Monitoring report form
(Version 03.1)

Monitoring report

Title of the project activity	Improving kiln efficiency in the brick making industry in Bangladesh
Reference number of the project activity	5125
Version number of the monitoring report	01
Completion date of the monitoring report	31/01/2013
Registration date of the project activity	18/08/2011
Monitoring period number and duration of this monitoring period	First monitoring period : 01/09/2011 to 31/08/2012
Project participant(s)	1. Industrial and Infrastructure Development Finance Company Ltd (IIDFC) (Private entity), Bangladesh 2. Ministry of Sustainable Development and Infrastructure, Luxembourg 3. International Bank for Reconstruction and Development (IBRD) as Trustee of the Danish Carbon Fund (DCF); Danish Ministry of Climate and Energy/Danish Energy Agency; DONG Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S, Denmark 4. BASF SE; KfW, Germany 5. Goteborg Energi AB, Sweden 6. Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnment - IBGE, Belgium 7. Ruukki Metals Oy, Finland 8. EDP - Energias de Portugal, S.A.; Endesa Generacion, S.A.; Gas Natural SDG, S.A.; Hidroelectrica del Cantabrico, S.A.; Kingdom of Spain - Ministry of Agriculture, Food and Environment and Ministry of Economy and competitiveness, Spain 9. The Netherlands' Ministry of Infrastructure and the Environment, Netherlands 10. Government of Italy - Ministry for the Environment, Land and Sea, Italy 11. Kommunal Kredit Public Consulting GmbH, Austria 12. Statoil ASA, Norway 13. Fujifilm Corporation, Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated, Japan
Host Party(ies)	Bangladesh

Sectoral scope(s) and applied methodology(ies)	Sectoral Scope: 4: Manufacturing industries; Methodology: AMS-II.D - Energy efficiency and fuel switching measures for industrial facilities, version 12, EB 51
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	44,656 t CO2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	17,390 t CO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The purpose of the project was to construct 8 new energy efficient kilns for reducing CO_2 emissions in Bangladesh. At present, brick making is a highly energy-intensive activity and is one of the largest sources of greenhouse gas (GHG) emission in the country. By employing the technology embodied in the Hybrid Hoffman Kiln (HHK), the project piloted the introduction of modern and sustainable brick making technology to Bangladesh.

The HHK is a hybrid version of the Hoffman kiln technology that was developed in Germany in the mid-nineteenth century. Since then, it has been redesigned to improve heat retention in the kilns and to capture waste heat for recirculation in the drying tunnel. In addition, the coal consumption is reduced by introducing pulverized coal into the wet clay in each brick, which then, bakes the brick from the inside.

The production capacity of a HHK varies from a minimum of 50,000 bricks per day to several multiples of 50,000 bricks per day. Though each kiln by itself would qualify as a Clean Development Mechanism (CDM) project, the project bundled 8 HHKs, the aggregate maximum daily production capacity of which is 500,000 bricks per day, into one Project Design Document (PDD) for reducing the CDM transaction costs, whilst remaining within the small scale threshold for this type of project activity.

The Industrial & Infrastructure Development Finance Company Ltd. (IIDFC), which is a Bangladeshi financial institution, acts as the bundling agent for the 7 kiln owners. The construction of first kiln (Universal) under this project was started in 2006 and began its commercial operation in 2008. Other kilns (Diamond, Kapita, SSL (kiln-1) and Banalata) started their construction and operation during 2009-10. Sunflower and Haair brick kilns were the last kilns that came into operation in 2012. During the monitoring period of 01/09/2011 to 31/08/2012, only 7 kilns were operating and the aggregate capacity of those 7 kilns was 450,000 bricks per day.

The project was registered on18/08/2011. This report presents the emission reduction achieved for the period of 01/09/2011 to 31/08/2012. The total emissions reported for this monitoring period is 17,390 t CO_2e.

A.2. Location of project activity

Of the 8 HHK kilns proposed, SSL Ceramic Bricks (Kiln 2) HHK facility was not constructed. Locations of the rest of 7 HHK facilities are shown in the table 1 below.

Table 1. Location of kilns

HHK facility	Daily brick production	Host Party	Region / state / province	City / town / community	Latitude ˚ N	Longitude ˚ E
Unive sal Bricks Ltd. (Universal)	50,000	Bangladesh	Dhaka Division	Dhamrai	+23.58	+90.11
Haair Bricks Ltd. (Haair)	50,000	Bangladesh	Dhaka Division	Dhamrai	+23.58	+90.11
Diamond Auto Bricks Ltd. (Diamond)	100,000	Bangladesh	Dhaka Division	Narayangonj	+23.48	+90.34
SSL Ceramic Bricks (SSL (kiln-1))	50,000	Bangladesh	Dhaka Division	Gazipur	+24.10	+90.23
Kapita Auto Bricks (Kapita)	100,000	Bangladesh	Dhaka Division	Dhamrai	+23.52	+90.01
Banalata Refractory Ltd. (Banalata)	50,000	Bangladesh	Rajshai Division	Natore	+23.56	+90.14
Sunflower Bricks & Construction Materials Ltd. (Sunflower)	50,000	Bangladesh	Dhaka Division	Narayanganj	+23.48	+90.34

