CLEAN DEVELOPMENT MECHANISM

AMS-III.BH

Small-scale Methodology

Displacement of production of brick and cement by manufacture and installation of gypsum concrete wall panels

Version 01.0

Sectoral scope(s): 06

United Nations
Framework Convention on
Climate Change

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1. Introduction

1. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	In developing countries, brickwork is a crucial component of construction in buildings. Bricks and cement mortar are used for constructing internal walls, external walls (load bearing and non-load bearing), and to build boundary walls. Brick and cement mortar represent GHG intensive construction materials. Typical projects covered by the methodology aim to replace brickwork with less GHG intensive gypsum concrete wall panels
Type of GHG emissions mitigation action	The project aims to reduce GHG emissions owing to the displacement of GHG intensive construction material (i.e. brick and cement mortar by gypsum concrete wall panels)

2. Scope, applicability, and entry into force

2.1. Scope

2. This methodology is applicable to project activities that make use of gypsum concrete wall panels to displace greenhouse gas (GHG) intensive brick and cement mortar construction material in wall making.

3. The project activity applying this methodology can include one or more of the types of application of gypsum concrete wall panels mentioned below:

   (a) Non load-bearing walls;

   (b) Load-bearing walls;

   (c) Fencing (compound/security walls).

2.2. Applicability

4. The methodology is applicable to domestic gypsum concrete wall panel production for any of the applications mentioned in paragraph 3 in Greenfield building projects or expansion of existing buildings (e.g. additional floors to existing building).

5. It shall be demonstrated that gypsum used as a raw material for manufacturing of gypsum concrete wall panel is not diverted from other useful applications, using one of the following options:

   (a) **Option 1:** Use relevant governmental data or official statistics from local authorities, based on the historic and/or present consumption of gypsum to show that the suppliers of gypsum are able to attend the increased consumption from the project activity without reducing the supply to other applications;

(b) **Option 2:** The current market supply situation for gypsum to be utilized is assessed and its surplus availability is demonstrated using one of the approaches below:

(i) **Approach 1:** Demonstrate that the gypsum utilized in the project activity is not fully utilized in the region. For this purpose, demonstrate that the quantity of gypsum exploited/marketed in the region is at least 25 per cent greater than the total demand for such materials (including the additional demand imposed by the project activity), based on the availability of this material (tons/year) for at least one year prior to the project implementation;

(ii) **Approach 2:** Demonstrate that suppliers of gypsum potentially utilizable in the project activity are not able to sell all of the subject raw materials. For this purpose, project participants shall demonstrate that a representative sample of suppliers (responsible for at least 80 per cent of the total production of the raw materials in the region) had a surplus of material (e.g. in the last two years or more prior to the project implementation), which they could not sell and which is not utilized, and this surplus is above the maximum amount of such raw material that will be demanded by the project activity;

(c) **Option 3:** This option is used for the situation where gypsum is mined (natural gypsum) from specific sites and is not purchased from open market. Demonstrate that at the sites where the gypsum is extracted, the material has not been collected or utilized (e.g. as additive or raw material to another process) prior to the implementation of the project activity, or that the available reserve of natural gypsum in the site is sufficient to attend the pre-existing demand and the additional demand imposed by project activity during the crediting period.

6. The end use of gypsum concrete wall panels used in the project activity shall be monitored as a part of the monitoring methodology. A database on the final consumers and individual usage of the panels will be maintained by the project activity, so as to allow the monitoring and verification at individual sites if necessary using sampling methods as per the standard for “Sampling and surveys for CDM project activities and programmes of activities”. The emission reduction claimed for every monitoring period is based on the actual consumption of the gypsum concrete wall panels installed at the consumer site.

7. It shall be demonstrated that bricks and cement mortar[1] would have been used in the applications listed under paragraph 3 in the project activity region in absence of the project activity, using survey methods or referring to published literature, reports or official statistics from local authorities.

8. It shall be demonstrated that service and performance level[2] of gypsum concrete wall panels exceeds or is comparable to the walls that would be constructed in the baseline

[1] The emission reductions on account of reduction in sand and any other materials usage are not claimed under this methodology.

