Joint Crediting Mechanism Proposed Methodology Form

Cover sheet of the Proposed Methodology Form	
Form for submitting the proposed methodology	
Host Country	Lao PDR
Name of the methodology proponents submitting this form	Taiheiyo Engineering Corporation Osumi Co., Ltd
Sectoral scope(s) to which the Proposed Methodology applies	5.Chemical Industry
Title of the proposed methodology, and version number	Biomass Utilization in Cement Kiln.
List of documents to be attached to this form (please check):	☐The attached draft JCM: ☐Additional information
Date of completion	08 October, 2014

History of the proposed methodology

Version	Date	Contents revised
01.0	08 October,2014	First draft
	03 January,2015	Second draft

A. Title of the methodology

Biomass Utilization in Cement Kiln.

B. Terms and definitions

Terms	Definitions
Clinker Production	The heat-treatment process of raw materials, including multistage pre-heater, precalciner, rotary kiln, and air quenching cooler.
Burning Process of Cement Clinker	The Cement is made from limestone, clay, silica material, and iron material as main raw material. It is heat-treatment process that the raw materials are ground into powder and manufacturing Clinker by heating while passing the rotary kiln after pre heater.
Biomass	It is renewable plant, animal, and organism of microorganism origin. There are some type wastes from agriculture and forestry industry waste, industrial waste, and a general waste, etc.
Biomass residues	Biomass generated as waste of agriculture and forestry industry. A rice husk plant is the target one for the project.
Alternative fuels	There are some wastes can be used as fuel alternatively- such as the waste of the fossil fuel origin (waste plastic, scrap tire, fiber, and rubber) and the biomass residues, etc. correspond. An agriculture system biomass is the target alternate fuel in this proposal.
Renewable biomass	It should be following the definition of renewable biomass "EB 23 Annex 18"
Project plant	The equipment to conduct activities. The Clinker manufacturing facilities is the target one in this proposal.
CSI protocol (Cement Sustainability Initiative protocol)	It is the standard statement for cement industry to implement self-measurement for sustainable development.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	The amount of the GHG exhaust reduction should be achieved by making it alternate the coal substitution in the clinker manufacturing process to an agricultural biomass (rice husk) baking process. Measurement for MRV methodology application should be carried out with the value measured by devices of certified accuracy, which are based on traceability system. Default values may be applied only above measurement is not possible. Also in JCM, accurate measurement of internationally recognized level should be applied. The reasons are the follows; ➢ Discount of CO_2 emission reduction by using default value for excess conservativeness may not accepted internationally if it is not clearly explained. ➢ Excess conservativeness will cause disadvantage to Project participant (PP), also make JCM project less attractive. This may lower the evaluation of JCM project. According to the above, the amount of GHG emission reduction is guaranteed with measuring the volume of clinker production and the energy consumption such as coal, electricity and diesel. <u>GHG emission reduction for coal consumption shall be;</u> GHG emission reduction = Reference GHG emission from coal – Project GHG emission from coal = Reference Coal consumption (= Project Clinker production ×unit heat value of coal for reference) ×CO_2 emission factor for coal ×conservative coefficient - Project Coal consumption (= Project Clinker production ×unit heat value of coal for project) ×CO_2 emission factor for coal ×conservative coefficient [1] ➢ The amount of GHG emission reduction is equivalent with the amount of substitute calorie from coal corresponds to rice

[1] The ratio of the lower limit value of a standard for an acceptability criterion of Laotian agency for Standardization and Methodology of the weight scale is adopted. (For conservative)

<table>
<tr><td></td><td>husk corresponds.

