Monitoring report form for CDM project activity
(Version 06.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT	
Title of the project activity	Improving Kiln Efficiency In The Brick Making Industry In Bangladesh
UNFCCC reference number of the project activity	5125
Version number of the PDD applicable to this monitoring report	Version 16
Version number of this monitoring report	01
Completion date of this monitoring report	08/12/2017
Monitoring period number	Fourth Monitoring Period
Duration of this monitoring period	01/01/2016 to 30/11/2017
Monitoring report number for this monitoring report	01
Project participants	• Industrial and Infrastructure Development Finance Company Ltd. (IIDFC) (Private Entity), Bangladesh • Ministry of Sustainable Development and Infrastructure, Luxembourg • International Bank for Reconstruction and Development (IBRD) as Trustee of the Danish Carbon Fund • Danish Ministry of Climate, Energy and Building / Danish Energy Agency, Denmark. • Dong Energy Slag & Service A/S, Denmark. • Maersk Olie og Gas AS, Denmark. • Nordjysk Elhandel A/S, Denmark. • Aalborg Portland A/S, Denmark. • Walloon Air and Climate Agency, Belgium. • Bruxelles Environment – IBGE, Belgium. • Government of Italy – Ministry for the Environment, Land and Sea. • Kommunal Kredit Public Consulting GmbH, Austria. • Fujifilm Corporation, Japan. • JX Nippon Oil & Energy Corporation, Japan.
Host Party	Bangladesh

Sectoral scopes	4: Manufacturing Industries	
Applied methodologies and standardized baselines	AMS-II.D – Energy efficiency and fuel switching measures for industrial facilities, version 12, EB 51	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 t CO2e	43,245 tCO2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	84,572 t CO2e[1]	

[1] As per PDD, 44,098 t CO_2e is estimated annually. Estimated CER for the monitoring period years is (44,098÷365×700)=84,572 t CO_2e

SECTION A. Description of project activity

A.1. General description of project activity

Brick making is a highly energy-intensive activity and is one of the largest sources of greenhouse gas (GHG) emissions 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 purpose of the project was to construct six[2] new energy efficient Hybrid Hoffman Kiln (HHK) brick making units for reducing CO2 emissions in Bangladesh.

Clay bricks, one of the most popular construction materials in Bangladesh, are generally produced by Fixed Chimney Kilns (FCKs). They produce this bricks using a very ancient technology where the heat loss is very high combined with inefficient burning of the fuel thus increasing coal consumption that results in further CO_2 emission. Moreover, these kilns operate only during the dry season.

The HHK is a hybrid version of the Hoffman Kiln technology, which was developed in Germany in the mid-nineteenth century. Since then, it has been modified to improve heat retention in the kilns and to capture the waste heat from the flue gas for recirculation in the drying chamber. In addition, the coal consumption is reduced by mixing a small amount of pulverised coal with the clay to introduce internal baking.

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 the six HHKs, the aggregate maximum daily production capacity of which is 400,000 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.

Industrial & Infrastructure Development Finance Company Ltd. (IIDFC), a Bangladesh based Financial Institution, acts as the bundling agent for the six kiln owners. The construction of the first kiln (Universal) under this project started in 2006 and began its commercial operation in 2008. Other kilns (Diamond, Kapita and Banalata) started their construction and operation during 2009-2010. Sunflower and Haair brick kilns were the last ones that came into operation in 2012. More details on operational timeline of each kiln are provided in section B.1.

The project was registered on 18/08/2011[3]. This report presents the emission reductions achieved for the period from 01/01/2016 to 30/11/2017. The total emission reduction reported for this monitoring period is 43,245 t CO2e.

[2] SSL Ceramic Bricks Ltd. (kiln 1 and kiln 2) were initially added in the bundle during registration of PDD. However, the SSL kiln 1 discontinued its operation from 01/07/2012 due to cracking issues in baked bricks. SSL kiln 2 is also not constructed due to the above issues. Hence, these two kilns are removed from PDD during Post Registration Changes (PRC).http://cdm.unfccc.int/PRCContainer/DB/prcp194084662/view

[3] http://cdm.unfccc.int/Projects/DB/DNV-CUK1313585039.34/view

A.2. Location of project activity

Locations of the six HHK facilities are furnished 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
Universal Bricks Ltd. (Universal)	50,000	Bangladesh	Dhaka Division	Dhamrai	+23.58 +90.11
Haair Bricks Ltd. (Dhamrai)	50,000	Bangladesh	Dhaka Division	Dhamrai	+23.58 +90.11
Diamond Auto Bricks Ltd.	100,000	Bangladesh	Dhaka Division	Narayanganj	+23.48 +90.34
Kapita Auto Bricks	100,000	Bangladesh	Dhaka Division	Dhamrai	+23.52 +90.01
Banalata Refractory Ltd.	50,000	Bangladesh	Rajshahi Division	Natore	+23.56 +90.14
Sunflower Bricks & Construction Materials Ltd.	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

A.3. Parties and project participants

Parties involved	Project participants	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 • Danish Ministry of Climate, Energy and Building / Danish Energy Agency • Dong Energy Slag & Service A/S • Maersk Olie og Gas AS • Nordjysk Elhandel A/S • Aalborg Portland A/S	Yes
Belgium	• Walloon Air and Climate Agency • Bruxelles Environment – IBGE	Yes
Italy	Government of Italy – Ministry for the Environment, Land and Sea	Yes
Austria	Kommunal Kredit Public Consulting GmbH	No
Japan	• Fujifilm Corporation • JX Nippon Oil & Energy Corporation	No

A.4. Reference to applied methodologies and standardized baselines

Title : Type II – Energy Efficiency Improvement Projects
Reference : AMS-II.D – Energy Efficiency and Fuel Switching Measures for Industrial Facilities
Version : 12, EB 51, December 2009
Sectoral Scope : 4, Manufacturing Industries

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[4]; and
- Guidelines for Objective Demonstration and Assessment of Barriers, version 1.0, EB 50[5]
- Guidelines for sampling and surveys for CDM project activities and programme of activities, version 3.0, EB 75[6] (as followed in PRC PDD)

A.5. Crediting period type and duration

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

Monitoring period reported in this report is from 01/01/2016 to 30/11/2017

[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf
[5] https://cdm.unfccc.int/EB/050/eb50_repan13.pdf
[6] http://cdm.unfccc.int/filestorage/e/x/t/extfile-20131010103828384-meth_guid48.pdf/meth_guid48.pdf?t=VzV8bmwwbHYxfDBlou_BWCE16E9nXjr4L72j

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

Technology description

Initially at the time of the registration, a total of eight brick kilns based on the HHK technology were planned to be constructed at different locations in Bangladesh.