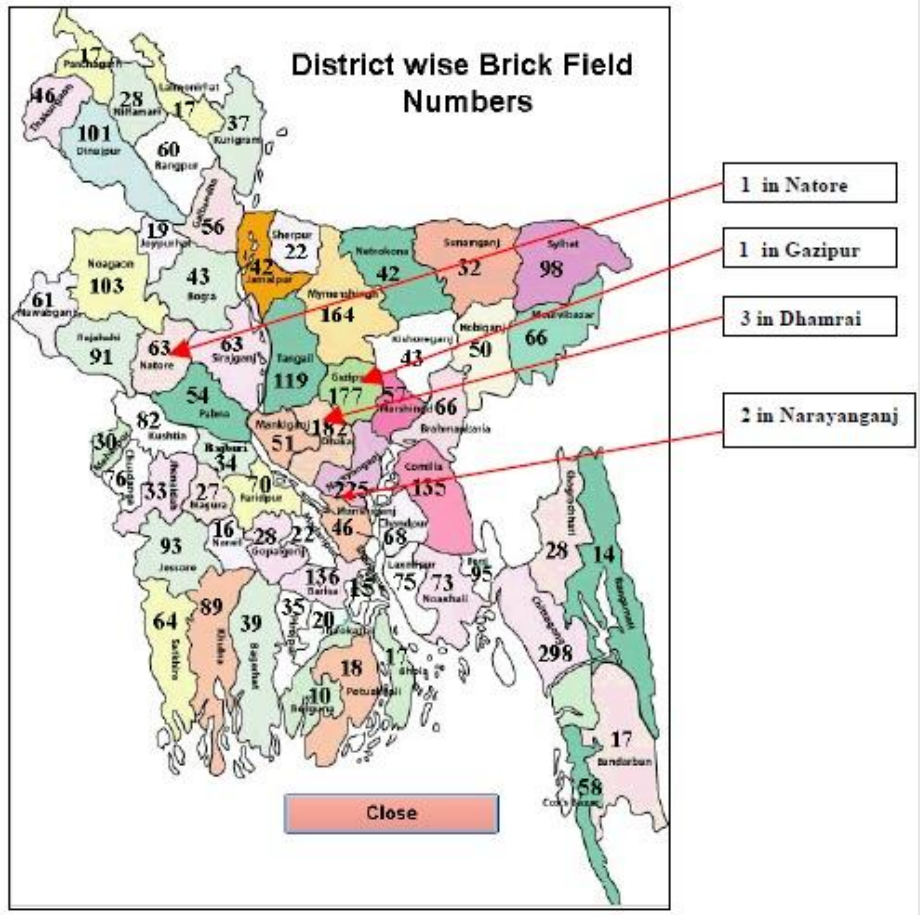

Figure 1: Map showing location of project kilns and the distribution of brick making activities throughout Bangladesh

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and / or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Bangladesh (host)	Industrial and Infrastructure Development Finance Company Ltd (IIDFC) (Private entity)	No
Luxembourg	Ministry of Sustainable Development and Infrastructure	Yes
Denmark	• International Bank for Reconstruction and Development (IBRD) as Trustee of the Danish Carbon Fund (DCF) • Danish Ministry of Climate and Energy / Danish Energy Agency • DONG Naturgas A/S • Maersk Olie og Gas A/S • Nordjysk Elhandel A/S	Yes
Germany	BASF SE; KfW	No
Sweden	Goteborg Energi AB	No

Belgium	• Walloon Region: Walloon Air and Climate Agency • Bruxelles Environnement - IBGE	Yes
Finland	Ruukki Metals Oy	No
Spain	• EDP - Energias de Portugal, S.A. • Endesa Generacion, S.A. • Gas Natural SDG, S.A. • Hidroelectrica del Cantabrico, S.A • Kingdom of Spain - Ministry of Agriculture, Food and Environment and Ministry of Economy and competitiveness	Yes
Netherlands	The Netherlands' Ministry of Infrastructure and the Environment	Yes
Italy	Government of Italy - Ministry for the Environment, Land and Sea	Yes
Austria	Kommunal Kredit Public Consulting GmbH	No
Norway	Statoil ASA	No
Japan	• Fujifilm Corporation • Idemitsu Kosan Co., Ltd. • JX Nippon Oil & Energy Corporation • The Okinawa Electric Power Corporation, Incorporated	No

A.4. Reference of applied methodology

Title : Type II – Energy Efficiency Improvement Projects
Reference : AMS-II.D - Energy Efficiency and Fuel Switching Measures for Industrial Facilities,
Version : 12, Sectoral Scope: 4, EB 51

The following CDM Executive Board guidelines and tools are also considered and applied:

- *Tool to calculate the emission factor for an electricity system, Version 2, EB 50, Annex 14; and*
- *General Guidelines for Sampling and Surveys for Small-Scale CDM Project Activities, version 01, EB 50, Annex 30*

A.5. Crediting period of project activity

Fixed crediting period of 10 years starting from 01/09/2011 to 31/08/2021 is chosen.

Crediting period reported in this monitoring report starts from 01/09/2011 to 31/08/2012.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

Initially at the time of the registration, a total of 8 brick kilns based on the HHK technology were planned to be constructed at different locations in Bangladesh. So far, 7 kilns have been commissioned at various points of time in the project timeline and are currently in operation. The construction of one brick kiln (SSL brick kiln 2) has been delayed and is expected to be in operation before the next monitoring report. As the technology is new to Bangladesh, technology services were largely imported from China by the brick kiln owners.

The brick kilns were designed and constructed to operate throughout the year in all seasons. However, to undertake corrective and preventive maintenance, the kilns were shutdown for 1-2 months a year.

The details of the implementation timeline and operation status of the kilns are presented in table 2.

