness in the history of the project. At the end of the year through successful trials and effective marketing, EEBP project received five requests from local kiln entrepreneurs to provide them with technical help in applying the technology, however due to time constraints and unfortunate decision on project closure from SDC, their requests went in vain.

Following are some of the key notes from the two successful trials made at BTKs;

a. Fuel Saving
   The existing firing practice in the brick kilns could only achieve coal consumption of 200-210 gm/brick to mark maximum efficiency and application of extra-ordinary skills from fire masters. The trial experiment of IFGBs firing at BTKs showed that the coal consumption during the internal fuel brick firing was reduced up to 20%, which means that the per brick consumption while firing with Internal Fuel (IF) remained 160-170 gm.

b. Efficient Kiln Firing
   Since the internal fuelling method provides excellent mode of fuel distribution in the kiln, the kiln attains maximum efficiency in terms of firing/baking the bricks. The wastage is minimized and reduced up to 15-20% if compared to normal brick firing with same kiln conditions.

c. Higher Quality and Quantity
   The quality of bricks produced with IF is excellent with metallic ring and uniform yellow colour. The test results showed that the bricks achieved strength (2300 psi) well beyond the standards required (1600 psi) for building construction in Pakistan. Due to firing of IFGBs in BTK, the speed of firing cycle (Chakkar) increases thus reducing the number of days spent on one Chakkar (cycle) for the same number of bricks; therefore the overheads also reduced accordingly. This way, the yearly fired brick production increases by 2.4 million bricks and approximately annual earnings of Pak Rs. 5.0 Million could additionally be achieved. The following table summarizes the advantages of adapting IF in traditional Bull's Trench Kiln without any modification or changing the kiln structure.

Table13.1:. Comparison of Normal and Internal Fuel Firing in BTK

Firing Mode in BTK	Coal Consumption / brick	Coal Saving / Firing Cycle	Firing Cycle Duration	Yearly Brick Production	Net Yearly Profit
IFGBs firing	160 gm / Brick	16.8 Tons	18 days	12.16 Million	16.21 Million
Normal GB Firing	200 gm / Brick	None	25 days	8.76 Million	11.67 Million

d. Environmental Protection

The kiln efficiency and environmental pollution are interrelated. As long as the kiln is fired in an efficient manner with sufficient air supply and complete combustion of applied fuel, the kiln emissions contain fewer contents that could harm the environment particularly the human life, otherwise known as pollution. Since the IF provided efficient kiln firing, the resultant emissions fully endorsed the principles of combustion vs. emissions and the kiln emissions were found drastically lowered than normal kiln emissions. The IFGBs firing was duly tested by the provincial and federal Environmental Protection Agencies and declared the emissions well within the National Environmental Quality Standards (NEQS). Table 2 provides summary of the emissions recorded by the respective agencies.

Table 13.2: Comparison of Kiln Emissions against standard NEQS

Parameters	NEQS	Normal Bricks Firing	IFGBs	MBTK*
Particulate Matter (PM^{10})	500	676.78	325	428
NOx	400	296	74.16	10.2
CO	800	334	831	370
SO_2	400	44.8	233	20.5
CO_2	Doesn't exist	8.99	7.5	7.9

**MBTK-Modified Bull's Trench Kiln (Indian Design-a solitary BTK exists in Burhan-Pakistan)*

e. Safer Work Conditions

Since the IFGBs production allows controlled consumption of fuel and less emissions of harmful gaseous material, the workers on the kiln are directly benefited from the safer work conditions. The fuel mixing in the clay has another added advantage of soft moulding and ease in brick making which alternatively increases the daily production of green brick making labour thus increasing their daily wages/income.

f. Increased Wages for Labour Force

The internal fuel brick making creates a win-win situation for the owner and the labour force of the brick kilns. Since the crushing and proportionate mixing of coal requires additional labour which the green brick moulders provide on overtime basis, the normal wages of the labour increases by 25-30% against their otherwise daily wages. The owner gets benefited from the higher rate of production and fuel saving with application of efficient kiln firing practices.