<u>GHG emission reduction for electricity consumption shall be;</u>
GHG emission reduction = Reference GHG emission from electricity – Project GHG emission from electricity
= Reference Electricity consumption (= Project cement production ×consumption rate of power for reference)×CO_2 emission factor for electricity ×conservative coefficient - Project electricity consumption (= Project clinker production ×consumption rate of power for project)×CO_2 emission factor for electricity × conservative coefficient [2]</td></tr>
<tr><td>Calculation of reference emissions</td><td>There are 10 cement factories produced by lime stone and coal using in Laos country. The original unit of cement is nothing to change based on the calculation.
We have confirmed that agricultural wastes expected for alternate fuel has been exhausting a lot, however, it has been abounding without effective utilization. Moreover, a positive profit use plan is insufficient.
Therefore, the continuance of manufacturing cement by the use of a current raw material and the fuel is BaU.

The table below shows both GHG of the emission source and the project boundary in the reference emission amount calculation contain.
<table>
<tr><th>Emission source</th><th>GHG</th><th>Yes/No</th><th>Explanation</th></tr>
<tr><td rowspan="3">Emission of fossil fuel of consumption calorie corresponding in project</td><td>CO_2</td><td>Yes</td><td>Main source</td></tr>
<tr><td>CH_4</td><td>No</td><td>Minor source. To simplify it.</td></tr>
<tr><td>N_2O</td><td>No</td><td>Minor source. To simplify it.</td></tr>
<tr><td rowspan="3">Disposal of biomass residue and exhaust according to incineration</td><td>CO_2</td><td>No</td><td>Carbon neutral</td></tr>
<tr><td>CH_4</td><td>No</td><td>Conservatively</td></tr>
<tr><td>N_2O</td><td>No</td><td>Minor source. To simplify it.</td></tr>
</table>

As for the maintainability in JCM, using the higher or lower limit</td></tr>
</table>

[2] The ratio of the lower limit value of a standard for an acceptability criterion of Laotian Agency for Standardization and Methodology of the electric power meter is adopted. (For conservative)

	of Authorized standard to secure the correction of measurement instrument as writing above. At the same time, Try to reduce the demand for the monitoring with using the conservative default value and purchase slip which have using for 3 years. Moreover, it is considered to use the minimum value of the energy basic unit of clinker manufacturing in the past three years as a reference. However, more excessive maintainability is not pursued In the CDM, ignoring a regional characteristic etc, and adopting the methodology of the base line and additionally uniformity. Therefore, there is the demerit not applying in the developing countries. So, the methodology proposed on this project is trying to complement the issue of CDM.
Calculation of project emissions	Project emission is calculated from monitored clinker production volume, fuel and electricity consumption, rice husk transport to the plant and each CO_2 emission factors. As for calculating the amount of the project emission, the amount of the calorie using the paddy rice husk instead of using coral is calculated. In the result, maintainability must be secured by comparing the calculation results of the amount of the CO_2 emission from a real turning on the coal and from the rice husk, which adopting the under limited amount of the exhaust. If mixing of materials to cement such as fly-ash is conducted, CO_2 emission reduction from reduction of limestone use. The project boundary for calculating the emission amount is all items relating the Clinker production shown as below. ◆ Pre-heater ◆ Rotary kiln ◆ Transportation vehicle for alternate fuel ◆ Rice husk receiving hopper, conveyors, silos and feeders ◆ Process relating to other Clinker production As for the leakage, it is considered that some GHG emits from

<table>
<tr>
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<td>coal mining, transportation and the rice husks' being abandoned etc. However, it is not adopted because of the viewpoint of maintainability for JCM.

Project emission from coal consumption
＝ (Unit consumption for project (MJ/t-clinker) ×Clinker production volume) × CO_2 emission factor × $f_{scale,y}$
Project emission from electricity consumption
＝ (Unit consumption for project(MWh/t- clinker) ×Clinker production volume) × CO_2 emission factor × $f_{elec,y}$
Project emission from the rice husk transport
＝（The amount of using of the agriculture bio-fuel (t-bio/y)÷The average load capacity of the transport truck(t-bio/truck)）×The average transport distance of the truck (km/truck)×Emission factor for truck (t- CO_2/km)

Maintainability in the calculation of project emissions is mortgaged by multiplying conservative coefficient by the expression as shown in measurement of the amount of the GHG exhaust reduction description.</td>
</tr>
<tr>
<td>Monitoring parameters</td>
<td>Parameters to be monitored are as follow;