[2] The service and performance levels refer to specific weight (per unit facing area), thermal conductivity, compressive strength, water absorption and minimum lifetime of wall panels in comparison to brick wall and in compliance with country building codes/standards.

scenario using brick and cement. This shall be demonstrated using test certificates issued by accredited laboratory for testing construction material.

9. The methodology is applicable for host countries where the proportion of imported cement is less than 10 per cent of the cement produced within the host country.

10. A declaration from the panel buyers and or final users, if they are not the same, stating that they would not claim certified emission reductions (CERs) for the panels used by them is required to avoid double counting.

11. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

2.3. Entry into force

12. The date of entry into force is the date of the publication of the EB 75 meeting report on 4 October 2013.

3. Normative references

13. Project participants shall apply the "General guidelines for SSC CDM methodologies" and the "Guidelines on the demonstration of additionality of small-scale project activities" (previously known as attachment A to appendix B) provided at: <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> mutatis mutandis.

14. This methodology refers to the latest version of the following methodological tools and guidelines[3] mutatis mutandis:

    (a) "General guidelines for SSC CDM methodologies";

    (b) "Guidelines on the demonstration of additionality of small-scale project activities";

    (c) The standard on "Sampling and surveys for CDM project activities and programmes of activities";

    (d) "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";

    (e) "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";

    (f) The methodological tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period".

4. Definitions

15. The definitions contained in the Glossary of CDM terms shall apply.

16. For the purpose of the methodology, the following definitions apply:

[3] Please refer to: <https://cdm.unfccc.int/Reference/index.html>.

(a) **Gypsum concrete (gypcrete) wall panel** - glass-fibre reinforced, water-resistant, prefabricated wall panel made of mainly gypsum plaster and the structural frames that serves as both internal and or external wall;

(b) **Manufacturing facility** - facility where the raw materials are processed to manufacture gypsum concrete wall panels. The manufacturing processes include calcining to produce gypsum plaster, casting, drying and cutting of the panel to the required sizes;

(c) **Gypsum concrete wall panel area** - area (m^2) of the walls erected using gypsum concrete wall panels (excluding windows and doors);

(d) **Brick (burnt clay brick)** - building blocks manufactured using clay-bearing earth or mud which are usually shaped, dried (in open air, in drying shed or in thermal dryers) and then burnt in kilns to give them their final hardness and appearance.

5. Baseline methodology

5.1. Project boundary

17. The project boundary encompasses the physical and geographical sites of:

(a) Sources of waste gypsum and or natural gypsum;

(b) The manufacturing facility where the gypsum concrete wall panels are manufactured;

(c) The locations where the gypsum concrete wall panels are used;

(d) All the locations where the baseline plants (e.g. manufacturing plants for cement, bricks) are situated.

5.2. Baseline emissions

18. The baseline emissions consists of emissions due to calcination, fossil fuel consumption, electricity consumption and emissions associated with the production of cement and bricks that are displaced by the project activity.

5.2.1. Quantity of baseline construction material

19. The quantity of baseline construction material which would have been used for any of the application listed under paragraph 3 shall be estimated in terms of $w_{cement,k}$ (tonnes of cement per square meter of wall) and $n_{brick,k}$ (number of bricks per square meter of wall) using one of the following options:

(a) **Option 1:** Based on country specific building construction codes/standards for the types of walls in the project activity. In case the construction codes provide a range or choice of possible values, the values which correspond to lowest quantity of construction materials, shall be used;

(b) **Option 2:** In case country specific construction codes/standards are not sufficient to establish the quantities of construction material or not available then, an alternative approach based on applicable international standards may be applied.

In case standards specify range of required parameters, the values, which correspond to lowest quantity of construction materials, shall be used;

(c) **Option 3:** Default value[4] of 50 bricks per square meter of brick wall and cement quantity of 0.010 tonnes per square meter of brick wall shall be used.