14.0 Economic & Cost Benefit Analysis

To find out a complete cost and benefit analysis of brick kilns in Pakistan, a separate study is recommended. The study team during the social conditions survey inquired about the various costs of the brick kilns operation. The entrepreneurs or their Munshi's are reluctant to share this information due to fear of taxation and business secrets. To respond to this specific aspect of the study the following general information was collected and believed to be true after comparing the data of 10 visited brick kilns. The figures on cost, price and sale of bricks and profits are summarized in the following tables.

Table 14.1: Cost and Benefit Analysis of Two Sample Brick Kilns

Description	**Tarlai BTK**	**Tarnol BTK**
Land	2829322	2829322
Cost of Kiln	377273	500000
Land cutting leveling	0	120000
Internal roads	25000	25000
Quarters & Office	865000	1000000
Over-ground Water Tank -25 KI or 3 wells	54319	220000
Advance to labourers (Paid)	397273	1500000
Total Fixed Costs	**4548187**	**6194322**
Depreciation @ 15% of installations in 10 Years	257829.75	504750
	Tarlai BTK	**Tarnol BTK**
	PKR	PKR
Capacity (Productivity) per season	6332000	5200000
Sales of 1st class Red Bricks (70%)	4432400	3640000
Sale of 2nd class Red Bricks (20%)	886480	728000
Unsellable Bricks(10%)	88648	72800
Rate per 000 1st class Bricks	6000	6500
Rate per 000 2nd class Bricks	3500	4500
Total Sales Turnover	**29697080**	**26936000**
Less expenses (Operational Cost per season)		
Mining & Transporting		200000
Land leveling after rain		35000
Mixing soil with tractor / pugging		70000
Initial Firing wood		85000
Fuel - Coal etc.	7817064	5070000
Direct Labour	3855042	4390000
Indirect Labour	99091	1602500
Consumable	415164	415164
Sub Total	**12186361**	**11867664**

Lease / rent	158409	520000
Depreciation	257829.75	504750
Sub Total	**416238.75**	**1024750**
Grand Total (Sub+Total)	**12602599.75**	**12892414**
Profit per season	**17094480.25**	**14043586**

The brief economic analysis of brick kilns shows the average profit margins in this business. As evident from the figures the profits earned from a brick kiln and the workmanship involved are

high enough for considering it as an industrial unit albeit working silently unto the peripheries of urban areas. There is a serious need to consider the sector in order to cater for the energy conservation issues and quality of building construction in the country.

15. Recommendations

National Energy Security Plan while incorporating various energy conservation measures, besides the energy efficient building designs and advocating smart housing appliances may also incorporate the brick sector reforms to capitalize the significant potential available within the sector.

After having done the in-depth analysis of the sector, energy conservation potential is recognized, technology gaps identified and means to bridge these gaps have been evaluated under a comparative regime. Corollary to this exercise, are the recommendations which are Pakistan specific and given in subsequent paragraphs.

15.1 Immediate Measures

Small scale, simple and low cost interventions yielding tangible and visible results, when offered within the prevailing system will readily be accepted by the kiln owners and workers alike. Following small scale energy conservation actions at basic kiln units can substantially capitalize on the energy saving potential, when implemented at national level keeping in view the economy of scale:-

a. Awareness through IEC Materials. To create awareness amongst the stake holders about the needed improvements, benefits which can be accrued from the recommended interventions and the methods through which these benefits can be achieved, Information, Education and Communication (IEC) materials be prepared and disseminated.

b. Introduction of Brick Kiln Trades. Trades, specific to brick kilns, such as Kiln Supervisor, Master Moulder, Fire Master, Extruder operator etc be introduced at “District Trade Training Schools” and workers be trained on the scientific based curriculum. Presently there is no such training arrangement/ institution available for the kiln workers.

c. The Interventions. These have already been discussed in detail at Part-A under the methodology and are enumerated as under:-

   (1) Improvement in green brick making practices and procedures such as soil selection its seasoning, mixing of internal fuel, maturing and ensuring optimal moisture content at the time of brick loading into the kiln.