Table 2. Project implementation details

No.	Kin name	Construction start date	Commissioning Date	Commercial operation start date	Is the kiln in continuous operation other than the maintenance period[1]?
1.	Universal	20/11/2006	01/01/2008	09/01/2008	Yes
2.	Haair	20/05/2007	19/02/2012	06/03/2012	Yes
3.	Diamond	23/03/2008	17/12/2008	01/02/2009	No[2]
4.	Kapita	14/04/2009	11/04/2010	09/05/2010	Yes
5.	SSL (kiln-1)	23/12/2008	16/05/2009	12/06/2009	No[3]
6.	SSL (kiln-2)	N/A	N/A	N/A	N/A[4]
7.	Banalata	13/10/2009	02/07/2010	15/08/2010	Yes
8.	Sunflower	01/10/2009	01/02/2012	01/03/2012	Yes

Technology description

A kiln consisting of 18-22 doors have a production capacity of 50,000 bricks per day and will be considered as single sized HHK. Universal, Haair, SSL (kiln-1), Banolata and Sunflower are single sized HHK kilns. A kiln consisting of 36-44 doors have a production capacity of 100,000 bricks per day and will be considered as double sized HHK. Diamond and Kapita are double sized HHK kilns.

The brick production process involves the following:

Clay extraction, transport and preparation: The clay is excavated by hydraulic excavator or by hand from a nearby area and transported to the plant-stacking yard by trucks. The clay is then crushed by means of roller mill, followed by a double-shaft mixer, where, water is added to ensure 15% moisture content.

Introduction of pulverized coal and shape the brick: Pulverized coal is mixed with the clay, which is fed into a vacuum extruder. A column of clay is pushed out / extruded. This is then cut into the green bricks, which are then manually loaded onto a drying car for drying.

Brick drying: The drying car is then moved into the drying tunnel. The drying cycle lasts for about 26 hours. The hot air in the drying tunnel is sucked in from the annular kiln.

Brick firing: The dried green bricks are removed from the drying tunnel and then, loaded manually into the annular HHK kiln. The speed of firing is 1.25 m/h at a sintering temperature of around 950°C - 1050°C. The fired bricks are unloaded and conveyed manually in carts to the stacking yard.

During the first monitoring period (01/09/2011 to 31/08/2012), the kilns were operating under 50 - 60% of their design capacities of brick production. The main reason for reduced brick production was that HHK being a new technology, little or no skilled labour was available for efficient kiln operations like raw material preparation for green bricks, proper coal feeding in kilns, effective equipment operation and maintenance. However, these are being addressed and capacity building is carried so that the kilns can achieve a stabilized / improved production capacity in the coming years.

[1] The kilns are totally shutdown for a period of 1-2 months annually to carry out regular planned maintenance.
[2] Not in operation since February 29, 2012 to till date. Since there is heat loss in kiln and leakage in the underground tunnel, the factory management has constructed overhead tunnel and is in the process of replacing blower. Expected start date: First week of February, 2013.
[3] Not in operation since July 01, 2012 due to the cracking problem of bricks. Factory management is consulting with the technology provider to resolve the issues.
[4] Since problem of the SSL-1 kiln is not solved yet, the construction of second kiln is postponed till the issue is resolved.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

Not applicable as there are no deviations from the registered monitoring plan**.**

B.2.2. Corrections

Not applicable as there are no corrections/modifications.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

Not applicable as there are no changes/modifications.

B.2.4. Changes to project design of registered project activity

Not applicable as there no changes in the project design.

B.2.5. Changes to start date of crediting period

Not applicable as there are no changes in the start date of the crediting period.

B.2.6. Types of changes specific to afforestation or reforestation project activity

Not applicable as the project does not involve afforestation or reforestation.

SECTION C. Description of monitoring system

The details of monitored parameters and their method of collection are described in Section D.2. The monitored data were recorded manually by the kiln operators during the kiln operation on daily basis. The line diagram of various locations of data monitoring are provided in figure 2.

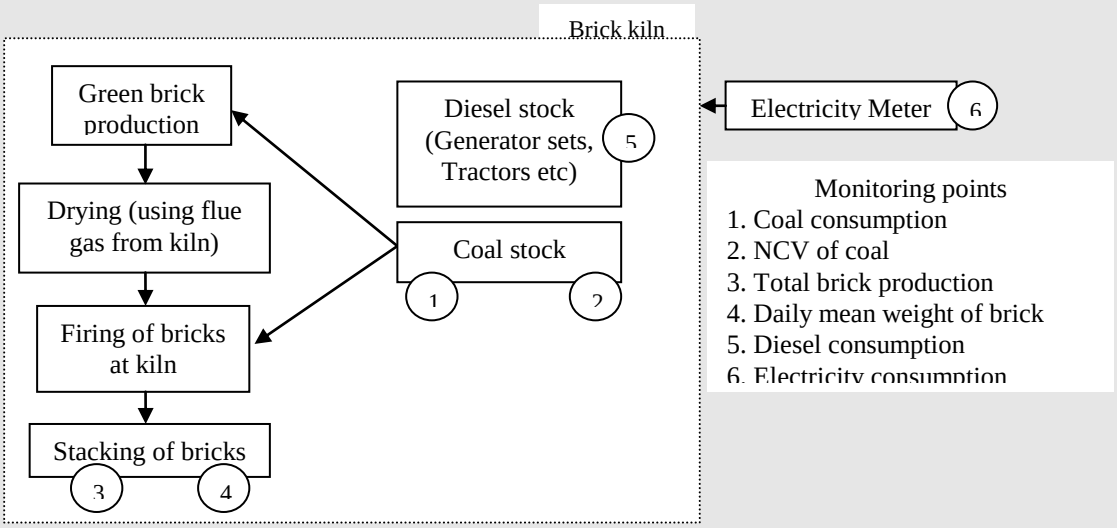

Figure 2: Location points of data monitoring

Each kiln owner has employed a competent person in his kiln / office as the CDM monitoring and compliance officer, whose responsibility is to collect the monitoring data as described in Section D.2. As mentioned in above figure, the CDM monitoring and compliance officer collects monitoring data from different departments / sections of the kiln and compile the data in the excel format provided by IIDFC, the bundling agent. The CDM monitoring and compliance officer is also responsible for monthly delivery of electronic version of the monitored data to IIDFC. Monitoring officer of IIDFC collects the data from each kiln on a monthly basis, creates the monitoring sheets (consolidation details of all the kilns), and submits these reports to the senior officer.