5.2.2. Baseline emission factor

5.2.2.1. Emission factor for bricks

20. In case the source of bricks that were used in baseline is clearly identified; the emission factor for the bricks ($EF_{BL,Brick}$) used in baseline should be determined as follows:

$$EF_{BL,Brick} = \sum_{k,j,i,y} \left(FC_{BL,i,j,k,y} \times NCV_{BL,j} \times EF_{CO2,j}\right) \div P_{Hy,k} \quad \text{Equation (1)}$$

Where:

$EF_{BL,Brick}$	=	Emission factor for the brick production (t CO_{2e}/brick)
$FC_{BL,i,j,k}$	=	Total fossil fuel consumption value for fuel type *j* combusted in the process *i*, in k^{th} brick manufacturing unit, for previous three years (volume or mass units)
$NCV_{BL,j}$	=	Average net calorific value of fuel type *j* combusted (TJ per unit volume or unit mass)
$EF_{CO2,j}$	=	CO_2 emission factor of fuel type j combusted in process *i*, (t CO_2/TJ)
$P_{Hy,k}$	=	Total number of bricks produced in k^{th} brick manufacturing unit[5] in baseline for previous three years in (number of bricks)

21. In case, the source of bricks in the region/project boundary is not identified with certainty; then one of the following options should be used for determination of emission factor:

(a) The following stepwise approach should be followed:

(i) Identify the technology(ies) contributing to produce in aggregate 80 per cent of the brick output within the region/host country. The technology with the lowest energy intensity among them is the baseline technology;

[4] The default value number of bricks and quantity of cement per square meter of brick wall is established in a conservative manner, assuming 4" thick wall with brick size of 228 x 107 x 69 mm (9"x 4"x 2.7"), with a cement mortar layer of 10mm in between bricklayers, with 4:1 standard mixing ratio of sand to cement and use of 230 kg cement per m^3 of mortar with 30 per cent excess mortar. A small variation in brick size is already accounted for in the estimation on number of bricks.

[5] If the data on brick production is available as total weight (tonnes), area (square meter) or volume (cubic meter), the number of individual bricks annually produced shall be calculated by dividing the total production by the weight, area or volume of a single brick. The standard brick size of 228 x 107 x 69 mm (9"x 4"x 2.7"), may be used, and its density based either on measurements or on locally accepted values, that are valid for the brick type (e.g. hollow or solid bricks).

(ii) Identify and list the fuels with decreasing carbon emission factors that together contribute to produce in aggregate 80 per cent or more of brick output based on the identified technology in earlier step. The fuel with the lowest carbon emission factor among them is the baseline fuel;

(iii) Based on the specifications of the identified technology (brick production rate, energy consumption in the process of brick manufacture) and the identified fuel, the emission factor per unit of brick will be determined;

(b) Conservative emission factor based on the governmental data or official statistics from local authorities and survey techniques for the host country.

5.2.2.2. Emission factor for cement

22. Emission factor for cement ($EF_{BL,cement}$) shall be determined using one of the following options:

(a) The average emissions of cement manufacturing units in the previous three years, in similar social, economic, environmental and technological circumstances within the region/host country, and whose performance is among the top 20 per cent of their category;

(b) Conservative emission factor based on the governmental data or official statistics from local authorities and survey techniques for the host country.

23. The baseline emissions for the displaced cement and brick shall be calculated as:

$$BE_y = \sum_k A_{k,y} \times \eta_{usage}\left(n_{brick,k} \times EF_{BL,brick} + w_{cement,k} \times EF_{BL,cement}\right) \quad \text{Equation (2)}$$

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2)
$n_{brick,k}$	=	Amount of bricks used in the baseline to build an unit area of wall type *k* (bricks per square meter)
$w_{cement,k}$	=	Amount of cement used in the baseline to build an unit area of wall type *k* (tonnes per square meter)
$A_{k,y}$	=	Area of gypsum concrete wall panel used in lieu of walls of type *k* during the year *y* (m^2)
η_{usage}	=	A net usage factor of 0.95 is used to account for minor losses, due to wastage of gypsum concrete wall panels during construction

5.3. Project emissions

24. Project emissions (PE_y) consist of emissions associated with the consumption of electricity and/or fossil fuel in the manufacturing facility of the gypsum concrete wall panels and shall be calculated in accordance with the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and/or "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". Project

emissions include the upstream emissions associated with the consumption of raw materials in the gypsum concrete wall panel production.