<table>
<tr><th>Parameter</th><th>Frequency</th><th>Note</th></tr>
<tr><td>Coal consumption</td><td>Every hour, Every truck load</td><td>Practically, weighing data from certified truck scale by a coal mine is considered.</td></tr>
<tr><td>Rice husk consumption</td><td>Every truck load
Every day, Every month</td><td>Measured by truck scale and the amount of injection to rice husk receiving hopper</td></tr>
<tr><td>Water content of rice husk</td><td>Every day</td><td>Measured in the laboratory</td></tr>
<tr><td>Limestone consumption</td><td>Every truck load</td><td>Measured by truck scale</td></tr>
</table>
</td>
</tr>
</table>

	Amount of clinker production	Every day	By the calculation
	Cement dispatch	Everyday	Packed cement –Packing machine. Bulk Cement – truck scale
	Electricity consumption	Every month	Monthly transaction meter reading. Real time reading is also possible
	Amount of unit consumption of Diesel	Every month	The lubrication slip for the rice husk transport truck and the travel distance for the truck. (Default value; Plan)
	Amount of transport of rice shell	Every truck load	Measured by truck scale

The following are by default value or by collected data.

- CO2 conversion factor for grid electricity（t-CO2/MWh）(CDM DNA Laotian)
- CO2 conversion factor for coal by grade（t- CO2/t-Coal）(IEA)
- Calorific value of the coal (GJ/t- Coal)
- The transport distance of rice husk. (20 km/truck)
  Collection of rice husk is done as return cargo of the cement transport to Vientiane.
- Emission factor for Diesel (t- CO_2/GJ) (IPCC)
- Calorific value of dryness rice shell (GJ/t- rice shell) (Decides by the measurement)
- Emission factor for truck (t- CO_2/km)

D. **Eligibility criteria**

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	The coal alternative fuel must be a biomass residue the agriculture system etc.
Criterion 2	Should not be influenced on others in case the biomass residue (rice husk) has

	been used more for other thing.
Criterion 3	Should not be forced for agriculture to an additional load to etc. in the result of using the biomass residue.
Criterion 4	The rice husk feeding system must have robustness and steady controls, causes no adverse effect to the quality of manufactured clinker.
Criterion 5	Having sufficient performance for environment protection ➢ To satisfy environmental regulatory standard and similar standard. ➢ Dust collector shall be installed.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Coal will be consumed for burning process	CO_2
Electricity will be consumed for manufacturing process	CO_2
The amount of liquid fuel consumption (Diesel etc.) for transportation such as coal	CO_2
N/A	N/A
N/A	N/A
N/A	N/A
Project emissions	
Emission sources	GHG types
Coal consumption for burning process	CO_2
Electricity consumption for manufacturing process	CO_2
The amount of liquid fuel consumption (Diesel etc.) for transportation such as coal	CO_2
The amount of liquid fuel consumption (Diesel etc.) for rice husk transportation	CO_2
N/A	N/A
N/A	N/A

(Note)

Major GHG is CO_2. GHGs to be emitted from coal, electricity and the Rice husk of the transport car other than CO_2 are CH_4 and N_2O. However for simplicity and conservativeness in calculating reference emission and project emission, CH_4 and N_2O are not taken into account.

F. Establishment and calculation of reference emissions

1. Establishment of reference emissions

As for setting reference emission, we can see reference situated between BaU and the project activity.

For calculation of Emission reduction in the proposed methodology, the main parameters are set in conservative manner and calculation methods securing for conservativeness are adopted. This will secure that emission reduction by the project is lower than the BaU emission. Therefore, results of the proposed methodology in a net reduction of emissions, since reference emissions are thought to be lower than the BaU emissions.

Setting and calculation of reference emissions proposed by this report, is applicable to the Biomass use plan of the Lao Cement company. Usually, a methodology with the generality is complex, and troublesome. Therefore, we thought about establishment of reference emissions in JCM with the simple is best.