IIDFC had conducted various training sessions to the kiln CDM monitoring and compliance officers, kiln operators and training materials were provided to them. Standard data collection formats were prepared by IIDFC and provided to the kilns. The brick kilns were also guided through the CDM monitoring mechanisms

in terms of record keeping, overall maintenance and procedures for corrective action.

An audit was also carried out at each brick kiln by IIDFC to review the CDM compliance practices. The results were presented as a report to kilns. Improvements in monitoring system such as use of daily CDM log sheet to improve data recording were suggested.

The monitoring operations were carried out according to the following table:

Task and area of responsibility	Method used	Frequency	Responsible person	Contact details
Measurement of monitored data	Manual measurement, data recording	Daily	Operator in-charge	Respective kiln owner
Electronic recording	Transfer of date to electronic workbook format provided by IIDFC	Daily	CDM compliance and monitoring officer	Respective kiln owner
Collection and Storage of the data (measured calculated, estimated data)	Collection of monitoring data from each kiln	Monthly	Monitoring Officer	IIDFC
Calculation of the emission reductions and any deviations from projections	As per PDD/ monitoring plan with excel spreadsheets	Yearly	Monitoring Officer	IIDFC
QA/QC	As per the Operation and Monitoring Plan (OMP)	Yearly	Monitoring Officer	IIDFC
Kiln owner's staff training (CDM monitoring)	Training program as and when required	As and when required	IIDFC or their Consultants	IIDFC
Signs off on monitoring reports and achieved ERs		Yearly	Project in-charge	IIDFC

SECTION D. Data and parameters

D.1. Data and parameters fixed ex-ante or at renewal of crediting period

(Copy this table for each piece of data and parameter.)

Data / Parameter:	**CEF_{coal}**
Unit:	t C/TJ
Description:	Carbon emission factor per energy unit of coal
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories: Chapter 1: Introduction, Table 1-3; Default values of carbon content, pg.21.
Value(s) applied):	25.80
Purpose of data:	To calculate baseline emissions
Additional comment:	Default data from IPCC has been used as country specific data is not available.

Data / Parameter:	**CF**
Unit:	t CO_2e/t C
Description:	Carbon to CO_2 conversion factor
Source of data:	Not applicable
Value(s) applied):	3.66
Purpose of data:	To calculate baseline emissions

Additional comment:	Not applicable

Data / Parameter:	**$EF_{CO2, Elec}$**
Unit:	t CO_2e/MWh
Description:	Grid emissions factor per MWh of power produced
Source of data:	Bangladesh Designated National Authority, letter dated 09/02/2011, for period 2007 -2009
Value(s) applied):	0.62
Purpose of data:	To calculate baseline emissions
Additional comment:	The value has been fixed ex-ante.

Data / Parameter:	**$SEC_{FCK, Bricks}$**
Unit:	TJ/kg-brick
Description:	Key value in determining the current energy consumption of the existing Fixed Chimney Kilns (FCK) in Bangladesh
Source of data:	Calculation result using equation
Value(s) applied):	2.125×10^{-6}
Purpose of data:	To calculate the baseline emissions
Additional comment:	The value has been fixed ex-ante. Calorific value of Barapukuria coal 6,135 kcal/kg (as measured for this project) and coal use of 24 tonnes per 100,000 bricks were utilized to calculate the specific fuel consumption per kg - brick in the baseline (FCK) technology.

Data / Parameter:	**$SFC_{FCK, Bricks}$**
Unit:	kg of coal/brick
Description:	Specific fuel **(**coal) consumption (SFC) per unit FCK brick
Source of data:	1. Clean Development Mechanism Project Opportunities in Bangladesh, Pre-Feasibility Report on a Brick Manufacturing Fuel Substitution CDM Project, Bangladesh University of Engineering, December 2002, Table A, pg 3: http://pubs.pembina.org/reports/cdm_bangladesh_brickkilns.pdf 2. Emissions Baseline Report for the IKEBMI Project (PDF-B Phase BGD/04/014) by The Louis Berger Group, Washington DC, June 2006, Table 2, pg 3
Value(s) applied):	0.24
Purpose of data:	To calculate the baseline emissions
Additional comment:	Country specific SFC data for FCK is available and therefore used

Data / Parameter:	**$M_{FCK ,brick}$**
Unit:	kg/brick
Description:	Weight of per unit FCK brick
Source of data:	As per IIDFC study titled " Weight of Bricks in Bangladesh, 2009"
Value(s) applied):	2.9
Purpose of data:	To calculate total mass of brick produced per year

Additional comment:	Average specific weight per unit brick was determined through direct measurement of a substantial number of FCK bricks.

Data / Parameter:	**$NCV_{Diesel,y}$**
Unit:	TJ/kl
Description:	Weighted average net calorific value of diesel (fuel type) in year y
Source of data:	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) applied):	0.036509
Purpose of data:	To calculate project emissions
Additional comment:	In mass unit, the value is 43.3 TJ/Gg or 43.3 MJ/kg. The density used for the conversion is 0.8432 litre/kg.

Data / Parameter:	**$Density_{Diesel,y}$**
Unit:	kg/litre
Description:	Density value of diesel (fuel type) in year y
Source of data:	IPCC default values as provided in Table 11 (pg. 81) of Chapter Energy of the 2002 IPCC Background Papers on Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories
Value(s) applied):	0.8432
Purpose of data:	To calculate project emissions
Additional comment:	Density = 1/Specific volume. The specific volume published by IPCC is 1,186 kilolitre/Gg or 1.186 litre/kg.

