CLEAN DEVELOPMENT MECHANISM

CDM-MP93-A01

Draft Large-Scale Methodology

Production of Geopolymer Cement

Version 01.0

Sectoral scope(s): 06

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The proposed new methodology "NM0382: Production of geopolymer cement" was submitted by Shanghai Geopoly New Materials Co., Ltd Climate Bridge (Shanghai) Ltd., and received in March 2023.

2. Purpose

2. The methodology covers project activities that produce Geopolymer Cement to displace ordinary portland cement (OPC) that would have otherwise been produced and used in the host country.

3. Key issues and proposed solutions

3. The methodology is applicable under the following conditions:

   (a) The geopolymer cement produced by the project activity is ambient-cured one-part geopolymer cement.

   (b) The precursor chemicals for the production of geopolymer cement are industrial by-products and mineral wastes. No carbonate materials that would result in CO_2 emissions, such as limestone, are used.

   (c) The industrial by-products and mineral wastes used by the project activity are disposed as waste and not used for any purpose in the baseline scenario.

   (d) The performance (e.g. compressive strength, setting time) of the concrete made with geopolymer cement produced by the project activity complies with applicable national/sectoral regulations.

   (e) The geopolymer cement shall be used in applications similar to those where OPC is used in the country, and such uses are acceptable under the national/sectoral standards.

   (f) Emission reductions may only be claimed by the producer of geopolymer cement.

   (g) The geopolymer cement produced under the project activity is used by consumers within the host country.

4. Impacts

4. The new methodology will allow the estimation of emission reductions for project activities that produce geopolymer cement to displace OPC that would have otherwise been produced and used in the host country.

5. Subsequent work and timelines

5. The draft version of the methodology is recommended by the Methodologies Panel (MP) for consideration by the Board at its 121st meeting. No further work is envisaged.

6. Recommendations to the Board

6. The MP recommends that the Board adopt this new methodology, to be made effective at the time of the Board's approval.

TABLE OF CONTENTS **Page**

1. Introduction

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

Table 1. Methodology key elements

Typical projects	Partial or full displacement of Ordinary Portland Cement (OPC) by Geopolymer Cement produced in greenfield Geopolymer Cement Plant(s) or in retrofitted existing cement grinding only plant(s).
Type of GHG emissions mitigation action	Avoidance of CO_2 emissions by displacing Ordinary Portland Cement (OPC) by Geopolymer Cement.

2. Scope, applicability, and entry into force

2.1. Scope

2. This methodology applies to project activities that produce Geopolymer Cement to displace Ordinary Portland Cement (OPC) that would have otherwise been produced and used in the host country.

2.2. Applicability

3. This methodology is applicable to project activities that produce Geopolymer Cement in either greenfield geopolymer cement plant(s) or retrofitted existing cement grinding only plant(s) (plants with no clinker manufacturing facility) to displace Ordinary Portland Cement (OPC) that would have otherwise been produced and used in the host country.

4. The methodology is applicable under the following conditions:

   (a) The Geopolymer Cement produced by the project activity is ambient-cured one-part Geopolymer Cement.

   (b) The precursor chemicals for the production of Geopolymer Cement are industrial by-products and mineral wastes. No carbonate materials that would result in CO_2 emissions, such as limestone, are used.

   (c) The industrial by-products and mineral wastes used by the project activity are disposed as waste and not used for any purpose in the baseline scenario. The project participants shall demonstrate ex-ante that prior to the implementation of the project there is a surplus in the region which is not utilised of at least 25%, compared to the total demand. If the industrial by-products and mineral wastes used by the project activity are sourced from an identified supplier, data on their final disposal within the last three years prior to the implementation of the project from the supplier shall be provided.

   (d) The project participants shall demonstrate that the performance (e.g. compressive strength, setting time) of the concrete made with Geopolymer Cement produced by the project activity complies with applicable national/sectoral regulations. In doing so, test results from a certified independent third party shall be provided.

(e) The Geopolymer Cement shall be used in applications similar to those of OPC in the country, and such uses are acceptable by the national/sectoral standards.

(f) Emission reductions may only be claimed by the producer of Geopolymer Cement. The project participants shall avoid double counting of emission reductions, through a contractual agreement with the end-user(s), feedstock producer or other stakeholder involved in the supply chain.

(g) The Geopolymer Cement produced under the project activity is used by consumers within the host country. This methodology is not applicable to project activities producing Geopolymer Cement to be exported beyond the boundaries of the host country.