The brick production involves the following processes:

Clay extraction, transportation and preparation: The clay is excavated by hydraulic excavator or by hand from a nearby area and transported to the kiln clay stock 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.

Pulverized coal introduction and shaping 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 *22*-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.

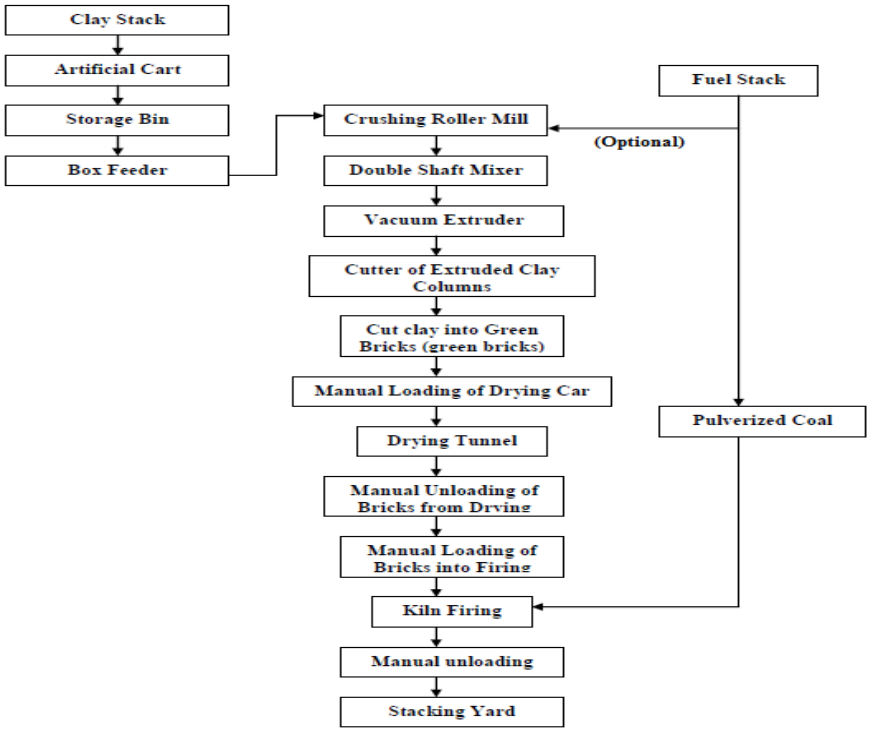


Figure 2: Process Flow Diagram of a HHK unit

During this monitoring period (01/01/2016 to 30/11/2017), the kilns were operating at 45 – 85% of their rated production capacity. The reason for less brick production during the monitoring period is mainly due to the extended monsoon this year, which resulted in shortfall of raw material supply and slowed down the construction sector.

Implementation and Actual Operation of the Project Activity

The idea of the project at the time of registration was to construct eight HHK based brick making units at different locations in Bangladesh.

SSL Ceramic Bricks Ltd. (kiln 1 & 2) were initially added in the bundle during the registration of the PDD. However, the SSL kiln 1 could not operate from 01/07/2012 due to cracking issues of the baked bricks. SSL kiln 2 was not constructed due to the above issue. Hence, these two kilns were removed from the PDD during Post registration Changes (PRC).

Diamond and Sunflower kilns are owned by the same person and were closed completely during the monitoring period due to some financial constraints of the kiln owner resulted from his other businesses. Thus, there were no operation or any kind of production from these 02 (two) kilns during this monitoring period. However, they are working to resume production by solving their issues.

The technology was imported from China by the brick kiln owners. Kilns were designed and constructed to operate throughout the year in all seasons. However, to undertake corrective and preventive maintenance, the kilns may be for 1-2 months a year. The details of operational and shutdown duration of each kiln during this monitoring period (01/01/2016 to 30/11/2017) are provided in appendix 2.

Table 2: Project implementation details

No.	Kiln Name	Construction start date	Commissioning Date	Commercial operation start date	Is the kiln in continuous operation other than the maintenance period[7]?	Operational days in the monitoring period
1	Universal	20/11/06	01/01/08	09/01/08	Yes	665
2	Haair	20/05/07	19/02/12	01/03/12	Yes	682
3	Diamond	23/03/08	17/12/08	01/02/09	No	0
4	Kapita	14/04/09	11/04/10	15/03/10	Yes	656
5	Banalata	13/10/09	02/07/10	01/06/10	Yes	687
6	Sunflower	01/10/09	01/02/12	01/03/12	No	0

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

Not applicable

[7] The kilns may be totally shut down for a period of 1-2 months annually to carry out maintenance activities

B.2.2. Corrections

Not applicable

B.2.3. Changes to the start date of the crediting period

Not applicable

B.2.4. Inclusion of monitoring plan

Not applicable

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

After the registration of the project, there were few changes in the registered monitoring plan. The changes were carried out in the revised PDD version 16, dated 08/04/2014 and was approved by UNFCCC through a Post Registration Change (PRC) request [8] (ref no: PRC-5125-001) on 01/07/2014. The main changes to the registered project were as follows:

- Direct monitoring of "Total consumption of coal" is implemented with the daily coal consumption measurement using digital weighing scale. The coal consumption will be measured by counting the number of buckets/sacks of coal consumed per day. Each of the bucket/sack of coal is weighed to determine the weight of a bucket of coal using a digital weighing scale.
- QA/QC procedures for ensuring the accuracy of digital weighing scales are revised to purchase new weighing scale, every year
- Direct monitoring of "Quantity of diesel (fuel type) combusted in process" is implemented with daily diesel consumption measurement using standard measuring cans.
- QA/QC procedures for ensuring the accuracy of measuring cans are added to purchase new measuring cans every year.
- Removal of calibration requirement for energy meters. There is no calibration procedure existing for the energy meters in Bangladesh. A letter from Bangladesh DNA is provided as a proof of evidence for the same.
- The revised PDD also clarifies that "In cases where a single electricity meter is used by two kilns and unless there is proper sub-meter installed and consumption is monitored, the total power consumption of the meter will be considered for each of the kilns."
- Brick sampling procedures is revised to multi-stage cluster sampling as per the latest "Guidelines for sampling and surveys for CDM project activities and programme of activities, version 03.0, EB 75"