In case of obligating for using biomass fuel by the law during the project period, the restriction value is assumed to be a reference.

2. Calculation of reference emissions

Calculation of reference emissions are as follows;

$REy = REcoal,y + REelec,y$ ・・・・・・・・・・・・・・・・・・・・・・・・eq-1

Where,

RE_y	Emission from reference activity without project activity	t-CO_2/ y
$RE_{coal,y}$	Emission from reference activity from consumption of coal for cement manufacturing without project activity	t-CO_2/ y
$RE_{elec,y}$	Emission from reference activity from consumption of electricity for cement manufacturing without project activity	t-CO_2/ y

Subscript indexes expressed in parameters means the following;

$_{coal}$: Coal for kiln

$_{elec}$: Electricity

$$REcoal_{,y} = \sum_{i=1}^{12} FC_{RE,y,i} * EFcoal_{,CO2,y} * f_{scale,y}$$

$$= \sum_{i=1}^{12} (ClinGN_{PJ,y,i} * SFC(C)_{RE,y,i}) * EFcoal_{,CO2,y} * f_{scale,y}$$ ・・・・・・・eq-2

$$SFC(C)_{RE,y,i} = \mathbf{FC}_{RE,y,i} / ClinGN_{\mathbf{PJ},y,i} \quad \cdots\cdots\cdots\cdots\cdots \text{eq-3}$$

$$CementGN_{\mathbf{PJ},y,i} = ClinGN_{\mathbf{PJ},y,i} + M(Gyp)_{\mathbf{PJ},y,i}$$

$$M(Gyp)_{\mathbf{PJ},y,i} = ClinGN_{\mathbf{PJ},y,i} * M(Gyp)rate_{RE}$$

$$ClinGN_{\mathbf{PJ},y,i} = M(Lim)_{\mathbf{PJ},y,i} + M(Iron)_{\mathbf{PJ},y,i} - Loss_{\mathbf{PJ},y,i}$$

$$M(Iron)_{\mathbf{PJ},y,i} = ClinGN_{\mathbf{PJ},y,i} * M(Iron)rate_{RE}$$

- The mixed rate of Gypsum to Clinker is being decided.
- The mixed rate of iron ore to the limestone is being decided.
- The consumption quantity measurement of the limestone, the iron ore and the gypsam is enforced from the viewpoint of PDCA. Therefore, a result of measurement isn't used for the calculation of the CO_2 emissions.

$$REelec,y = \sum_{i=1}^{12} EC_{RE,y,i} \quad *EFelec,_{CO2,y} * f_{elec,y}$$

$$= \sum_{i=1}^{12} (ClinkerGN_{PJ,y,i} * SFC(E)_{RE,y,i}) * EFelec,_{CO2,y} * f_{elec,y} \cdots\cdots\cdots \text{eq-4}$$

$$SFC(E)_{RE,y,i} = \sum_{i=1}^{12} \mathbf{EC}_{RE,y,i} / \sum_{i=1}^{12} ClinkerGN_{PJ,y,i} \cdots\cdots\cdots\cdots\cdots \text{eq-5}$$

Where,

$FC_{RE,y,i}$	（On month i of year y）Energy of coal consumption for clinker manufacturing without project activity $FC_{RE,y,i} = PFC_{RE,y,i} \times NCV_{c,y,i}$	Gcal/month
$PFC_{RE,y,i}$	（On month i of year y）Consumption of coal for clinker manufacturing without project activity	t-coal/month
$NCV_{c,y,i}$	（On month i of year y）Net calorific value of coal used for Clinker manufacturing	GJ/t-coal
$f_{scale,y}$	Conservative coefficient. （In year y）The ratio of the lower limit value of a standard for the Lao People's Democratic Republic Agency for Standardization and Metrology of the track scale. (For conservative)	-
$EFcoal,_{CO2,y}$	（In year y）CO_2 emission factor for coal	t-CO_2/Gcal
$CementGN_{PJ,y,i}$	（On month i of year y）Cement production after project implementation	t-cement/month
$ClinkerGN_{\mathbf{PJ},y,i}$	（On month i of year y）Clinker production after	t-clinker/month