Data / Parameter:	**$EF_{CO2, Diesel,y}$**
Unit:	t CO_2/TJ
Description:	Weighted average CO_2 emission factor of fuel type i in year y
Source of data:	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) applied):	74.8
Purpose of data:	To calculate project emissions
Additional comment:	Default data from IPCC is used in the absence of values provided by the fuel supplier in invoices, measurements by the project participants and regional or national default values.

D.2. Data and parameters monitored

(Copy this table for each piece of data and parameter.)

Data / Parameter:	**$TC_{Coal,i,y}$**
Unit:	Tonnes/year
Description:	Total consumption of coal for brick making in brick kiln i in year y

Measured/ Calculated / Default:	Measured
Source of data:	Invoices from the coal suppliers and coal stock / consumption registers
Value(s) of monitored parameter:	

No.	Kiln name	t/year
1.	Universal	1,701
2.	Haair	723
3.	Diamond	1,407
4.	SSL kiln-1	850
5.	Kapita	2,465
6.	Banalata	1,049
7.	Sunflower	935

Monitoring equipment:	Total purchase indicates the amount of coal supplied and consumed in brick production. These invoices are gathered in the project office. Data is included in the monthly report. Net consumption is calculated at the end of each year by tallying out the total coal purchase with opening stock and closing stock of coal in that year. No equipment is used.
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Coal stock at the end of each verification period is estimated and noted down. The coal stock register is used to cross check the brick production.
Purpose of data:	To calculate the project emissions
Additional comment:	The data will be archived for two years after the crediting period

Data / Parameter:	**$NCV_{Coal,i,y}$**
Unit:	TJ/kg
Description:	Net calorific value of coal used in y^{th} year in brick kiln i
Measured/ Calculated / Default:	Measured
Source of data:	Independently tested at a credible laboratory in Bangladesh.
Value(s) of monitored parameter:	

No.	Kiln name	x 10^{-5} TJ/kg
1.	Universal	2.64
2.	Haair	2.92
3.	Diamond	2.06
4.	SSL (kiln-1)	3.10
5.	Kapita	2.71
6.	Banalata	2.40
7.	Sunflower	1.93

Monitoring equipment:	No equipment is used.
Measuring/ Reading/ Recording frequency:	Quarterly
Calculation method (if applicable):	A composite sample of 1 kg is taken from each new consignment of coal at each kiln. At the end of each quarter, all the samples taken in that quarter are crushed and mixed to produce a representative sample for that quarter. The sample is laboratory tested to determine the net calorific value of coal used for that particular quarter. The entire data is monitored and archived on paper and in electronic format. Average of the net calorific values of different quarters is calculated at the end of each verification / crediting period and is considered as the net calorific value of coal used by related brick kiln in that crediting period.
QA/QC procedures:	IIDFC check the coal consumption data by inspecting the coal stock register and reports of calorific value tests at the end of crediting period.
Purpose of data:	To calculate project emissions
Additional comment:	The data will be archived for two years after the crediting period

Data / Parameter:	**$DP_{Bricks,i}$**
Unit:	Bricks
Description:	Annual cumulative daily production of bricks in brick kiln i
Measured/ Calculated / Default:	Measured
Source of data:	Daily brick production registers through manual count of bricks.
Value(s) of monitored parameter:	

No.	Kiln name	Bricks
1.	Universal	8,030,800
2.	Haair	4,952,800
3.	Diamond	8,814,326
4.	SSL (kiln-1)	5,906,000
5.	Kapita	18,213,536
6.	Banalata	7,822,804
7.	Sunflower	6,926,900

Monitoring equipment:	No equipment is used.
Measuring/ Reading/ Recording frequency:	Daily

Calculation method (if applicable):	The daily brick production is noted in a log sheet every day which is maintained in the project plant. Supervisor verifies the log sheet at the end of each day. The data is provided to the CDM monitoring and compliance officer, who maintains the data gathered at the project office. Monthly reports are prepared regularly by the CDM monitoring and compliance officer and are stored in electronic and paper modes.
QA/QC procedures:	The amount of bricks manufactured at the end of each crediting period is cross checked with the invoices for the sale of bricks and the stock in the plant.
Purpose of data:	To calculate the baseline and project emissions
Additional comment:	The data will be archived for two years after the crediting period

Data / Parameter:	**$DMW_{HHK\ Bricks,di}$**
Unit:	kg
Description:	Daily mean weight of baked HHK bricks in brick kiln i
Measured/ Calculated / Default:	Measured
Source of data:	On-site measurements by the operator in-charge
Value(s) of monitored parameter:	<table><tr><th>No.</th><th>Kiln name</th><th>kg</th></tr><tr><td>1.</td><td>Universal</td><td>3.25</td></tr><tr><td>2.</td><td>Haair</td><td>3.18</td></tr><tr><td>3.</td><td>Diamond</td><td>3.57</td></tr><tr><td>4.</td><td>SSL (kiln-1)</td><td>3.63</td></tr><tr><td>5.</td><td>Kapita</td><td>3.02</td></tr><tr><td>6.</td><td>Banalata</td><td>3.06</td></tr><tr><td>7.</td><td>Sunflower</td><td>3.60</td></tr></table>
Monitoring equipment:	Weighing scale
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	The average weight of bricks is calculated using the simple random sampling as per the “General Guidelines for Sampling and Surveys for Small Scale CDM Project Activities (EB 50, Annex 3)”. On each production day, a sample of 100 bricks is taken and weighed using a weighing scale and the mean weight is calculated. The average mean weight of bricks of all the daily mean brick weight of that monitoring period is used for CER calculation.
QA/QC procedures:	Since there is no proper institutional / laboratory set up available for easy processing of calibration, new weighing scales are purchased every year by the kilns to ensure the accuracy of measurements. This is also supported by the affordable cost of weighing scales.
Purpose of data:	To calculate the baseline and project emissions