B.2.6. Changes to project design

The project activity in the registered PDD comprised of eight HHK brick making units, whereas the revised PDD indicates the number of units to be six only. Of the two units removed, one of the units, SSL-1 Ceramics Bricks Limited (Kiln 1) was shut down due to technical problems and quality issues from 01/07/2012 onwards. The second unit, SSL–2 Ceramics Bricks Limited (kiln 2), was

[8] https://cdm.unfccc.int/PRCContainer/DB/prcp194084662/view

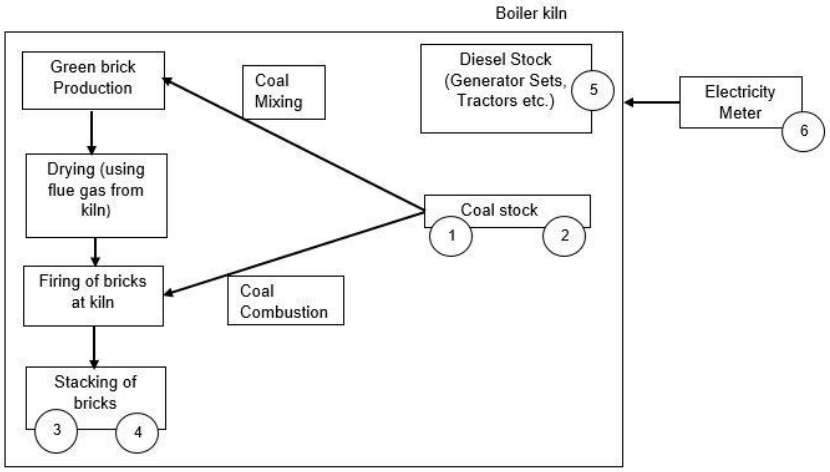
not implemented due to the technical problems faced in kiln 1 unit. The above corrections were reflected in revised PDD version 16, dated 08/04/2014 and was approved by UNFCCC through a Post Registration Change (PRC) request[9] (ref no: PRC-5125-001) on 01/07/2014.

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. Data monitoring points are indicated below in the figure 2.

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 monitored data as described in Section D.2. The CDM monitoring and compliance officer collects the monitored data from different departments/sections of the kiln as given in Figure 2 and compiles the data in the excel format provided by IIDFC, the bundling agent. He 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 (consolidated details of all the kilns) and submits these reports to IIDFC senior officer.

IIDFC had conducted various training sessions to the kiln CDM monitoring and compliance officers and the kiln operators. Training materials were provided to them. Standard data collection formats were prepared by IIDFC and were 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 the corrective action to be taken.



Monitoring points:

1. Coal consumption
2. NCV of coal
3. Total brick production
4. Mean weight of brick
5. Diesel consumption
6. Electricity consumption

Figure 3: Location Points of Data Monitoring

An annual audit was also carried out for 3 consecutive days, at each brick kiln by IIDFC to review the CDM compliance practices. The results were presented as a report to the kilns. Improvements in monitoring system such as use of daily CDM log sheet to improve data recording were suggested. The details of the period of audit at each kiln are mentioned in table 3.

[9] https://cdm.unfccc.int/PRCContainer/DB/prcp194084662/view

Table 3: Audit days of the kilns

No.	Kiln name	Audit days for the Year 2016	Audit days for the Year 2017
1.	Universal	20-22 October 2016	14-16 September 2017
2.	Haair	15-17 November 2016	15-17 October 2017
3.	Diamond	N/A	N/A
4.	Kapita	28-30 October 2016	06-08 September 2017
5.	Banalata	23-25 November 2016	04-06 October 2017
6.	Sunflower	N/A	N/A

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

Table 4: CDM monitoring and responsibilities

Task and area of responsibility	Method used	Frequency	Responsible Person	Responsible Entity
Measurement of monitored data	Manual measurement, data recording	Daily	Operator in-charge	Respective kiln
Electronic recording	Data transfer to electronic workbook format provided by IIDFC	Daily	CDM compliance and monitoring officer	Respective kiln
Collection and storage of 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 staff training (CDM monitoring)	Training program as and when required	As and when required	IIDFC or their Consultants	IIDFC
Approval of monitoring reports and achieved ERs	Not applicable	Yearly	Project in-charge	IIDFC

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	$CV_{coal, FCK}$
Unit	TJ/kg
Description	Net calorific value (energy content) per mass unit of a fuel (*calorific value of the coal used in the baseline)*
Source of data	Coal specifications reported by Barapukuria Coal Mining Company Limited (BCMCL) (http://www.bcmcl.org.bd/)
Value(s) applied	6,135 kCal/kg or $6,135 \times 4.186 \times 10^{-9}$ TJ/kg
Choice of data or measurement methods and procedures	Fixed ex-ante value
Purpose of data/parameter	To calculate baseline emissions
Additional comments	Not applicable

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
Choice of data or measurement methods and procedures	Fixed ex-ante value
Purpose of data/parameter	To calculate baseline emissions
Additional comments	Not applicable

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
Choice of data or measurement methods and procedures	Fixed ex-ante value
Purpose of data/parameter	To calculate baseline emissions
Additional comments	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

Value(s) applied	0.62
Choice of data or measurement methods and procedures	Fixed ex-ante value
Purpose of data/parameter	To calculate baseline emissions
Additional comments	Not applicable

Data/Parameter	**$SEC_{FCK, Bricks}$**
Unit	TJ/kg-brick
Description	Specific energy consumption per kg-brick in conventional FCK kilns 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}
Choice of data or measurement methods and procedures	It has been fixed ex-ante. In the absence of published data, calorific value of Barapukuria coal 6,135 kCal/kg (as measured for this project) and coal use of 24 tons per 100,000 bricks were utilized to calculate the Specific Fuel Consumption per kg-bricks in the baseline (FCK) technology.
Purpose of data/parameter	To calculate baseline emissions
Additional comments	Not applicable

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
Choice of data or measurement methods and procedures	Country specific SFC data for FCK is available and therefore used. This value is used only to calculate the specific energy consumption per kg-brick (SECFCK, Bricks) in conventional FCK kilns
Purpose of data/parameter	To calculate baseline emissions
Additional comments	Not applicable
Data/Parameter	**$M_{FCK, brick}$**
Unit	kg/brick
Description	Weight of a single FCK brick
Source of data	As per IIDFC study titled " Weight of Bricks in Bangladesh, 2009"
Value(s) applied	2.9