	project implementation	
$SFC(C)_{RE,y,i}$	（On month i of year y） Unit coal consumption for clinker manufacturing without project activity	Gcal/ t- clinker
$M(Gyp)_{PJ,y,i}$	（On month i of year y） Gypsum consumption for clinker manufacturing	t-gypsum/t- clinker
$M(Gyp)rate_{RE}$	Gypsum injection rate is decided.	-
$M(Lim)_{PJ,y,i}$	（On month i of year y） Limestone consumption for clinker manufacturing	t-limestone/t-clinker
$M(Iron)_{PJ,y,i}$	（On month i of year y） Iron ore consumption for clinker manufacturing	t-iron ore/t-clinker
$M(Iron)rate_{RE}$	Iron ore injection rate is decided.	-
$Loss_{PJ,y,i}$	（On month i of year y）Clinker production loss after project implementation	t-clinker/month
$EC_{RE,y,i}$	（On month i of year y） Electricity consumption for clinker manufacturing without project activity	MWh/month
$EFelec_{,CO2,y}$	（In year y） CO_2 emission factor for grid electricity	t-CO_2/MWh
$f_{elec,y}$	Conservative coefficient （In year y） The ratio of the lower limit value of a standard for the Lao People's Democratic Republic Agency for Standardization and Metrology of the electric power meter. (For conservative)	-
$SFC(E)_{RE,y,i}$	（On month i of year y）Unit electricity consumption for clinker manufacturing without project activity	MWh/t-clinker

Subscript indexes expressed in parameters means the following;

$_{CO2}$: CO_2

$_{PJ}$: Project

$_{RE}$: Reference

$_{scale}$: Track scale

$_{elec}$: Electric power meter

[Note]

An official approval by the standard of Truck Scale is being enforced one times every year.

Acceptance standard is the following.

Instrument : Truck scale

Capacity and error : Max 50t±20kg,

Reference Standard : A set of National Standard Weights Class M1

Calibration Method : Weighing Performance Test

G. Calculation of project emissions

As for calculating the amount of the project emission, it is necessary to consider the amount of the emission of GHG from the coal transportation of the clinker manufacturing, the electric power using, and the biomass residue (rice husk) transportation. In other hand, the limestone transportation is not included for the calculating because there is no difference between the reference and the project scenario. The coal transportation is not conservatively considered as well.

The rice husk is secondarily generated as waste during year that lies growing of farm products in the amount of the emission, and it doesn't think here as an amount of the emission from the project.

As for the amount of yearly emission from farm products, it is not considered for the emission of the project because the rice husk is product secondly.

Calculations of project emissions are as follows.

$$PEy = PEcoal,y + PEelec,y + PETr,y + PE_{BC,y} \cdots \text{eq-6}$$

Where

PEy	CO2 emission from project activity	t-CO_2/ y
PEcoal,y	Emission from project activity from consumption of coal for cement manufacturing	t-CO_2/ y
PEelec,y	Emission from project activity from consumption of electricity for cement manufacturing	t-CO_2/ y
$PE_{Tr,y}$	Amount of project emission according to rice husk transportation	t-CO_2/ y
$PE_{BC,y}$	Amount of emission according to cultivation of farm products (Do not consider it.)	t-CO_2/ y

Subscript indexes expressed in parameters means the following;

Tr : Truck

BC : Biomass Cultivation

$$PEcoal_{,y} = \sum_{i=1}^{12} \mathbf{FC}_{PJ,y,i} * EFcoal_{,CO2,y}$$

$$= \sum_{i=1}^{12} (ClinGN_{\mathbf{PJ},y,i} * SFC(C)_{PJ,y,i}) * EFcoal_{,CO2,y} \cdots \text{eq--7}$$

$$SFC(C)_{PJ,y,i} = \mathbf{FC}_{PJ,y,i} / ClinGN_{\mathbf{PJ},y,i} \quad \cdots\cdots\cdots\cdots\cdots \text{eq--8}$$