   (2) Enhancing firing efficiency through selection of quality coal, reducing it to desired size, appropriate stoking of coal and monitoring the fire for temperature adjustments.

(3) Periodically conducting the "Energy Audit "at brick kilns, by the owners/ workers themselves.

d Free Technical Support. Kiln owners/ entrepreneurs be provided with free technical support for energy conservation measures i.e. availability of green brick making manual, guide line on efficient firing techniques, modified kiln designs, construction drawings and technical trouble shooting check lists for the kilns etc.

15.2 Long Term Measures

a. Statutory and Regulatory Legislation for the Sector. Brick sector of Pakistan is un-regulated, undocumented and not even recognized as a cottage industry. Pakistan Standard and Quality Control Authority (PSQCA), Pakistan Council of Scientific & Industrial Research (PCSIR), Environmental Protection Authority (EPA) and different other public sector organizations have issued standards and quality control statutes for products and industries but none has framed kiln specific standards which are mandatory for regulating the sector for improvement. Statutes specific to bricks kilns, establishing base line standards on quality bricks, energy efficient kiln designs, emissions etc need to be promulgated for implementation and improving upon the sector.

b. Approved Kiln Technologies. Energy efficient kiln technologies alternate to traditional, in-efficient kilns be approved/ specified for small, medium and large enterprises e.g. VSBK, Mod BTK, Habla Kiln, Hybrid Hoffman Kiln and Tunnel Kiln.

c. Mechanized Green Brick Making. Mechanized IFGB be approved for the specified technologies, a mandatory provision for successful adoption of these high production technologies. This will not only conserve energy but will also eradicate the curse of child women and bonded labour issues for which the brick sector is notorious.

d. Public Private Partnership (PPP) Initiatives. Energy efficient technologies yielding high production, stipulate substantial capital investment which can be reassured by the government through PPP ventures.

e. Establishment of Provincial Brick Authorities. These authorities will have a focused approach on issues pertaining to the brick sector, besides the energy conservation will also specify the locations of brick fields away from fertile lands, vocational training for the women, occupational safety and health at the kilns etc. etc.

f. Status of Industry. Brick sector needs to be given the status of an industry to avail the industrial privileges facilitating the implementation of energy efficiency improvements discussed above.

15.3 To frame recommendations a "mind map at large" was prepared and is appended at "Annexure D".

"Annexure D"

"A Mind Map At Large"

The recommendations at large, in the light of the study findings are enunciated as per segregated sections as follows;

Demand for Bricks: Bricks are the major ingredients in construction material. Pakistan is in huge deficit of housing for which both public and private sectors are initiating mega projects. Building and construction activities are at lower pace at present due to current economic crisis and socio-political situation. However a boom in the sector is expected as soon as the situation improves. A proper handling of this huge demand for brick could effectively be utilized for the technological advancement in this field.

Supply Side: Brick Industry in Pakistan is a neglected sector and is running on traditional unorganized pattern. The brick kilns are operating mainly to cater for the needs of local areas and are uncoordinated. Labor at these kilns is seasonal and production is intermittent for an average period of eight months in a year with intervals in between. Due to present slump in the construction business, many of the kilns are working under capacity.

Lack of Knowledge and Research: Brick business in Pakistan grossly lacks modern knowledge about mechanization and innovative methods. None of the respondents in brick kilns was found using computers or other IT equipment at their sites. Those few who are conversant with modern knowledge and technique are uncoordinated.

Environment Concerns are Looming: Despite the ignorance of majority of EPs regarding environmental pollution created by the traditional BTK, the fact is that this issue will be a major concern in coming days. The countries are under global obligations to reduce emission of polluting gases such as produced by the brick kilns. The government has recently decided to relocate BTKs from outskirts of Islamabad. The project needs to devise a comprehensive strategy to be proactively involved at relevant quarters in this arena. The Capital Development Authority has learnt to hint at financial requirement for relocation of BTKs. The project may negotiate to fill the gap by investing on Public-Private-Partnership.