(h) The applicability conditions of the relevant methodological tools shall apply.

(i) This methodology is only applicable if the application of the procedure to identify the baseline scenario results in the production and usage of OPC being the most plausible baseline scenario.

2.3. Entry into force

5. The date of entry into force is the date of the publication of the EB XX meeting report on DDMonthYYYY.

2.4. Applicability of sectoral scopes

6. Designated operational entities validating and verifying clean development mechanism (CDM) project activities and programmes that use this methodology shall apply sectoral scope 04.

3. Normative references

7. This baseline and monitoring methodology is based on the following proposed new methodology and approved consolidated methodologies:

(a) “NM0382: Production of Geopolymer Cement” by Shanghai Geopoly New Materials Co., Ltd and Climate Bridge (Shanghai) Ltd.

(b) “ACM0005 “Increasing the blend in cement production”;

(c) “ACM0015 “Reduction of emissions from raw material switch in clinker production”.

8. This methodology also refers to the latest approved versions of the following methodological tools:

(a) “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality.”

(b) “TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”

(c) “TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”;

(d) "TOOL11: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period";

(e) "TOOL12: Project and leakage emissions from transportation of freight".

9. For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/methodologies/index.html>.

4. Definitions

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

11. For the purpose of this methodology, the following definitions apply:

(a) **Alkaline activators** - are responsible for the dissolution of the alumino silicates present in the raw material. The most commonly used alkaline activators are silicate solutions and alkaline hydroxides.

(b) **Ambient-cured one-part Geopolymer Cement**: is a pre-mixed material containing precursor chemicals and alkaline activators which is hydrated by adding water and that is cured at ambient condition without applying any heat or other control of the atmospheric conditions.

(c) **Precursor chemicals** – are a range of input materials that are rich in aluminosilicates, sourced from industrial by-products or mineral wastes used to produce Geopolymer Cement.

(d) **Raw materials**: input materials for the production of the baseline clinker.

(e) **Region:** the geographical area defined by a radius of 200 km around the project activity that include at least the five cement plants nearest to the plant of the project activity. In the event where there are less than five plants within 200 km radius, the radius shall be increased to accommodate at least five plants. The cement plants having the registered CDM projects which similar applicability conditions (for example projects using ACM0003, ACM0005, ACM0015) are not included.

5. Baseline methodology

5.1. Project boundary

12. The spatial extent of the project boundary encompasses all process units related to the production of Geopolymer Cement. Transportation of precursor chemicals, alkaline activators and product(s) is also included in the project boundary.

13. The greenhouse gases included in or excluded from the project boundary are shown in Table 2.

Table 2. Emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Calcination of raw material in the kiln	CO_2	Yes	Direct emission from clinker kiln
		CH_4	No	Emissions negligible, excluded for simplification
		N_2O	No	Emissions negligible, excluded for simplification
	Use of fuel in the kiln including burner and pre-calcinator	CO_2	Yes	Direct emission from clinker kiln
		CH_4	No	Emissions negligible, excluded for simplification
		N_2O	No	Emissions negligible, excluded for simplification
	Use of fuel for drying raw materials & kiln fuel	CO_2	No	Excluded for simplification
		CH_4	No	Emissions negligible, excluded for simplification
		N_2O	No	Emissions negligible, excluded for simplification
	Use of electricity (grid and self-generated) for the preparation of fuels and raw materials, kiln operation, preparation of additives and cement grinding	CO_2	Yes	Direct emission from self-generation sources and indirect emission from plants connected to the grid supplying the plant with electricity
		CH_4	No	Emissions negligible, excluded for simplification
		N_2O	No	Emissions negligible, excluded for simplification
Project activity	Use of electricity for the production of Geopolymer Cement and preparation of precursor chemicals	CO_2	Yes	Main emission source
		CH_4	No	Emissions negligible, excluded for simplification
		N_2O	No	Emissions negligible, excluded for simplification
	Use of fuels for the production of Geopolymer Cement and preparation of precursor chemicals	CO_2	Yes	Main emission source
		CH_4	No	Emissions negligible, excluded for simplification
		N_2O	No	Emissions negligible, excluded for simplification
	Transportation of precursor chemicals, activators and products	CO_2	Yes	Possible main emission source
		CH_4	No	Emissions negligible, excluded for simplification
		N_2O	No	Emissions negligible, excluded for simplification
	Consumption of alkaline activator	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

5.2. Identification of the baseline scenario and demonstration of additionality

14. The selection of the baseline scenario and demonstration of additionality shall be conducted in accordance with "TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality."