Or,

$$PEcoal_{,y} = REcoal_{,y} - PER_{Husk,y}$$

$$PER_{Husk,y} = \sum_{i=1}^{12} ((M_{(Husk),y,i} * NCV_{Husk,y,i}) / NCV_{C,y,i}) * EFcoal_{,CO2,y} \quad \cdots\cdots \text{eq--9}$$

- CO2 emission reduction from the coal substitution by the husk is calculate.

$$PEelec,y = \sum_{i=1}^{12} \mathbf{EC}_{PJ,y,i} * EFelec_{,CO2,y}$$

$$= \sum_{i=1}^{12} (ClinGN_{PJ,y,i} * SFC(E)_{PJ,y,i}) * EFelec_{,CO2,y} \quad \cdots\cdots\cdots \text{eq--10}$$

$$SFC(E)_{PJ,y,i} = \sum_{i=1}^{12} \mathbf{EC}_{PJ,y,i} / \sum_{i=1}^{12} ClinkerGN_{PJ,y,i} \quad \cdots\cdots\cdots\cdots \text{eq--11}$$

$$PE_{Tr,y} = \sum_{i=1}^{12} \left(\frac{M_{(Husks),y,i}}{TL_{Tr,y,i}} \times AVD_{Husks,y,i} \times EF_{tr,CO2} \right) \cdots\cdots\cdots \text{eq—12}$$

- I In general, " $AVD_{Chaff,y,i}$ " is calculated by the round trip distance. However, it can be almost disregarded levl in this project. The reason is why the rice husk is collected from the rice milles along the national road on one's way back to the cement transportation in Vientiane city.
  However, considering the maintainability, constant transportation distance is assumed (=20 km/truck).

$$PE_{BC,y} = 0 \quad \cdots\cdots\cdots\cdots\cdots \text{eq—13}$$

- It is not aimig to grow rice for the fuel using. And, the rice husk is alomost all abandoned without efficient use.

Energy of coal consumption for clinker manufacturing without project activity

Where,

$FC_{PJ,y,i}$	（On month i of year y）Expected energy of coal consumption for clinker manufacturing by project activity $FC_{PJ,y,i} = PFC_{PJ,y,i} \times NCV_{c,y,i}$	Gcal/month
$PFC_{PJ,y,i}$	（On month i of year y）Expected coal consumption for clinker manufacturing by project activity	t-coal/month
$NCV_{c,y,i}$	（On month i of year y）Net calorific value of coal used for Clinker manufacturing	GJ/t-coal
$EFcoal_{,CO2,y}$	（In year y）CO_2 emission factor for coal	t-CO_2/GJ

$ClinkerGN_{PJ,y,i}$	（On month i of year y） Clinker production after project implementation	t-clinker/month
$SFC(C)_{PJ,y,i}$	（On month i of year y） Expected unit coal consumption for clinker manufacturing after project implementation	t-coal/t-clinker
$EC_{PJ,y,i}$	（On month i of year y）Expected electricity consumption for clinker manufacturing after project implementation	MWh/month
$EFelec_{,CO2,y}$	（In year y） CO_2 emission factor for grid electricity	t-CO_2/MWh
$SFC(E)_{PJ,y,i}$	（On month i of year y） Expected unit electricity consumption for clinker manufacturing after project implementation	MWh/t-clinker
$M_{(Husks),\ y,i}$	（On month i of year y） The amount of one month rice husk using for the clinker manufacturing.	t-husks /month
$PER_{Husk,y,i}$	（On month i of year y） The amount of CO2 emission reduction of Rise Husk	t-CO_2/ month
$NCV_{Husk,y}$	Net calorific value of dried rice husk used for Clinker manufacturing (Default value is presumed.)	GJ/t-husk
TL Tr, y,i	（On month i of year y） Average load of transportation track for rice husk	t-husks /truck
AVD_{Husks}, y,i	（On month i of year y） Average transportation distance of additional track for the project activity such as one way distance from rice husk exhaust facilities to clinker manufacturing plant etc. (20km/track; default value)	km /truck
EFtr, CO_2	CO_2 emission factor for truck (t- CO_2/km)	tCO_2/km