Social Conditions Improvement of Brick Kiln Labour

Based on findings emerging from the field, we propose the following interventions as a way forward:

a. Ensuring that workers obtain NICs for themselves, and their families including birth registration of their children. The NICs are critical for access to social protection programs of the government, as well as ensuring that workers can access social services and exercise their rights as voters.

b. Adult Literacy and/or Vocational Training with compensation (and in-built requirements for completion of course) so livelihood is not affected. Alternative skills training can be initiated.

c. Schooling for children through lobbying with the Education Ministry/Department for implementation of Education for All (EFA) and provision of non-formal schools in the area.

d. Access to better quality government health facilities through lobbying with district governments.

e. Explore the possibility of health insurance schemes for the poor as initiated by RSPN /PRSP in Punjab.

f. Improved work conditions such as shelter to protect from adverse weather conditions; improved work timings, fewer hours of work (than the present 11-13 hours) and minimum wage, equal pay for equal work. Simple facilities on the work site such as clean drinking water and first-aid box can also be initial steps to improve work conditions that do not require substantial investments. The provision of latrines at the worksite, though it requires a small investment, is a must.

g. Improved living conditions for the workers who live on the site: This includes infrastructure improvements such as improved building materials in houses, provision of latrines, proper drains, running water, safe drinking water, piped gas for cooking etc.

h. Employers/owners emphasized the introduction of fuel-efficient technologies more than the introduction of mechanization. We believe such technologies should be introduced but the profits that accrue should be shared with the workers in the form of improved work and living conditions.

i. Tripartite dialogue between employers, workers and stakeholders to ensure 2-way benefits accruing from fuel-efficient technology transfers.

j. Interface with private sector businesses for accessing better technologies and financial incentives that will result in environmentally responsible practices as well as direct material benefits to workers.

k. Explore the possibility of forming formal forums for dispute resolution and associations for articulating workers' demands.

Environmental Aspects of Brick Kilns

a. Data on emissions from brick kilns for Pakistan does not exist; therefore, primary data must be collected. Pakistan Environmental Protection Agency is the appropriate agency to be contacted in this regard.

b. Data on health impacts of brick kiln is also not available. Pakistan Medical Research Council is the appropriate body to be contacted in this regard.

c. One way forward to bring brick kilns into the realm of monitoring of environmental agencies is to lobby for the recognition of brick kiln as an industry in the Pakistan Environmental laws.

d. Like India and Nepal Standards, for brick kilns in particular emissions are much needed in Pakistan.

e. Studies are needed to assess the health impacts of brick kiln smoke on the adjoining residential areas and the same may be compared with control areas to draw inferences.

f. Proper Guidelines for Brick kiln workers especially those involved in coal fire should be prepared.

g. Alternate coal fire ignition fuels be considered instead of used tires

h. Environmental education of brick kiln owners, workers and those living nearby is needed.

i. Research on brick kiln emissions, effects of top soil removal for green brick making, vegetation trends on abandoned sites of kilns, comparison of vegetation at kiln sites and control sites, and faunal surveys and assessments of PAHs and ionized silicates emissions are much need.

Green Brick Making

- Introduction of good practices for green brick making like (i) mechanized green making, (ii) fencing and covering / storage under sheds, (iii) proper brick stacking techniques, (iv) artificial drying, using exhaust air
- Separate studies may be carried out to:
  - determine the suitability and availability of mud for green brick making from canals and water courses dredging
  - determine the viability of fly ash bricks in Pakistan
- The local brick making plants can be the most suited mechanized green brick making technology in areas / localities facing power connectivity and supply issues.