Choice of data or measurement methods and procedures	Average specific weight per unit brick was determined through direct measurement of a substantial number of FCK bricks. This value is used to calculate only the specific energy consumption per kg-brick (SECFCK, Bricks) in conventional FCK kilns.
Purpose of data/parameter	To calculate total mass of brick produced per year
Additional comments	Not applicable

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
Choice of data or measurement methods and procedures	In mass unit, the value is 43.3 TJ/Gg or 43.3 MJ/kg. The density used for the conversion is 0.8432 kg/litre.
Purpose of data/parameter	To calculate project emissions
Additional comments	Not applicable

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
Choice of data or measurement methods and procedures	Density = 1/Specific volume. The specific volume published by IPCC is 1,186 kilolitre/Gg or 1.186 litre/kg.
Purpose of data/parameter	To calculate project emissions
Additional comments	Not applicable

Data/Parameter	**$EF_{CO2, Diesel,y}$**
Unit	t CO_2/TJ
Description	Weighted average CO_2 emission factor of diesel 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
Choice of data or measurement methods and procedures	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.
Purpose of data/parameter	To calculate project emissions
Additional comments	Not applicable

D.2. Data and parameters monitored

<table>
<tr><td>Data/Parameter</td><td>$TC_{Coal,i,y}$</td></tr>
<tr><td>Unit</td><td>Tonnes/year</td></tr>
<tr><td>Description</td><td>Total consumption of coal for brick making in brick kiln i in year y</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured using digital weighing scale</td></tr>
<tr><td>Source of data</td><td>Invoices from the coal suppliers and coal consumption registers</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>Tonnes/year</th></tr>
<tr><td>1.</td><td>Universal</td><td>2,808.06</td></tr>
<tr><td>2.</td><td>Haair</td><td>3,007.19</td></tr>
<tr><td>3.</td><td>Diamond</td><td>0</td></tr>
<tr><td>4.</td><td>Kapita</td><td>4,842.28</td></tr>
<tr><td>5.</td><td>Banalata</td><td>3,946.58</td></tr>
<tr><td>6.</td><td>Sunflower</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>Digital weighing scale (used for both coal and brick weight measurement):

Monitoring Year: 2016
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>Make</th><th>Accuracy (± full scale reading)</th><th>Purchase date</th></tr>
<tr><td>1.</td><td>Universal</td><td></td><td></td><td>12/09/2016</td></tr>
<tr><td>2.</td><td>Haair</td><td></td><td></td><td>15/02/2016</td></tr>
<tr><td>3.</td><td>Diamond</td><td></td><td></td><td>N/A</td></tr>
<tr><td>4.</td><td>Kapita</td><td></td><td></td><td>10/06/2016</td></tr>
<tr><td>5.</td><td>Banalata</td><td></td><td></td><td>18/08/2016</td></tr>
<tr><td>6.</td><td>Sunflower</td><td></td><td></td><td>N/A</td></tr>
</table>
Monitoring Year: 2017
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>Make</th><th>Accuracy (± full scale reading)</th><th>Purchase date</th></tr>
<tr><td>1.</td><td>Universal</td><td></td><td></td><td>10/09/2017</td></tr>
<tr><td>2.</td><td>Haair</td><td></td><td></td><td>13/02/2017</td></tr>
<tr><td>3.</td><td>Diamond</td><td></td><td></td><td>N/A</td></tr>
<tr><td>4.</td><td>Kapita</td><td></td><td></td><td>08/06/2017</td></tr>
<tr><td>5.</td><td>Banalata</td><td></td><td></td><td>16/08/2016</td></tr>
<tr><td>6.</td><td>Sunflower</td><td></td><td></td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Every brick production day</td></tr>
<tr><td>Calculation method (if applicable)</td><td>The coal consumption at the kiln is measured through counting the number of buckets/sacks of coal consumed per day. A bucket/sack of coal is weighed to determine the weight of a bucket of coal using a digital weighing scale. The coal purchased is also cross verified by the supplier invoice provided with each coal consignment. The records are maintained at the kiln office for the amount of coal consumed, which can be cross checked against the invoices taking into account the balance of coal not consumed for the monitoring period concerned.</td></tr>
</table>

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. The kilns may purchase a new weighing scale every year or calibrate the existing weighing scale in case the calibration services/facilities become more affordable, during that monitoring period. In case of any delay in procuring new weighing scales or calibration of existing equipment after one year, then the maximum permissible error as per the respective manufacturer specifications shall be applied on the measured readings for the period until next calibration or procurement of new equipment.
Purpose of data/parameter	To calculate the project emissions
Additional comments	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	As per the data provided by the supplier and independently verified by a credible Bangladesh laboratory.
Value(s) of monitored parameter	**Serial** / **Kiln Name** / **x 10^{-5} TJ/kg** **1.** Universal 2.39 **2.** Haair 2.44 **3.** Diamond - **4.** Kapita 2.16 **5.** Banalata 1.97 **6.** Sunflower -
Monitoring equipment	Lab analysis
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 monitoring period and is considered as the net calorific value of coal used by related brick kiln in that crediting period.
QA/QC procedures	IIDFC checks the coal consumption data by inspecting the coal stock register and reports of calorific value tests at the end of the monitoring period.
Purpose of data/parameter	To calculate project emissions
Additional comments	The data will be archived for two years after the crediting period

Data/Parameter	**$DP_{Bricks,i}$**
Unit	Bricks
Description	Daily production of bricks in brick kiln i