15. The project participants shall identify alternative scenarios for the production of Geopolymer Cement, including but not limited to:

    (a) The proposed project activity not undertaken as a CDM project activity;

    (b) The continuation of the current production and usage levels of OPC;

    (c) The production and usage of other less carbon intensive types of cement;

    (d) Usage of other alternative construction materials to concrete;

    (e) Implementation of the proposed project activity at a later date (e.g. when the investment conditions become more favourable).

5.3. Baseline emissions

16. The baseline emissions are determined as follows:

$$BE_y = Q_{OPC,y} \times EF_{OPC,BL,y} \quad \text{Equation (1)}$$

Where:

BE_y	=	Baseline emissions in year y (t CO_2)
$Q_{OPC,\,y}$	=	Quantity of OPC replaced by Geopolymer Cement in year y (t).
$EF_{OPC,BL,y}$	=	Baseline emission factor of OPC replaced by Geopolymer Cement in year y (t CO_2/t OPC)

17. Quantity of OPC replaced by Geopolymer Cement in year y is determined as follows.

$$Q_{OPC.y} = \sum_i \left(Q_{GC,i,y} \times \frac{BR_{OPC,i,BL}}{BR_{GC,i,y}} \right) \quad \text{Equation (2)}$$

Where:

$Q_{GC,i,y}$	=	Quantity of Geopolymer Cement produced and used to produce concrete or concrete product *i* in year y (t)
$BR_{OPC,i,BL}$	=	Mass of OPC used in one cubic meter of the project concrete or concrete product *i* in the baseline (t/m^3). Based on relevant standards or applicable regulations for similar uses in the host country.
$BR_{GC,I,y}$	=	Mass of Geopolymer Cement used in one cubic meter of the project concrete or concrete product *i* in year y (t/m^3). Based on relevant standards or applicable regulations for similar uses in the host country.
i	=	Type of concrete or concrete product

18. The baseline emission factor of OPC replaced by Geopolymer Cement ($EF_{OPC,BL}$) in year is calculated as follows:

$$EF_{OPC,BL,y} = w_{clinker,BL} \times EF_{clinker,BL} \times IR^t + EF_{elec,add,BL} \quad \text{Equation (3)}$$

Where:

$w_{clinker,\ BL}$	=	Baseline benchmark share of clinker per tonne of OPC (t clinker/t OPC)
$EF_{clinker,\ BL}$	=	Baseline emission factor of clinker (t CO_2/t clinker)
IR	=	Technology improvement rate (default decrease rate of clinker usage) for baseline OPC production, set as 0.98 for *t* = 1
t	=	Year counter for the annual improvement during the crediting period
$EF_{elec,\ add,BL}$	=	Baseline emission factor for electricity consumption of OPC grinding and preparation of additives (t CO2/t OPC)

19. The benchmark share of clinker per tonne of OPC ($w_{clinker,BL}$) shall be determined as the lowest value between approaches (a), (b) and (c) specified under ***Step 2.1*** of the approved methodology "ACM0005: Increasing the blend in cement production".

20. The baseline emission factor of clinker ($EF_{clinker,BL}$) is determined as per ***Step 1.1*** of ACM0005 using data collected from the clinker production lines whose performance are among the top five or the top 20 percent (whichever results in the lowest levels of CO_2 emissions per ton of OPC). Average value for at least one year prior to the start date of CDM project activity shall be applied.

21. The baseline emission factor for electricity consumption of OPC grinding and preparation of additives ($EF_{elec,add,BL}$) is determined using one of the following options:

    (a) **Option 1**: Calculated as per ***Step 3*** of ACM0005 using data collected from the clinker production lines whose performance are among the top five or the top 20 percent (whichever results in the least emissions of CO_2 per ton of OPC) in the host country. Average value for at least one year prior to the start date of CDM project activity shall be applied.

    (b) **Option 2**: Using the default value of **0** t CO_2/t OPC for conservativeness and simplification.