Brick Baking

- Introduction of best practices in terms of (i) Solid fuel placement in kiln and (ii) Air-flow control technologies / techniques
- The local FCBTKs and Modified FCBTKs are not as environmental friendly as deemed necessary. At the same time the Hoffman kiln has the longest pay-back period and is the most capital intensive. The two alternates available are the VSBK and tunnel Kiln. The two types have certain advantages in terms of fuel efficiency, emissions, productivity, yield etc. The tunnel kiln is, however, more capital intensive as compared to the VSBK.
- While “re-introducing” the VSBK, lessons from the past should be given due consideration, in terms of sustainability of efforts, long term technical and training support etc.
- A core group of engineers and technicians should to be trained as master trainers to provide further training and disseminate good practices on a large scale.
- Introducing the concept of cluster councils can help the kiln owners to deal with issues like training, testing & inspection and marketing
- A separate study may be conducted to
  - Analyze the viability of tunnel in Pakistan’s perspective along with the VSBK; covering aspects like increased production capacity, adaptability to local conditions etc.
  - Analyze the technological aspects of briquetting technology for brick making sector, in terms of brick raw material and multiple-fuels. It may also include the development of briquetting techniques and equipment at local level.

Annex- E

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
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
- Any other information which member states may like to share for preparation fo 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	10 July 2012
Appointment of consultant and signing contract with SEC	20 July 2012
Submission of draft Report	20 Sep 2012
First Peer Review of Report	10 Oct 2012
Second Peer Review of Report	10 Nov 2012
Printing & uploading of Report	10 Dec 2012

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

7. Remuneration

SEC will pay the USD 2500 honorarium to each expert and USD 500 per report to reviewer for their services after completion and acceptance of the study by SEC. The payment of honorarium shall follow the following schedule:

- 25% of the total payment at the time of appointing the consultant and contract signing with SEC.
- 25% of the total payment at the submission of draft study report.
- 50% of the total payment at the end of second peer review and final acceptance by SEC.

8. Minimum Experience and Qualifications

- Hold a post-graduate degree in engineering (master or equivalent) in the area of energy management, energy efficiency and policies or equivalent.
- Have extensive experience in carrying out consultancies for national and international agencies
- Be familiar with the energy sector, especially with regard to energy efficiency and conservation
- Have capability in the region for information gathering and seeking cooperation with relevant organizations
- Have worked in the area of institutional capacity building on energy efficiency for more than 5 years preferably having dealt with government officials at different levels
- Have an excellent command of English both written and oral and a proven ability to communicate results

Annex-F

Questionnaire for Survey of Brick Kilns

Introduction:

Name of Site _____	
Name of Respondent: _____	**Name of Researcher:** _____
Age: _____ years	
Home District of the respondent	**Date of interview:** _____/_____/ 2012
Work categories **Moulder/ Sanchi wala…..1** **Baker/ Fireman ……2** **Kharkar / Carriage……3**	

Section A: Household Roster

S.N	Relationship with the head of HH Self……..1 Wife…….2 Housband …3 Daughter.. 4 Son……5 Mother……...6 Sister…….7 Brother…….8 Daughter-in-law……9 Mother-in-law…….10 Sister-in-law……..11 *Brother-in-law……12* *Uncle……13* *Other……..* *……77*	Gender 1. Male 2. Female	Age In complete Years	Marital status Never Married….1 Married……2 Divorced/Separated ……..3 Widowed…….4	*Education Mention in completed years* Illiterate Technical education Informal education Religious Education Primary Middle Secondary High Other…….77	Occupation Housewife……..0 Farming……..1 Business…….2 Labour……..3 Labour in brick klin……4 Child labour…….5 Student……6 HH chores……7 Other s*pecify)* *……....77*
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

Section B: Socio-economic profile

Qno.	Question	Responses
B1	Household monthly income (Rs.)	1. Crops_____Rs. 2. Livestock_____Rs. 3. Labour_____Rs. 4. Private job_____Rs. 5 Remittances_____Rs. 77. Other *(Specify)*_____, _____Rs.
B2	House Ownership	Own……..01 Rent……...02 Without rent/ rent free……...03 Provided free by the employer……..04
B3	Type of house	Pacca……….01 Katcha……...02 Pacca/katcha……….03 Other ……77