Additional comment:	The data will be archived for two years after the crediting period

Data / Parameter:	**$SEC_{i,y}$**
Unit:	TJ/kg-brick
Description:	Specific energy consumption in brick kiln i
Measured/ Calculated / Default:	Calculated using the annual mass of brick production and annual energy consumption using coal as fuel
Source of data:	Calculation result using equation (Refer section E.2)
Value(s) of monitored parameter:	
Monitoring equipment:	No equipment is used.
Measuring/ Reading/ Recording frequency:	Annual
Calculation method (if applicable):	The specific fuel consumption per brick is calculated once a year based on the data of coal consumed and the total mass of bricks produced during the corresponding period.
QA/QC procedures:	The data is cross checked by comparing it with the quantity of bricks sold / in stock and coal purchased based on the purchase receipts and coal registers
Purpose of data:	To calculate the project emissions
Additional comment:	The data will be archived for two years after the crediting period.

No.	Kiln name	x 10^{-6} TJ/kg-brick
1.	Universal	1.088
2.	Haair	1.340
3.	Diamond	0.923
4.	SSL (kiln-1)	1.223
5.	Kapita	1.215
6.	Banalata	1.055
7.	Sunflower	0.727

Data / Parameter:	**N**
Unit:	days
Description:	Number of operational days of the kiln in a year
Measured/ Calculated / Default:	Measured
Source of data:	Recorded by the operator in-charge

Value(s) of monitored parameter:	<table><tr><th>No.</th><th>Kiln name</th><th>Days</th></tr><tr><td>1.</td><td>Universal</td><td>272</td></tr><tr><td>2.</td><td>Haair</td><td>153</td></tr><tr><td>3.</td><td>Diamond</td><td>182</td></tr><tr><td>4.</td><td>SSL (kiln-1)</td><td>225</td></tr><tr><td>5.</td><td>Kapita</td><td>286</td></tr><tr><td>6.</td><td>Banalata</td><td>305</td></tr><tr><td>7.</td><td>Sunflower</td><td>170</td></tr></table>
Monitoring equipment:	No equipment is used
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	The operator in-charge keeps a record of the number of operational days of the kiln during the year based on the brick production from kilns.
QA/QC procedures:	The CDM monitoring and compliance officer verifies the recorded data.
Purpose of data:	To calculate the baseline and project emissions
Additional comment:	The data will be archived for two years after the crediting period

Data / Parameter:	**$FC_{Diesel,j,y}$**
Unit:	kl/yr
Description:	Quantity of diesel (fuel type) combusted in the process j during the year y
Measured/ Calculated / Default:	Measured
Source of data:	Invoices from the suppliers and diesel consumption / stock registers
Value(s) of monitored parameter:	<table><tr><th>No.</th><th>Kiln name</th><th>kl/yr</th></tr><tr><td>1.</td><td>Universal</td><td>45.6</td></tr><tr><td>2.</td><td>Haair</td><td>33.5</td></tr><tr><td>3.</td><td>Diamond</td><td>15.7</td></tr><tr><td>4.</td><td>SSL (kiln-1)</td><td>44.5</td></tr><tr><td>5.</td><td>Kapita</td><td>85.0</td></tr><tr><td>6.</td><td>Banalata</td><td>30.3</td></tr><tr><td>7.</td><td>Sunflower</td><td>17.3</td></tr></table>
Monitoring equipment:	No equipment is used.
Measuring/ Reading/ Recording frequency:	Daily

Calculation method (if applicable):	Purchase indicates the amount of diesel supplied. These invoices are gathered in the project office. Data is included in the monthly report. At the end of each year, net consumption is calculated from total purchase, opening stock and closing stock of that year.
QA/QC procedures:	The diesel stock at the end of each verification period is estimated and noted down in the annual report and the diesel stock register is used to cross check brick production.
Purpose of data:	To calculate project emissions
Additional comment:	The data will be archived for two years after the crediting period

Data / Parameter:	**$EC_{i,y}$**
Unit:	MWh
Description:	Electricity consumption in kiln i per year
Measured/ Calculated / Default:	Measured
Source of data:	Electricity bill from the REB or the electricity supplier
Value(s) of monitored parameter:	
Monitoring equipment:	Energy meter
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Monthly electricity bill paid to Rural Electricity Board (REB) is used to calculate the total electricity consumption of the month and is noted down in the monthly report
QA/QC procedures:	Monthly electricity bill readings are cross checked with the monthly meter readings
Purpose of data:	To calculate project emissions
Additional comment:	The data will be archived for two years after the crediting period

No.	Kiln name	MWh
1.	Universal	385.8
2.	Haair	135.2
3.	Diamond	188.7
4.	SSL (kiln-1)	212.9
5.	Kapita	846.3
6.	Banalata	346.4
7.	Sunflower	146.0

D.3. Implementation of sampling plan

The project proponent used the simple random sampling method to determine the mean daily value of the HHK brick weight for each kiln. The representative sample size was chosen ex-ante so as to achieve 90% confidence interval with +/-10% error margin. The sample size was calculated based on precision, confidence level and standard deviation. Since the standard deviation for the entire population was unknown, an estimate of standard deviation was used.