5.4. Project Emissions

22. Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{trans,y} + PE_{AA,y} \quad \text{Equation (4)}$$

Where:

PE_y	=	Project emissions in year y (t CO2)
$PE_{EC,y}$	=	Project emissions due to electricity consumption in year y (t CO_2)
$PE_{FC,y}$	=	Project emissions due to fuel consumption in year y (t CO_2)
$PE_{trans,y}$	=	Project emissions due to transportation of precursor chemicals, alkaline activators and Geopolymer Cement in year y (t CO_2)

$PE_{AA,y}$	=	Project emissions due to consumption of alkaline activators in year y (t CO_2)

23. Project emissions due to electricity consumption ($PE_{EC,y}$) are determined as per the latest version of CDM Methodological "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

24. Project emissions due to fuel consumption ($PE_{FC,y}$) are determined as per the latest version of CDM Methodological "TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

25. Project emissions due to transportation of precursor chemicals, alkaline activators and products ($PE_{trans,y}$) are determined as per the latest version of the methodological "TOOL12: Project and leakage emissions from transportation of freight", only if the transportation distance is over 200 km, otherwise they can be neglected.

26. Project emissions due to consumption of alkaline activators ($PE_{AA,y}$) is determined as follows:

$$PE_{AA,y} = \sum_{j} Q_{AA,j,y} \times EF_{AA,j,y} \quad \text{Equation (5)}$$

Where:

$Q_{AA,j,y}$	=	Quantity of alkaline activators j used by the project activity in year y (t). ($Q_{AA,j,y}$ should not be lower than the amount estimated ex-ante in the PDD (Q_{AA}) and validated by the DOE, which conforms to the relevant standards or regulations in the host country)
$EF_{AA,j,y}$	=	Life cycle emissions factor for alkaline activators j in year y (t CO2/t)

5.5. Leakage

27. Leakage emissions are not considered for the use of precursor chemicals since the industrial by-products used by the project activities shall be left as waste and would not have any previous usage in the baseline scenario.

5.6. Emission reductions

28. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (6)}$$

Where:

ER_y	=	Emission reductions in year *y* (t CO_2)
BE^y	=	Baseline emissions in year *y* (t CO_2)
PE_y	=	Project emissions in year *y* (t CO_2)
LE_y	=	Leakage emissions in year *y* (t CO_2)

6. Monitoring methodology

6.1. Data and parameters not monitored

29. All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

30. In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools and approved CDM methodology ACM0005 referred to in this methodology apply.

Data / Parameter table 1.

Data / Parameter:	**$BR_{OPC,i,BL}$**
Data unit:	t
Description:	Mass of OPC used in one cubic meter of the baseline concrete or concrete product *i* in the baseline
Source of data:	Based on relevant standards or applicable regulations in the host country
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	**$w_{clinker,BL}$**
Data unit:	t clinker / t OPC
Description:	Baseline benchmark share of clinker per tonne of OPC
Source of data:	Actual or local/regional data to be used
Measurement procedures (if any):	Determined as the lowest value between approaches (a), (b) and (c) specified under Step 2.1 of "ACM0005: Increasing the blend in cement production"
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	**$EF_{clinker,BL}$**
Data unit:	t CO_2/t clinker
Description:	Baseline emission factor of clinker
Source of data:	Actual or local/regional data to be used. If not available, international data should be used

Measurement procedures (if any):	Determined as per Step 1.1 of "ACM0005: Increasing the blend in cement production"
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	**$EF_{elec,add,BL}$**
Data unit:	t CO_2/t OPC
Description:	Baseline emission factor for electricity consumption of OPC grinding and preparation of additives
Source of data:	Actual or local/regional data shall be used.
Measurement procedures (if any):	(a) Option 1: Calculated as per Step 3 of "ACM0005: Increasing the blend in cement production". (b) Option 2: Using the default value of 0 t CO2/t OPC for conservativeness and simplification.
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	**Q_{AA}**
Data unit:	t AA / t GC
Description:	Permissible amount of alkaline activator per ton of Geopolymer Cement
Source of data:	Based on relevant standards or applicable regulations for similar uses in the host country
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	

6.2. Data and parameters monitored

Data / Parameter table 6.

Data / Parameter:	**$Q_{OPC,y}$**
Data unit:	t
Description:	Quantity of OPC replaced by Geopolymer Cement in year y
Source of data:	Calculated based on on-site measurements and plant records
Measurement procedures (if any):	
Monitoring frequency:	Daily monitoring and monthly recording

QA/QC procedures:	Monitoring equipment shall be calibrated as per manufacturer's specification or national/industrial standard of the host country. Crosscheck the measurements with sales invoices and with an annual balance based on sales and stock change.
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	**$Q_{GC,i,y}$**
Data unit:	t
Description:	Quantity of Geopolymer Cement produced and used to produce concrete or concrete product *i* in year *y*
Source of data:	Measurements as part of normal operations by Geopolymer Cement producer and consumer(s)
Measurement procedures (if any):	Measured using weight meter(s)
Monitoring frequency:	Daily monitoring and monthly recording
QA/QC procedures:	Monitoring equipment shall be calibrated as per manufacturer's specification or national/industrial standard of the host country. Crosscheck the measurements with an annual balance based on sales and stock change
Any comment:	-

Data / Parameter table 8.