$$PE_y = PE_{FC,y} + PE_{EC,y} + PE_{upstream,y} \quad \text{Equation (3)}$$

Where:

PE_y = Project emissions in year *y* (t CO_2)

$PE_{FC,y}$ = Project emissions from fossil fuel consumption (t CO_2)

$PE_{EC,y}$ = Project emissions from electricity consumption (t CO_2)

$PE_{upstream,y}$ = Project emissions associated with the consumption of raw materials in the gypsum concrete panel production

25. Project emissions associated with the consumption of raw materials in the gypsum concrete panel production ($PE_{upstream,y}$) shall be calculated based on the monitored amount of each material consumed by the plant ($Q_{rm,x,y}$).

$$PE_{upstream,y} = \sum_x Q_{rm,x,y} \times EF_x \quad \text{Equation (4)}$$

Where:

$Q_{rm,x,y}$ = Quantity of raw material type *x* consumed by the gypsum concrete panel producing plant in the year *y* (tonnes)

EF_x = Upstream emission factor for the production of raw material type *x* (t CO_{2e}/tonne), referred to in table 2

26. The emission factors for the consumption of raw materials (EF_x) shall be based on the following data:

Table 2. Emission factors associated with the consumption of raw materials for gypsum concrete wall panel production

Raw material	Emission factor (t CO_2/t)	Source
Gypsum[6]	0.004	Table 4.20 of life cycle analysis report on Gypsum[7]
Glass Fibre	0.25	IPCC 2006 Volume 3 Chapter 2, Table 2.6

[6] In case gypsum used for gypsum concrete wall panel is sourced from industrial waste (phosphor gypsum, flue gas gypsum) its emission factor is considered as zero otherwise emission factor indicated in table should be used.

[7] The emission factor is based on life cycle analysis of Gypsum as per table 4.20 in document available at:<http://calculatelca.com/wp-content/themes/athena/images/LCA%20Reports/Gypsum_Wallboard.pdf>. The document indicates 0.0423 GJ of energy consumption to extract one tonne of gypsum, which relates to approximately 0.004 t CO_2/ tonne gypsum assuming conservative energy source (i.e. coal 96.1 t CO_2/TJ).

Raw material	Emission factor (t CO_2/t)	Source
Steel Studs	1.46	IPCC 2006 Volume 3 Chapter 4, Table 4.1
Water	0	-
Additives[8]	0	-

5.4. Leakage

27. No leakage calculation is necessary.

6. Monitoring methodology

28. Relevant parameters shall be monitored as indicated in the table below. The applicable requirements specified in the recent version of "General guidelines for SSC CDM methodologies" are also an integral part of the monitoring guidelines specified below and therefore shall be referred by the project participants.

6.1. Data and parameters monitored

29. The following parameters shall be fixed ex ante at the time of validation.

Data / Parameter table 1.

Data / Parameter	Type of applications of gypsum concrete wall panels
Data Unit	-
Description	This is to establish the types of applications which would be focused or form part of project activity
Source of Data	As per paragraph 6
Value to be applied	-
Any comment	

Data / Parameter table 2.

Data / Parameter	Gypsum concrete composition
Data Unit	Mass of each component represented per m^2 for each type of wall panel
Description	This provides the composition of raw material in the gypsum concrete wall panel. In case the composition varies, provide a range for each component
Source of Data	Gypsum concrete wall panel manufacturer
Value to be applied	-
Any comment	-

[8] The use of additives (e.g. silicon as water repellent, retarder, and/or consistency setting acid) should be monitored, and the associated emissions may be disregarded if the total amount consumed is less than 0.30 kg/m^2 of gypsum concrete wall produced. Otherwise, a revision to this methodology to include a conservative default value for the additive consumption should be proposed.

Data / Parameter table 3.

Data / Parameter	**$n_{brick,k}$**
Data Unit	units/m^2 of wall
Description	Number of bricks used per square meter of wall type *k* in the baseline scenario
Source of Data	As per paragraph 19
Value to be applied	As per paragraph 19
Any comment	To be established for each wall type. In case building codes/standards refer to a range, the value corresponding to a conservative limit of the range shall be applied

Data / Parameter table 4.