<table>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Daily brick production registers through manual count of bricks</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Cumulative daily production for the monitoring period in each kiln are given below:
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>No. of bricks</th></tr>
<tr><td>1.</td><td>Universal</td><td>27,608,000</td></tr>
<tr><td>2.</td><td>Haair</td><td>25,297,000</td></tr>
<tr><td>3.</td><td>Diamond</td><td>-</td></tr>
<tr><td>4.</td><td>Kapita</td><td>42,239,544</td></tr>
<tr><td>5.</td><td>Banalata</td><td>28,493,550</td></tr>
<tr><td>6.</td><td>Sunflower</td><td>-</td></tr>
</table>
For the period 01/01/2016 to 30/11/2017, cumulative brick production values were used for CER estimation, as per PRC PDD.</td></tr>
<tr><td>Monitoring equipment</td><td>No equipment is used</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Every brick production day</td></tr>
<tr><td>Calculation method (if applicable)</td><td>The daily brick production is noted down by the technician in a daily log sheet maintained in the kiln. 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 kiln or kiln head office. Monthly reports are prepared regularly by the CDM monitoring and compliance officer and are stored in electronic and paper modes.</td></tr>
<tr><td>QA/QC procedures</td><td>The amount of bricks manufactured at the end of each monitoring period is cross checked with the invoices for the sale of bricks and the stock in the plant.</td></tr>
<tr><td>Purpose of data/parameter</td><td>To calculate the baseline and project emissions</td></tr>
<tr><td>Additional comments</td><td>The data will be archived for up to two years after the end of the crediting period. In the event that different size or types of bricks, such as holed brick are produced, the number of each type of brick produced will be recorded in the daily register.</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$DMW_{HHK\ Bricks,di}$</td></tr>
<tr><td>Unit</td><td>kg/brick</td></tr>
<tr><td>Description</td><td>Daily mean weight of baked HHK bricks in brick kiln i</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>On-site measurements by the operator in-charge</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Annual average of daily mean brick weight values are given below:
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>kg/brick</th></tr>
<tr><td>1.</td><td>Universal</td><td>3.00</td></tr>
<tr><td>2.</td><td>Haair</td><td>3.19</td></tr>
<tr><td>3.</td><td>Diamond</td><td>-</td></tr>
<tr><td>4.</td><td>Kapita</td><td>3.22</td></tr>
<tr><td>5.</td><td>Banalata</td><td>3.05</td></tr>
<tr><td>6.</td><td>Sunflower</td><td>-</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>Monitoring equipment</td><td>Digital weighing scale (used for both coal and brick weight measurement):

Monitoring Year: 2016
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>Make</th><th>Accuracy (± full scale reading)</th><th>Purchase date</th></tr>
<tr><td>1.</td><td>Universal</td><td></td><td></td><td>12/09/2016</td></tr>
<tr><td>2.</td><td>Haair</td><td></td><td></td><td>15/02/2016</td></tr>
<tr><td>3.</td><td>Diamond</td><td></td><td></td><td>N/A</td></tr>
<tr><td>4.</td><td>Kapita</td><td></td><td></td><td>10/06/2016</td></tr>
<tr><td>5.</td><td>Banalata</td><td></td><td></td><td>18/08/2016</td></tr>
<tr><td>6.</td><td>Sunflower</td><td></td><td></td><td>N/A</td></tr>
</table>
Monitoring Year: 2017
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>Make</th><th>Accuracy (± full scale reading)</th><th>Purchase date</th></tr>
<tr><td>1.</td><td>Universal</td><td></td><td></td><td>10/09/2017</td></tr>
<tr><td>2.</td><td>Haair</td><td></td><td></td><td>13/02/2017</td></tr>
<tr><td>3.</td><td>Diamond</td><td></td><td></td><td>N/A</td></tr>
<tr><td>4.</td><td>Kapita</td><td></td><td></td><td>08/06/2017</td></tr>
<tr><td>5.</td><td>Banalata</td><td></td><td></td><td>16/08/2016</td></tr>
<tr><td>6.</td><td>Sunflower</td><td></td><td></td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Daily</td></tr>
<tr><td>Calculation method
(if applicable)</td><td>The average weight of bricks is calculated as per the “Guidelines for sampling and surveys for CDM project activities and programme of activities, version 03.0, EB 75” using digital weighing scale and as per the monitoring plan in PRC PDD, version 16 dated 18/04/2014. In accordance to these, 960 samples were taken from 01/01/2016 to 30/11/2017 and cumulative mean brick weight was estimated</td></tr>
<tr><td>QA/QC procedures</td><td>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.</td></tr>
<tr><td>Purpose of data/parameter</td><td>To calculate the baseline and project emissions</td></tr>
<tr><td>Additional comments</td><td>The data will be archived for two years after the crediting period</td></tr>
</table>

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 of coal as fuel
Source of data	Calculation result using equation (Refer section E.2)

Value(s) of monitored parameter	

Serial	Kiln Name	x 10^{-6} TJ/kg-brick
1.	Universal	0.8087
2.	Haair	0.9089
3.	Diamond	-
4.	Kapita	0.7962
5.	Banalata	0.8969
6.	Sunflower	-

Monitoring equipment	No equipment is used
Measuring/reading/recording frequency	Recording frequency is annual
Calculation method (if applicable)	The specific energy consumption per kg-brick is calculated once in 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/parameter	To calculate the project emissions
Additional comments	The data will be archived for two years after the crediting period

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	

Serial	Kiln Name	Days
1.	Universal	665
2.	Haair	682
3.	Diamond	0
4.	Kapita	656
5.	Banalata	687
6.	Sunflower	0

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/parameter	To calculate the baseline and project emissions
Additional comments	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