Qno.	Question		Responses
B 4	Water supply	Piped *(inside)*……..01 Piped *(outside - Govt. tab).*…….02 Hand pump…….03 Well inside……04 Well out side…..……..05 Canal/ stream …...……..06 Boring ……07 Other *(Specify)*_____77	Codes Provided by Govt = 1 Provided by the owner of brick kiln = 2 other specify …… ……..77
B5	Latrine		Inside……01 Outside……02 Open field……03
B6	Drainage		Yes……01 No……02
B7	Fuel *(For cooking & heating)*		Gas……01 LPG……02 Wood…….03 Kerosene……04 Electricity……05 Other *(specify)*_____77

Monthly Household Expenditure (Rs.) *Please use average if reported expenditure are other than monthly*		
B8	1. Food_____Rs.	*5. Clothing_____Rs.*
	2. Health care……Rs	*6. Education ……..Rs*
	3. Transport ……..Rs	*7. Housing ……..Rs*
	4. Social Function ……Rs	*Utility Bills ……Rs*

Assets

B9	Item	Yes = 1 No = 0	Number	Item	Yes = 1 No = 0	Number
	1. Fan			7. Sewing machine		
	2. Bicycle			8. Cart		
	3. Motorcycle			9.Horse/donkey		
	4. Riksha			10. Cell phone		
	5. Poultry			11. House		
	6. Livestock			77. Other specify		

Section C: Access to social services

Health

C .1 Do you access to health care facility?

Yes = 1 No = 2,

C .2 Type of health care facility accessed

Public……..1
Private……2
Other specify…… …….. ……77

C.3. Do you have any specific health issues arising from your work?

Yes = 1 No = 2, **if yes** use the following codes

C. 4 Types of health problems

Encircle codes (multiple options possible

Backache ……...1 Fever, cold ……2 Eye infection ……3 Ear infection ……..4 Watery eyes ……..5 Cough ……..6 Asthma ……7 Skin problem ……8 Breathing problem ……9 Stiff neck ……10 Anemia ……11 Pain in legs ……..12	Pain in some limb……..13 Pain in joints ……14 Swelling in some body parts ……..15 Pain in chest ……16 Stomach / belly pain ….17 Dizziness / nausea ……18 Skin cracking / discoloration ……19 Muscular pain ……..20 Exhaustion ……21 High Blood Pressure….22 Low Blood Pressure…23 Other specify …….. ……..77

C.5. Do children and women have any specific health issues due to living near the brick kiln?

Yes =1	No = 2, if no go to C 7

C. 6 If yes, which type?

Education

C. 7 Is there any education facility available?

Yes = 1 No = 2, if no go to C9

C. 8 If yes, which type of facility?

Type of facility	Distance in Km
Public ……1	
Private school…2	
Madrasah……..3	
None…….4	
Other……77	

C. 9 Are there opportunities available for adult literacy?

Yes = 1	No = 2

C. 10. Are there separate schools/facilities for girls?

Yes = 1	No = 2

***Section D**: Employment, working conditions, workers and employers' relations*

D. 1 Who introduced you to this work?

Parents/ family	1
Jamadar / Contractor	2
I myself	3
Other specify	77

D. 2 How long have you been engaged in this activity? Years _____ Months _____

D. 3 What are the reasons for doing this work?

D. 4 If you ever got other opportunity, would you leave this job?

Yes = 1	No = 2

D. 5 What do you think about the advance payment system?

It made me bound to work here ……1
Have to work for long hours ……2
Have to work on less wages than the market ……3
Other specify …….77

D. 6 What type of terms and conditions are included in the contract?

Encircle codes

No contract at all ……1
Only verbal memorandum……..2.
Amount of minimum remuneration……3
Duration of working hours……..4
Leave with pay……5
Leave without pay……..6

Maternity leave……7 Medical cover / self / family……8 Other specify …….. 77

D. 7 How many hours do you work?

Hours _____ day time	Hours _____Night time

D. 8 Do you work seasonally or round the year?

Seasonally = 1	Round the year =2

D. 9 If seasonally how many months per season? _____ Days _____months
D.10 Do you migrate to your hometown during the off-season?