Sample size was calculated as,

Minimum Sample Size, $n_O = (Z^2 \times \sigma^2) / e^2$

Where,

Z = Z value (1.645 for 90% confidence level)

σ = 0.5 (standard deviation based on maximum expected variance)

e = 0.1 (margin of error for 10% precision)

Substituting the values in the above equation, the sample size required was calculated as,

n_O = (1.6452× 0.52) / 0.12 = 68

However, as a conservative approach, 100 samples per day were taken for brick weight measurement. A sample of 100 bricks is randomly selected from total bricks unloaded on every operational day from each kiln. It was ensured that the samples were collected from all the gates that were unloaded on a day so as to get a representative sampling. The bricks were weighed separately using weigh scale and the daily mean weight of brick produced was recorded by the operator in-charge.

To prove that the required precision is achieved, the 100 sample weight measurement of each brick kiln is analyzed. The analysis results are tabulated as below.

Table 3. Analysis of brick weight measurements

No.	Parameter[5]	Universal	Haair	Diamond	SSL (Kiln-1)	Kapita	Banalata	Sunflower
1	Mean	3.257	3.188	3.599	3.634	3.031	3.098	3.584
2	Standard deviation	0.084	0.054	0.109	0.224	0.019	0.102	0.109
3	Sample variance	0.007	0.003	0.012	0.050	0.000	0.010	0.012
4	Minimum	3.100	3.110	3.390	3.200	2.988	2.840	3.390
5	Maximum	3.400	3.250	3.880	4.109	3.131	3.270	3.880
6	Standard error	0.008	0.005	0.011	0.022	0.002	0.010	0.011
7	Confidence interval	3.271	3.197	3.617	3.671	3.035	3.114	3.602
		3.243	3.179	3.581	3.597	3.028	3.081	3.566
8	Precision (%)	0.43	0.28	0.50	1.02	0.11	0.55	0.50

From the above analysis, the lowest precision level of the brick weight measurement in the brick kilns was found to be 1.02% as against the required level of 10%. Hence, the sampling results are in conformity with the CDM requirements.

The average of daily mean weight measurements taken for all the operating days in a year is taken as brick weight for emission reduction calculation for each kiln.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

The baseline emissions BE_y from the baseline activity, if the equivalent amount of bricks that were produced in the i^{th} kiln were to be produced by using FCK technology, are calculated as follows:

$$BE_y = \sum_{i=1}^{7} BE_{FCK\ i,\ y}$$

$$= 5{,}231 + 3{,}156 + 6{,}323 + 4{,}300 + 11{,}055 + 4{,}803 + 4{,}998$$

$$= 39{,}886\ t\ CO_2/year$$

Where,

$BE_{FCK\ i,\ y}$ = Baseline emissions per year for the i^{th} kiln

[5] For 100 samples weighed for a respective production day of a kiln

=	$TP_{Bricks, i, y}$	x	$SEC_{FCK, Bricks, y}$	x	CEF_{coal}	x	CF	
	[kg-bricks(y)]		[TJ/kg-brick]		[t C/TJ]		[t CO_2/t C]	

Where,

$TP_{Bricks,i,y}$ = Total production of bricks per year in kiln i (kg-bricks/year)
$SEC_{FCK, Bricks,y}$ = Specific energy consumption in FCK technology (TJ/kg-brick)
CEF_{coal} = IPCC default carbon emission factor for fuel used (t C/TJ)
CF = Carbon to CO_2 Conversion Factor (t CO_2/t C)

Table 4. Estimation of baseline emission

No.	Kiln name	$TP_{Bricks, i, y}$ kg-bricks		$SEC_{FCK, Bricks, y}$ TJ/kg-brick		CEF_{coal} t C/TJ		CF t CO_2/t C		$BE_{FCK i, y}$ t CO_2/year
1.	Universal	26,063,515								5,231
2.	Haair	15,725,949								3,156
3.	Diamond	31,505,339	x	2.125×10^{-6}	x	25.8	x	3.66	=	6,323
4.	SSL (kiln-1)	21,426,968								4,300
5.	Kapita	55,084,606								11,055
6.	Banalata	23,933,087								4,803
7.	Sunflower	24,905,182								4,998

E.2. Calculation of project emissions or actual net GHG removals by sinks

Total project emissions in y^{th} year, PEy, by operations of N units of HHK kilns (N=7) are given by:

$$PE_y = \sum_{i=1}^{7} PE_{HHK\ i,\ y}$$

= 3,043 + 2,165 + 2,907 + 2,749 + 7,080 + 2,683 + 1,848
= 22,475 t CO_2/year

Where,

$PE_{HHK\ i,\ y}$ = Project emissions from operation of i^{th} kiln in year y

= $SEC_{i,y}$ [TJ/kg-brick(y)] x $TP_{Bricks, i, y}$ [kg-bricks(y)] x CEF_{coal} [t C/TJ] x CF [t CO_2/tC] +

$EC_{i,y}$ [MWh] x $EF_{CO2,Elec}$ [t CO_2/MWh] + $PE_{FC,j,y}$ [t CO_2/year]

Where,

$SEC_{i,y}$ = Specific energy consumption in kiln i (TJ/kg-brick)
$TP_{Bricks,i,y}$ = Total production of bricks per year in kiln i (kg-bricks/year)
CEF_{coal} = IPCC default carbon emission factor for fuel used (t C/TJ)
CF = Carbon to CO_2 Conversion Factor (t CO_2/t C)
$EC_{i,y}$ = Electricity consumption in kiln i per year (MWh)
$EF_{CO2, Elec}$ = Estimated CO_2 emissions factor for grid electricity in Bangladesh (t CO_2/MWh)
$PE_{FC,j,y}$ = CO_2 emissions from fossil fuel combustion in year y (t CO_2/yr)

Table 5. Estimation of project emission

Table 6.