<table>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Measured using standard measuring cans</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>kl/year</th></tr>
<tr><td>1.</td><td>Universal</td><td>75.6</td></tr>
<tr><td>2.</td><td>Haair</td><td>28.5</td></tr>
<tr><td>3.</td><td>Diamond</td><td>-</td></tr>
<tr><td>4.</td><td>Kapita</td><td>151.3</td></tr>
<tr><td>5.</td><td>Banalata</td><td>93.4</td></tr>
<tr><td>6.</td><td>Sunflower</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>1/2/5 litre standard measuring cans
<table>
<tr><th rowspan="2">Serial</th><th rowspan="2">Kiln Name</th><th colspan="2">Purchase date</th></tr>
<tr><th>2016</th><th>2017</th></tr>
<tr><td>1.</td><td>Universal</td><td>11/03/2016</td><td>09/03/2017</td></tr>
<tr><td>2.</td><td>Haair</td><td>14/03/2016</td><td>12/03/2017</td></tr>
<tr><td>3.</td><td>Diamond</td><td>-</td><td>-</td></tr>
<tr><td>4.</td><td>Kapita</td><td>09/03/2016</td><td>07/03/2017</td></tr>
<tr><td>5.</td><td>Banalata</td><td>08/03/2016</td><td>06/03/2017</td></tr>
<tr><td>6.</td><td>Sunflower</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Daily</td></tr>
<tr><td>Calculation method (if applicable)</td><td>The purchased diesel in drums is measured at the supplier end itself and is recorded in the purchase invoice. The diesel consumption at the kiln is measured using 1/2/5 litre standard measuring cans. The records are maintained at kiln office on the diesel purchase and consumption as obtained from the above measurements. Net consumption is calculated at the end of the monitoring period by tallying out the total purchase with the opening and closing stocks of diesel in that period.</td></tr>
<tr><td>QA/QC procedures</td><td>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. Every day consumption and stock records cross checked with purchase invoices show that the diesel consumed for kiln operations is only from the diesel purchased under the project.
Since there is no proper institutional/laboratory set up available for easy calibration, new measuring cans are purchased every year by the kilns to ensure the accuracy of measurements. This is also supported by the affordable cost of the measuring cans.
In case of any delay in procuring new measuring cans after one year, the suitable error shall be applied on the measured readings for the period until new equipment are procured. The error value shall be estimated based on actual conditions during the verification in discussion with the verifying DOE. The kilns purchased new weighing scans every year which avoided the necessity of adjusting the values with suitable errors.</td></tr>
<tr><td>Purpose of data/parameter</td><td>To calculate project emissions</td></tr>
<tr><td>Additional comments</td><td>The data will be archived for two years after the crediting period</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$EC_{i,y}$</td></tr>
<tr><td>Unit</td><td>MWh</td></tr>
<tr><td>Description</td><td>Electricity consumption in kiln i per year</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Electricity bill from the REB or the electricity supplier</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>MWh</th></tr>
<tr><td>1.</td><td>Universal</td><td>941.12</td></tr>
<tr><td>2.</td><td>Haair</td><td>646.60</td></tr>
<tr><td>3.</td><td>Diamond</td><td>-</td></tr>
<tr><td>4.</td><td>Kapita</td><td>2072.21</td></tr>
<tr><td>5.</td><td>Banalata</td><td>958.04</td></tr>
<tr><td>6.</td><td>Sunflower</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>Energy meter
<table>
<tr><th>Serial</th><th>Kiln Name</th><th>Make</th><th>Serial no.</th><th>Accuracy Class</th><th>Year of make</th></tr>
<tr><td>1.</td><td>Universal</td><td>Fitzall</td><td></td><td>0.5</td><td>2006</td></tr>
<tr><td>2.</td><td>Haair</td><td>Itron</td><td></td><td>0.2</td><td>2014</td></tr>
<tr><td>3.</td><td>Diamond</td><td>Fitzall</td><td></td><td>0.5</td><td>2009</td></tr>
<tr><td>4.</td><td>Kapita</td><td>Fitzall</td><td></td><td>0.5</td><td>2009</td></tr>
<tr><td>5.</td><td>Banalata</td><td>Fitzall</td><td></td><td>0.5</td><td>2011</td></tr>
<tr><td>6.</td><td>Sunflower</td><td>Fitzall</td><td></td><td>0.5</td><td>2009</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Monthly</td></tr>
<tr><td>Calculation method (if applicable)</td><td>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</td></tr>
<tr><td>QA/QC procedures</td><td>Electricity consumption from the individual monthly electricity bills shall be cross checked with the electricity consumption calculated from the first and the last month of the monitoring period.

In case of energy meters, there is no practice of regular calibration in Bangladesh. A letter from Bangladesh DNA is provided as proof of evidence for the same.</td></tr>
<tr><td>Purpose of data/parameter</td><td>To calculate project emissions</td></tr>
<tr><td>Additional comments</td><td>The data will be archived for two years after the crediting period</td></tr>
</table>

D.3. Implementation of sampling plan

Multi stage sampling is used for brick weight measurement as stated in the revised monitoring plan in the PDD version 16, dated 08/04/2014.The complete details of sampling calculation, sample size estimation and sample selection are given in Appendix 3.

As per revised sampling procedure,

- 40 samples (150 samples/4 months) must be selected from a month
- Taking 20 samples per day, 2 days shall be selected for a month

As per the sampling plan, a kiln operating for a year will be able to achieve 480 sample measurements, which is above the minimum requirement of 150 samples during this monitoring period.

Table 5: Analysis of weight measurements of baked brick samples

No.	Parameter	Universal	Haair	Diamond	Kapita	Banalata	Sunflower
1.	*No. of. months of operation*	22	23	0	21.67	23	0
2.	*No. of. brick samples*	880	920	-	920	920	-
3.	*Mean*	3.00	3.19	-	3.22	3.05	-
4.	*Standard deviation*	0.04	0.04	-	0.09	0.08	-
5.	*Sample variance*	0.0016	0.0019	-	0.008	0.006	-
6.	*Minimum*	2.56	3.10	-	2.92	2.87	-
7.	*Maximum*	3.20	3.26	-	3.48	3.19	-
8.	*Standard error*	0.001	0.001	-	0.003	0.003	-
9.	*Confidence interval (max level / min level)*	3.004	3.189	-	3.228	3.050	-
		3.00	3.184	-	3.218	3.041	-
10.	*Precision (%)*	0.07	0.08	-	0.15	0.14	-

The above analysis, the lowest precision level of the brick weight measurement in the brick kilns was found to be 0.15% as against the required level of 10%.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

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:

$$BE_y \text{ [t } CO_2\text{/year]} = \sum_{i=1}^{6} BEFCK_{i,y}$$

$$= 16{,}631.60 + 16{,}178.76 + 27{,}320.08 + 17{,}416.13$$

$$= \mathbf{77{,}547\ t\ CO_2/year}$$

Where,

$BE_{FCK\ i,\ y}$ = Baseline emissions per year for the i^{th} kiln [t CO_2/year]

$$= TP_{Bricks,\ i\ ,y} \times SEC_{FCK,\ Bricks,\ y} \times CEF_{coal} \times CF$$

[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 5: Estimation of baseline emission

Serial	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	27,608,000	×	**2.125×10^{-6}**	×	**25.8**	×	**3.66**	=	16,631.60
2.	Haair	25,297,000								16,178.76
3.	Diamond	-								-
4.	Kapita	42,239,544								27,320.08
5.	Banalata	28,493,550								17,416.13
6.	Sunflower	-								-