Subscript indexes expressed in parameters means the following;

$_{Husks}$: Rice husks

$_{tr,}$: Track

H. Calculation of emissions reductions

Calculation of emission reduction from implementing project is as follows.

$$ERy = REy - PEy \quad \cdots\cdots\cdots\cdots \text{eq-- 14}$$

Where,

ERy	Annual CO_2 emission reduction	t-CO_2/ y
REy	Annual reference CO_2 emission	t-CO_2/ y
PEy	Annual project CO_2 emission	t-CO_2/ y

Basically, the calculation both CO_2 emission of reference and project is based on the cement basic unit evaluation. As for CDM, the method of basic unit evaluation may not be recommended. However, we proposed JCM at this time. The calculation of the emission reduction of every countermeasure menu is from the viewpoint of with PDCA cycle..
The advantage of this original unit technique is effect of the operations improvement in the project is reflected.
The calculation of CO_2 emission for reference and project adopted a simple method. But, rational conservative calculation technique was secured. Therefore, annual CO_2 emission reduction is conservative value fully.

The proposed JCM methodology can be applied to other fossil fuel substitutions making efficient use of the biomass residues based on the assumption of some attention needs.

Ⅰ. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
Iron ore injection rate :$M(Iron)_{rate}$	Iron ore injection rate is decided Lao Cement Company Ltd. (Lao Cement).	Set as the default value. ✓ Lao cement record
Gypsum injection rate :$M(Gyp)_{rate}$	Gypsum injection rate is decided Lao Cement.	Set as the default value. ✓ Lao cement record
Unit heat value of coal :$SFC(C)_{RE,y,i}$	（On month i of year y）Unit coal consumption for clinker manufacturing. (t-coal/t- clinker) Unit heat value for coal is calculated by the past data of amount of clinker manufacture and the amount of coal consumption. But, setting more boldly than BaU conservative unit heat value.	Set as the default value. ✓ Lao cement record
CO2Emission factor for Coal :$EFcoal_{,CO2,y}$	（In year y） CO_2 emission factor for coal. (t-CO_2/Gcal) Default value from IEA CO_2 Emissions From Fuel Combustion Documentation for Beyond 2020	Set as the default value. ✓ IEA CO_2 Emissions From Fuel Combustion Documentation for Beyond 2020

	Proximate analysis of coal	✓ Lao cement record
Unit value of electricity :$SFC(E)_{RE,y,i}$	（On month i of year y） Unit electricity consumption for clinker manufacturing. (MWh/t- clinker) Unit value of electricity is calculated from the past amount of clinker manufacture and the amount of electric power consumption.	Set as the default value. ✓ Lao cement record
Grid electricity CO2 Emission factor :$EFelec_{,CO2,y}$	（In year y） CO_2 emission factor for grid electricity. (t-CO_2/MWh) Grid electricity CO_2 emission factor is as follow; 0.5764 t-CO_2/MWh	To be fixed ex ante before the project starts. ✓ Grid factor for Lao People's Democratic Republic
$f_{scale,y}$	（In year y） The ratio of the lower limit value of a standard for an acceptability criterion of Lao People's Democratic Republic Agency for Standardization and Methodology of the track scale. (For conservative)	Set as the default value. Lao cement record
$f_{elec,y}$	（In year y） The ratio of the lower limit value of a standard for an acceptability criterion of Lao People's Democratic Republic Agency for Standardization and Methodology of the electric power meter. (For conservative)	Set as the default value. Lao cement record
EFtr, CO_2	CO_2 emission factor for truck (t- CO_2/km)	Set as the default value. IPCC 2006
$AVD_{Husks, y,i}$	（On month i of year y） Transportation distance from each rice mill by track (km/truck) The rice husk is transported on one's way back of the cement transportation to Vientiane. Therefore, it conservatively set 20km per track even though the transportation distance is not generated.	Set as the default value.