No.	Kiln name	$SEC_{i, v}$ TJ/kg-brick x 10^{-6}		$TP_{Bricks, i, y}$ kg-bricks		CEF_{coal} t C/TJ		CF t CO_2 / t C		$EC_{i, v}$ MWh		$EF_{CO2,Elec}$ t CO_2 / MWh		$PE_{FC,i,v}$ t CO_2 / year		$PE_{HHK i, v}$ t CO_2 / year
1.	Universal	1.088		26,063,515						385.8				124		3,043
2.	Haair	1.340		15,725,949						135.2				91		2,165
3.	Diamond	0.923	x	31,505,339	x		x		+	188.7	x		+	43	=	2,907
4.	SSL (kiln-1)	1.223		21,426,968		25.8		3.66		212.9		0.62		122		2,749
5.	Kapita	1.215		55,084,606						846.3				232		7,080
6.	Banalata	1.055		23,933,087						346.4				83		2,683
7.	Sunflower	0.727		24,905,182						146.0				47		1,848

From the monitored data, the specific energy consumption for the individual kilns is calculated using the following formulae:

$$SEC_{i, y} = TC_{Coal\ i,y} \times NCV_{Coal\ i, y} / TP_{Bricks, i, y}$$

[tonnes(y)] [TJ/kg(y)] [kg-bricks (y)]

Where,

$TC_{Coal\ i,y}$ = Total consumption of coal per year for kiln i (tonnes)

$NCV_{Coal\ i, y}$ = Weighted average net calorific value of coal used in y^{th} year in kiln i (TJ/kg)

Table 7. Estimation of specific energy consumption

No.	Kiln name	T $C_{Coal\ i,y}$ tonnes(y)		$NCV_{Coal\ i, y}$ TJ/kg(y) x 10^{-5}		$TP_{Bricks, i, y}$ kg- bricks(y)		$SEC_{i, y}$ TJ/kg-brick x10^{-6}
1.	Universal	1,701		2.64		26,063,515		1.088
2.	Haair	723		2.92		15,725,949		1.340
3.	Diamond	1,407		2.06		31,505,339		0.923
4.	SSL (kiln-1)	850	x	3.10	÷	21,426,968	=	1.223
5.	Kapita	2,465		2.71		55,084,606		1.215
6.	Banalata	1,049		2.40		23,933,087		1.055
7.	Sunflower	935		1.93		24,905,182		0.727

$$TP_{Bricks,i,y} = \sum_{d=1} DP_{Bricks,di} \times DMW_{HHK\ brick,di}$$

[nos] [kg/brick]

Where,

$DP_{Bricks\ di}$ = Daily pr duction of bricks in kiln i (bricks/day)

$DMW_{HHK\ bricks,di}$ = Daily mean weight of HHK bricks in kiln i (kg/brick)

n = Total no. of production days for kiln i in a year

Table 8. Estimation of total mass of brick production

No.	Kiln name	No. of production days	$DP_{Bricks,di}$ nos.		$DMW_{HHK\ brick,di}$ kg/brick		$TP_{Bricks, i, y}$ kg-bricks(y)
1.	Universal	272	8,030,800	x	3.25	=	26,063,515
2.	Haair	153	4,952,800		3.18		15,725,949
3.	Diamond	182	8,814,326		3.57		31,505,339
4.	SSL (kiln-1)	225	5,906,000		3.63		21,426,968

5.	Kapita	286	18,213,536		3.02		55,084,606
6.	Banalata	305	7,822,804		3.06		23,933,087
7.	Sunflower	170	6,926,900		3.60		24,905,182

$PE_{FC,j,y}$ = $FC_{Diesel, j, y}$ x $COEF_{Diesel, y}$
[kl/year] [t CO_2/ kl]

Where,

$FC_{Diesel, j,y}$ = Quantity of diesel (fuel type) combusted in process *j* during the year *y* (kl/yr)
$COEF_{Diesel, y}$ = CO_2 emission coefficient of diesel (fuel type) in year *y* (t CO_2/ kl)

Table 9. Estimation of emissions from fossil fuel combustion

No.	Kiln name	$FC_{Diesel, i, v}$ kl/yr		$COEF_{Diesel, v}$ t CO_2/kl		$PE_{FC,i,v}$ t CO_2/yr
1.	Universal	45.6				124
2.	Haair	33.5				91
3.	Diamond	15.7	x	2.7	=	43
4.	SSL (kiln-1)	44.5				122
5.	Kapita	85.0				232
6.	Banalata	30.3				83
7.	Sunflower	17.3				47

E.3. Calculation of leakage

Not applicable

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	39,866	22,475	0	17,390

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	44,656	17,390

E.6. Remarks on difference from estimated value in registered PDD

No increase was observed in the actual GHG emission reductions versus those estimated in the PDD. Instead, the value achieved is less than the PDD estimated value.

Among the 8 brick kilns proposed for construction, SSL brick kiln (kiln 2) is yet to be constructed. Only 4 brick kilns (Diamond, Kapita, SSL (kiln-1) and Universal) started their operations before 01/09/2011 (start date of crediting period). Banalata brick kiln started operations in October 2011 and Sunflower and Haair started operations only in March 2012. Thus, the overall operation days of the kilns were less than the expected during this monitoring period.

Also, most of the kilns are yet to fully stabilize their kiln operations and are still running at around 50-60% of their full brick production capacity. The main reason for reduced brick production is that HHK being a new technology, little or no skilled labour is available for efficient operations like raw material preparation for green bricks, proper coal feeding in kilns, effective equipment operation and maintenance, etc. However, these are being addressed and capacity building is carried so that the kilns can achieve a stabilized/improved production capacity in coming years.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	17,390	Not applicable.

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Document information

Version	*Date*	*Description*
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
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