E.2. Calculation of project emissions or actual net removals

Total project emissions in y^{th} year, PE_y, by operations of N units of HHK kilns (N=6) is given by:

$$PE_y = \sum_{i=1}^{6} PE_{HHK\ i, y}$$

PE_y [t CO_2/year]

$$= 7,118.65 + 7,397.98 + 11,586.10 + 8,198.58$$

$$= \mathbf{34,301\ t\ CO_2/year}$$

Where,

$PE_{HHK\ i, y}$ [t CO_2/year] = Project emissions from operation of i^{th} kiln in year y

$$= SEC_{i, y} \times TP_{Bricks, i, y} \times CEF_{coal} \times CF +$$

[TJ/kg-brick(y)] [kg-bricks(y)] [t C/TJ] [t CO_2/t C]

$$EC_{i, y} \times EF_{CO2,Elec} + PE_{FC,j,y}$$

[MWh] [t CO_2/MWh] [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 6: Estimation of Project Emission

No.	Kiln Name	$SEC_{i, y}$ TJ/kg-brick × 10^{-6}		$TP_{Bricks,i,y}$ kg-bricks		CEF_{coal} t C/TJ		CF tCO2/tC		$EC_{i,y}$ MWh		$EF_{CO2,Elec}$ tCO2/MWh		$PE_{FC,j,y}$ tCO2/year		$PE_{HHK\ i,y}$ tCO2/year
1.	**Universal**	0.8087	×	82,871,686.55	×	**25.8**	×	**3.66**	+	941.12	×	**0.62**	+	206	=	**7,118.65**
2.	**Haair**	0.9089		80,615,297.24						646.60				78		**7,397.98**
3.	**Diamond**	-		-						-				0		**-**
4.	**Kapita**	0.7962		136,130,107.44						2072.21				413		**11,586.10**
5.	**Banalata**	0.8969		86,780,823.08						958.04				255		**8,198.58**
6.	**Sunflower**	-		-						-				0		**-**

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

$SEC_{i, y}$ [TJ/kg-brick] = $TC_{Coal\ i,y}$ [tonnes(y)] x $NCV_{Coal\ i, y}$ [TJ/kg(y)] / $TP_{Bricks, i ,y}$ [kg-bricks(y)]

Where,

$SEC_{i, y}$ = Specific energy consumption in kiln i (TJ/kg-brick)
$TC_{Coal\ i,y}$ = 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)
$TP_{Bricks,i ,y}$ = Total production of bricks per year in kiln i (kg-bricks/year)

Table 7: Estimation of specific energy consumption

No.	Kiln name	$TC_{Coal\ i,y}$ 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**	2,808.06	×	2.39	÷	82,871,686.55	=	**0.8087**
2.	**Haair**	3,007.19		2.44		80,615,297.24		**0.9089**
3.	**Diamond**	0		-		-		**-**
4.	**Kapita**	4,842.28		2.16		136,130,107.44		**0.7962**
5.	**Banalata**	3,946.58		1.97		86,780,823.08		**0.8969**
6.	**Sunflower**	0		-		-		**-**

Total production of bricks per year in a kiln is given by,

$TP_{Bricks,i,y}$ [kg-bricks/year] = $\Sigma_{d=1}^{} DP_{Bricks,di}$ [nos] x $DMW_{HHK\ brick,di}$ [kg/brick]

Where,

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

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

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

For the period of 01/01/2016 to 30/11/2017, total production of bricks per year is calculated as a product of sum of brick production on every brick production day and mean brick weight of sample bricks during that period.

For elaborate calculation, refer to the attached the CER estimation file, sheet "Monthly data 2016 - 17"

CO_2 emissions from fossil fuel combustion in year y is given by,

$PE_{FC,j,y}$ [t CO_2/yr] = $FC_{Diesel,\ j,\ y}$ [kl/year] x $COEF_{Diesel,\ y}$ [t CO2/ 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 8: Estimation of emissions from fossil fuel combustion

No.	Kiln Name	$FC_{Diesel,\ j,\ y}$ kl/yr		$COEF_{Diesel,\ y}$ t CO_2/kl		$PE_{FC,j,y}$ t CO_2/yr
1.	Universal	75.6	x	2.7	=	206
2.	Haair	28.5				78
3.	Diamond	-				0
4.	Kapita	151.3				413
5.	Banalata	93.4				255
6.	Sunflower	-				0

E.3. Calculation of leakage emissions

Not applicable

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	**77,547**	**34,301**	**0**	**0**	**43,246**	**43,246**

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period ($t CO_2e$)	Amount estimated ex ante ($t CO_2e$)
43,246	**84,572**

E.6. Remarks on increase in achieved emission reductions

Not applicable

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	[X] Project participant [X] Responsible person/ entity for completing the CDM-MR-FORM
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Appendix 2

Details of kiln operation and shutdown periods

Kiln name	Jan 16	Feb 16	Mar 16	Apr 16	May 16	Jun 16	Jul 16	Aug 16	Sep 16	Oct 16	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Apr 17	May 17	Jun 17	Jul 17	Aug 17	Sep 17	Oct 17	Nov 17	Comments
Universal	01/01/2016 to 30/09/2017																							01/10/2017 to 31/10/2017 Closed for maintenance.
Haair	01/01/2016 to 30/11/2017																							Kiln was in continuous operation except a few holidays & religious festival.
Diamond																								01/01/2016 to 30/11/2017 Closed
Kapita	01/01/2016 to 07/05/2016					17/06/2016 to 30/11/2017																		08/05/2016 to 16/06/2016 Closed for maintenance
Banalata	01/01/2016 to 30/11/2017																							Kiln was in continuous operation except a few holidays & religious festival.
Sunflower																								01/01/2016 to 30/11/2017 Closed

Days when kilns are not in operation for more than a week

Kilns in operation except some holidays

Appendix 3: Sampling plan (as per revised PDD for PRC approval)

In the following section the Sampling plan and its implementation procedure for brick weight measurement is discussed.

According to "Guidelines for sampling and surveys for CDM project activities and programme of activities, version 03.0, EB 75", The following sampling plan will be used to determine the Daily Mean Weight of HHK bricks in Kiln i during the crediting period.

Multistage sampling is a complex form of cluster sampling. Measuring all the elements in the selected clusters may be prohibitively expensive, or not even necessary. In multi-stage sampling, the cluster units are often referred to as the primary sampling units (PSU) and the elements within the clusters, as the secondary sampling units (SSU). In contrast to the cluster sampling, where all of the secondary units are measured, in multi-stage sampling, data are collected for only a random sample of the secondary units.