Data / Parameter:	**$BR_{GC,i,y}$**
Data unit:	t
Description:	Mass of Geopolymer Cement used in one cubic meter of the project concrete or concrete product *i* in year y
Source of data:	Laboratory test results or based on relevant standards or applicable regulations for similar uses in the host country.
Measurement procedures (if any):	Measured using weight meter(s)
Monitoring frequency:	Annually
QA/QC procedures:	Monitoring equipment shall be calibrated as per manufacturer's specification or national/industrial standard of the host country. Crosscheck the measurements with an annual balance based on sales and stock change
Any comment:	Laboratory test result from qualified third party for the quantity of Geopolymer Cement used to prepare the test specimen(s) for each type of concrete or concrete product(s)

Data / Parameter table 9.

Data / Parameter:	**$Q_{P,k,y}$**
Data unit:	t
Description:	Quantity of precursor chemical type k used by the project activity in year y
Source of data:	On-site measurements and plant records

Measurement procedures (if any):	Measured as part of normal operations using weight meter(s)
Monitoring frequency:	Monthly
QA/QC procedures:	Monitoring equipment shall be calibrated as per manufacturer's specification or national/industrial standard of the host country.
Any comment:	The quantity of Geopolymer Cement produced and used shall be crosschecked with an annual balance based on sales and stock change

Data / Parameter table 10.

Data / Parameter:	**$Q_{AA,j,y}$**
Data unit:	t
Description:	Quantity of alkaline activators type *j* used by the project activity in year *y*
Source of data:	On-site measurements and plant records
Measurement procedures (if any):	Measured as part of normal operations using weight meter(s)
Monitoring frequency:	Monthly
QA/QC procedures:	Monitoring equipment shall be calibrated as per manufacturer's specification or national/industrial standard of the host country.
Any comment:	$Q_{AA,j,y}$ should not be lower than the ex-ante amount (Q_{AA}) estimated in the PDD and validated by the DOE, and which conforms to the relevant standards or regulations in the host country

Data / Parameter table 11.

Data / Parameter:	***$EF_{AA,j,y}$***
Data unit:	tCO_2/t
Description:	Life cycle emissions factor for alkaline activators type *j*
Source of data:	Supplier(s) or default value
Measurement procedures (if any):	Determined as per the following two options: a) Provided by alkaline activators supplier(s); b) Internationally recognized emission factor database, such as IPCC Emission Factor Database, US EPA's GHG Emission Factors Hub, etc.
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 12.

Data / Parameter:	***$PE_{EC,y}$***
Data unit:	tCO_{2e}
Description:	Project emissions due to electricity consumption in year y (t CO2)
Source of data:	As per "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

Measurement procedures (if any):	As per “TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”.
Monitoring frequency:	As per “TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”.
QA/QC procedures:	As per “TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”.
Any comment:	-

Data / Parameter table 13.

Data / Parameter:	$PE_{EC,y}$
Data unit:	tCO_{2e}
Description:	Project emissions due to fossil fuel consumption in year y (t CO2)
Source of data:	As per “TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
Measurement procedures (if any):	As per “TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
Monitoring frequency:	As per “TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
QA/QC procedures:	As per “TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
Any comment:	-

Data / Parameter table 14.

Data / Parameter:	$PE_{trans,y}$
Data unit:	tCO_{2e}
Description:	Project emissions due to transportation of precursor chemicals, alkaline activators and produced Geopolymer Cement
Source of data:	As per “TOOL12 “Project and leakage emissions from transportation of freight”.
Measurement procedures (if any):	As per “TOOL12 “Project and leakage emissions from transportation of freight”.
Monitoring frequency:	As per “TOOL12 “Project and leakage emissions from transportation of freight”.
QA/QC procedures:	As per “TOOL12 “Project and leakage emissions from transportation of freight”.
Any comment:	Only if the transportation distance is over 200 km, otherwise this source of emissions can be neglected.

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Document information

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