Data / Parameter	**$W_{cement,k}$**
Data Unit	tonnes/m^2 of wall
Description	Quantity of cement used per square meter of wall type *k* in the baseline scenario
Source of Data	As per paragraph 19
Value to be applied	As per paragraph 19
Any comment	To be established for each wall type. In case building codes/standards refer to a range, the value corresponding to a conservative limit of the range shall be applied

Data / Parameter table 5.

Data / Parameter	**$EF_{BL,Brick}$**
Data Unit	t CO_2/tonne
Description	Emission factor for the bricks used in baseline
Source of Data	-
Value to be applied	As per paragraph 20 or 21
Any comment	-

Data / Parameter table 6.

Data / Parameter	**$EF_{BL,cement}$**
Data Unit	t CO_2/tonne
Description	Emission factor for the cement used in baseline
Source of Data	-
Value to be applied	As per paragraph 22
Any comment	-

30. The following parameters shall be monitored and recorded during the crediting period.

Data / Parameter table 7.

Data / Parameter	**$A_{k,y}$**
Data Unit	m^2
Description	Area of wall panel sold and used by final consumers in year *y*, for wall of type *k*
Source of Data	Information collected from the end buyers on end use of the gypsum concrete wall panels
Measurement procedures (if any)	The monitoring shall include the quantity of gypsum concrete wall panel sold to the consumers classified for each type of use in line with paragraph 3

Monitoring frequency	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedure	The contact details of the end users and the usage of the wall panels is recorded in manual/electronic format and data backups are done to ensure data availability
Any comment	A statistically valid sample of the locations where the gypsum concrete wall panels are used, with consideration, in the sampling design, of usage type can be used to determine parameter values used to calculate emission reductions, as per the relevant requirements for sampling in the standard for "Sampling and surveys for CDM project activities and programmes of activities"

Data / Parameter table 8.

Data / Parameter	**$Q_{rm,x,y}$**
Data Unit	volume or mass unit
Description	Quantity of raw material *x* consumed in the production of gypsum concrete wall panel in year *y*
Source of Data	Consumption log sheets or the composition information made available by gypsum concrete wall panel manufacturing company
Measurement procedures (if any)	The monitoring shall include the quantity of each raw material consumed in the production of gypsum concrete wall panels. The data is monitored continuously based on purchase records or based on the product's standard specification
Monitoring frequency	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedure	Standard composition can be crosschecked with operation log sheets or purchase records of raw materials
Any comment	In case composition is specified in a range, the values corresponding to higher project emissions are used. For raw materials procured from natural sources, the availability of surplus quantities is established based on the survey/data

Data / Parameter table 9.

Data / Parameter	**EF_x**
Data Unit	t CO_2/Tonne
Description	Emission factor of the raw material used in manufacturing gypsum concrete wall panel
Source of Data	Default values based on IPCC data or source as mentioned in Table 2
Measurement procedures (if any)	-
Monitoring frequency	-
QA/QC procedure	-
Any comment	-

Data / Parameter table 10.

Data / Parameter	**$PE_{FC,y}$**
Data Unit	t CO_2
Description	Project emissions from fossil fuel consumption
Source of Data	-

Measurement procedures (if any)	Project emissions from fossil fuel consumption calculated in accordance with the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"
Monitoring frequency	-
QA/QC procedure	-
Any comment	-

Data / Parameter table 11.

Data / Parameter	**$PE_{EC,y}$**
Data Unit	t CO_2
Description	Project emissions from electricity consumption
Source of Data	-
Measurement procedures (if any)	Project emissions from electricity consumption calculated in accordance with the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"
Monitoring frequency	-
QA/QC procedure	-
Any comment	-

6.2. Project activity under a programme of activities

31. The methodology is applicable to programme of activities.

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Document information

Version	*Date*	*Description*
01.0	4 October 2013	EB 75, Annex 17 Initial adoption.

Decision Class: Regulatory
Document Type: Standard
Business Function: Methodology
Keywords: simplified methodologies, type (iii) projects