Yes =1 No = 2, if no go to D 15

D. 11 Do you have any economic activities in your home town?

Yes =1 No =2, if no go to 13

D. 12 If yes, specify type of economic activities

Loubor agriculture ……..1 Unskilled labour in construction……2 Skilled labour in construction……3 In brick kiln……..4 Other specify ……..77

D. 13 Do you have any property in home town?

Yes =1 No = 2 , if no go to 15

D. 14 If yes type of property

Type of property House ……1 Agricultural land ……2

Non-agricultural land……3
Commercial land……..4
Livestock ……..5
Other
……..77

D. 15 What are the reasons of family migration from your home town?

Due to insecurity in the absence of male memebers ……..1
Due to poverty ……2
To employee female and children also in the brick kiln sector …3
Other specify ……77

D. 16 Do they face any problems / issues here?

Yes = 1 No = 2, if no go to D18

D. 17 If yes, what type of problems / issues?

Lost contacts with relatives ……1
Children lost future due to involvement in work ……2
Poor living conditions ……3
Women / children face harassment / abuse ……..4
Drug addiction ……5
Other specify ……
……..77

D. 18 What is the wage system in the brick kiln sector?

Daily base ……1
Lump sum ……2
Performance base ….3
Piece base……..4
Other specify ……
……..
……..77

D. 19 How many times has your remuneration increased during last year?

Once ……1
More than once …….2
None……..3

D. 20 What type of role does the *Munshi* / manager plays?

Hiring for employer ……1 Oversee the labourers at work place …….2 Pay advance on behalf of employer ……..3 Determine remuneration ……..4 Check the quality of work/production……5 Deducts remuneration for poor quality……6 Other specify ……77

D. 21 Can you report negative incidents?

Yes = 1	No = 2, if no go to D 23

D. 22 If yes, to whom?

Employer ……1 Munshi ……2 Jamadar……..3 Relative ……4 Union ……..5 NGO ……6 Other specify ……77

D. 23 Do women and children face harassment?

Yes = 1	No = 2, if no go to D26

D 24 If yes, is it: Physical or verbal?

D 25 Provide details if possible of the nature of harassment specify _____

D. 26 What are the disadvantages / hazards you face in this work?

Please specify _____
_____

D. 27 Do you think this work / brick mould ring should be mechanized?

Yes = 1	No = 2

D. 28 If yes, what are the advantages and disadvantages?

Advantages	Disadvantages
Can ease the job ……1	Unemployment…….1
Can increase Production ……2	Poor quality of production ……..2

Can improve quality ……..3 Can reduce health problems …..4 Other specify ……..77	Other specify …… ……77

Facilities at Workplace:

D. 29 Are the following facilities available at work place?

Drinking water……1
Latrine ……2
First aid box……3
Shelter……4
Orientation to preventive health practices..5
Other specify……77

D. 30 Do you have a union / workers representative body where you can raise job related issue with the owner?

Yes = 1 No = 2, if no go to D31

D. 31 If yes, please specify ----------

D. 32 Have you raised any issue on that forum?

Yes = 1 No = 2, if no go to D 33

D. 33 If yes, what type of issue?

Demand for advance……1
Medical allowance……2
Leave in case of illness……3
Misbehave by the Munshi……4
Harassment……..5
Other ……..77

D. 34 Who mostly resolves / addresses your problems / issues?

J*amadar*/Contractor……..1
Munshi/manger……..2
Employer……3
Other ……77

D. 35 Who monitors the situation of workers and the working conditions in brick kiln sector?

Labour department ……1
Environmental agency ……..2
NGO ……3
INGO ……4
Labour union ……..5
None ……6
Other specify ……77

D. 36 Are you satisfied with this monitoring mechanism?

Yes = 1 N0 = 2

D. 37 If not, what would you suggest?

Improve working conditions……1
Provide education facilities to children…….2
Informal school for adult……..3
Vocational training……4
Health care facilities……5
Other ……77

D. 38 Do you have a CNIC?

Yes = 1 No = 1

D. 39 Are you registered as a voter?

Yes = 1 No = 1

D. 40 Are you the beneficiary of the following?

Zakat ……1
Bitualmal ……..2
Others……77

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Annexure G

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