Since the quantity of brick production is high and the brick production from each day shall be considered as a cluster, multi-stage sampling is chosen for this project

1. Requirements of multi-stage sampling

For the sample size calculations, the following details on the population are required:

(a) Variations in brick weight within a day
(b) Variations in brick weight between days
(c) Average mean brick weight within a day
(d) Overall average mean brick weight

The expected mean and standard deviation are calculated from brick weight measurements carried out at Kapita Auto Bricks Ltd. (kiln capacity - 100,000 bricks/day). The measurements were taken for 100 brick samples randomly selected from fired bricks produced on those respective days. The mean and standard deviations arrived from the above measurements are used for the multi-stage sampling estimations.

2. Assumptions

Following assumptions have been made with respect to the HHK brick kiln operations at Kapita brick kiln, for estimating the sample size:

- Primary sampling unit (PSU) = Each brick production day
- Secondary sampling unit (SSU) = All fired bricks output on a production day
- Max. brick output on day = 100,000 (for Kapita brick kiln)
- Max. no. of brick production days = 365
- 90% confidence level and 10% precision as per small scale CDM requirement is taken

3. Estimation of number of days to be selected

The following table gives the mean and standard deviation calculated for the 100 brick weight measurements from each of the 11 production days (randomly selected) during first monitoring period at Kapita brick kiln, which is typical for the other kilns in the bundle.

The number of days to be selected for sampling can be calculated using the following formula:

Day	Bricks produced per day	Mean Weight per brick (kg)	Total weight of bricks per day (kg)	Standard deviation within a day
1	47,137	3.018	142,250	0.044
2	69,841	3.008	210,105	0.015
3	32,104	3.026	97,157	0.028
4	73,646	3.031	223,209	0.015
5	71,318	3.013	214,897	0.027
6	90,324	3.056	276,059	0.084
7	67,075	3.036	203,639	0.033
8	56,754	3.031	172,029	0.022
9	59,037	3.021	178,342	0.049
10	66,065	3.024	199,783	0.024
11	67,672	3.034	205,335	0.027
Total bricks	**700,973**	-	-	-
Overall mean weight (brickmean)		**3.028**	-	-
Overall mean total weight of each day (daymean)			**193,946**	-
SD of total weight of days (SD_b)			**46,175**	-
Standard deviation within a day (SD_W)				**0.041**

$$c \geq \frac{\left(\frac{SD_B}{daymean}\right)^2 \times \left(\frac{M}{M-1}\right) + \left(\frac{1}{u}\right) \times \left(\frac{SD_W}{brickmean}\right)^2 \times \left(\frac{N-u}{N-1}\right)}{\left(\frac{0.1}{1.645}\right)^2 + \frac{1}{M-1}\left(\frac{SD_B}{daymean}\right)^2}$$

Where,

c	=	No. of days to be selected
M	=	Total number of days
N	=	Average number of bricks per day
u	=	Number of bricks to be sampled per day
1.645	=	Represents the 90% confidence required
0.1	=	Represents the required 10% precision
SD_B	=	Standard deviation of weight of each day
SD_w	=	Standard deviation within a day

brickmean = Overall mean brick weight (kg)
daymean = overall mean of total brick weight of each day (kg)

Number of samples is estimated as follows:

$$c \geq \frac{\left(\frac{46{,}175}{193{,}946}\right)^2 \times \left(\frac{365}{365-1}\right) + \left(\frac{1}{10}\right) \times \left(\frac{0.041}{3.028}\right)^2 \times \left(\frac{100{,}000-10}{100{,}000-1}\right)}{\left(\frac{0.1}{1.645}\right)^2 + \frac{1}{365-1}\left(\frac{46{,}175}{193{,}946}\right)^2}$$

Therefore, the number of days to be sampled,
c = 15.

Here, the required number of days to be selected per year is 15. The following table gives the calculation carried out for all the kilns and their sample size estimation.

No.	Kiln	Brick Mean (kg)	Std. deviation within a day (SD_w)	Std. deviation of total weights of days (SD_B)	Sample size per day	No. of days to be selected	Total samples required
1	Kapita	3.03	0.04	46,175	10	15	150
2	Diamond	3.60	0.11	17,289	10	03	30
3	Sunflower	3.59	0.10	13,218	10	02	20
4	Banalata	3.06	0.11	9,438	10	04	40
5	Haair	3.18	0.05	22,064	10	13	130
6	Universal	3.25	0.07	15,886	10	07	70

From the above table, it is inferred that the sample size depends very much upon the standard deviation within a day (SD_w) and standard deviation of total weights of days (SD_B). The maximum number of samples to be selected is 150 for Kapita brick kiln.

3. Selection of sample bricks from each gate

A list of number of sample bricks per day and the corresponding estimation of number of days per year has been generated based on above calculation.

No. of samples per day	No. of days to be selected
1	14.81
5	14.76
10	14.77
15	14.76
20	14.76
25	14.76
30	14.76

From the above table, it is observed that the required days per year does not vary much with the samples selected per day.

Required sampling as per cluster sampling

From the above estimations, the minimum required sample size for all kilns = 10 bricks per day x 15 days = 150 brick samples per year.

It is observed that the kilns operate in a wide range of periods from a minimum of 4 months to one year. Hence, the number of samples per day and selection of number of days must be estimated such that even at the minimum operating period of 4 months, the kilns are able to achieve the required sample size of 150 bricks. To achieve this

- 40 samples (150 samples/4 months) must be selected from a month
- Taking 20 samples per day, 2 days shall be selected for a month

As per the above plan, a kiln operating for a minimum of 4 months will be able to achieve 160 (8 days x 20 samples) sample measurements, which is above the minimum requirement of 150 samples.

Therefore, below are the sampling numbers required as per the multi-stage sampling procedure:

- Stage 1 (PSU) - no of days to be selected per year : 24 (2 per month)
- Stage 2 (SSU) - no of bricks to be sampled in each day : 20 (fixed)
- Total bricks to be sampled per year : 480
- 2 days shall be randomly selected from every operational month based on the production pattern
- 20 bricks will be taken for every type of brick (solid, 3 holed, 6 holed, etc.) produced on a day
- Sample selection within a day shall also be carried out by random.

However, the total Number of bricks to be sampled per year (480) is not fixed for all kilns and the total number of brick samples may vary based on the number of operational months of an individual kiln. For example, if a kiln operates for only 6 months of year, then it will have, 6 months x 2 days/month x 20 samples/day = 240 samples only while a kiln operating for 12 months will have 480 samples.

Document Information

Version	*Date*	*Description*
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
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 GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, 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).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: Issuance Keywords: monitoring report		