

**CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT (CDM-PDD)
HOLCIM COSTA RICA: CARTAGO PLANT EXPANSION PROJECT**

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A. General description of project activity

A.1 Title of the project activity:

HOLCIM Costa Rica's Cartago Plant Expansion Project

A.2 Description of the project activity:

Purpose of the project activity is to expand the current clinker capacity with a new 3,000 t/p/d state-of-the-art kiln at the Cartago plant, which will result in a decrease of production costs and substantial improvement in energy efficiency. The new kiln will be operated at 2,400 t/p/d throughout the projection period up to 2012 and will supply both HOLCIM Costa Rica's Costa Rican as well as Nicaraguan cement markets, guaranteeing HOLCIM Costa Rica's market-share in the long term. The new kiln technology guarantees stable operations and higher clinker quality, which additionally offers opportunities for:

- Increased use of AFR (Alternative Fuels and Raw Materials, also called Waste derived fuel WDF) which have lower CO₂ emission factors than traditional fossil fuels.
- A lower clinker factor overall through higher degree of blending with mineral components (MIC) at the cement production level

In regard to **sustainable development**, it is the view of the project developers that it provides global as well as local benefits in terms of air pollution and GHG emissions reductions:

- Increased energy efficiency will reduce the specific use of fossil fuels
- The project reduces impacts on overall raw material quarrying, because of the increased reduction of the clinker factor of cement with additives like limestone and puzzolanas.
- The project foresees increased use of AFR (Alternative Fuels and Raw Materials, also called Waste derived fuel WDF) which have lower CO₂ emission factors than traditional fossil fuels. The Costa Rica Health Ministry has recently¹ published binding regulations limiting the contents and emissions of AFR to be burned in cement kilns, and its minute measuring and monitoring procedures. To comply with new regulations HOLCIM Costa Rica is in the process of selecting the appropriate Continuous Monitoring Equipment (CEM) to measure emissions according to European standards for this type of equipment. The CEM equipment should be installed by early 2003 and fully adapted by mid 2003.
- By increasing the processing of Alternative Fuels and Residual waste as alternative fuels (AFR) will derive in indirect benefits for water and soil environments on a regional or even national basis: the waste which would have had to be disposed in a less sustainable manner in the absence of the CDM project, will be dealt with on a more sustainable level.

Moreover, while the local economy will be benefited greatly during the construction period, over the long term this export-oriented project will derive in more macroeconomic advantages and improvement of the trade balance. The cost reduction benefits that are expected from the new technology will also lead to higher returns on investments for shareholders, which to a significant degree (38%) are local (microeconomic efficiency). We must also underline that cement has the highest local value-added benefits of any construction materials. Both Costa Rica and Nicaragua require large investments in infrastructure and housing in the mid-term. The new kiln will make local production displace imported clinker and cement from 3rd countries. Last but not least, the project requires major civil works, which will increase employment in the Cartago area by up to 500 jobs during its somewhat less than two-year construction phase. The positive local short-term and permanent employment impact will also have re-

¹ La Gaceta No 146, 31.7.2002

distributive effects, since construction workers tend to earn less than the national average wage. Local subcontractors will benefit from increased work volume and capacity development during the implementation of such a complex project. Approximately USD 150,000 (around 1.5% of the overall cost of the civil works) will be paid local municipal building permits and others.

A.3. Project participants:

- HOLLICM Costa Rica,
- The Ministry of Environment and Energy, Republic of Costa Rica and its
- Oficina Costarricense de Implementación Conjunta (OCIC)

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1	Host country: Republic of Costa Rica
A.4.1.2	Province: Cartago
A.4.1.3	Community: Agua Caliente
A.4.1.4	Detail on physical location:

The production site of HOLLICM Costa Rica is located in Agua Caliente, Cartago, in the Central Valley of Costa Rica, approximately 27 Km. West of its capital city, San Jose. The main raw materials quarry (La Chilena) is located 3 kms from the plant. The entire expansion project will take place on the current plant premises.

A.4.2. Category of project activity

It is the view of the project participants that the project activity of replacing of the old kiln at the Cartago plant falls mainly under the category of **energy efficiency improvement** which reduce energy consumption on the demand side for specific technologies, in this case for the cement sector. It is also true that the project will allow for typical cement sector specific project activities, like fuel input changes and clinker blending that will also add to the overall GHG emissions. But it is only because of the new kiln technology that those project activities can be implemented to the expected degree during operations.

A.4.3. Technology to be employed by the project activity:

After a full-scale feasibility analysis of the new kiln project to be under HOLLICM's technical guidance, in 2001 HOLLICM Costa Rica initiated negotiations with Fives-Lille, a French international industrial engineering group. All of the necessary contracts were subsequently signed with FCB.Ciment, a company of the international industrial engineering group Fives-Lille. A state-of-the-art 3.000 t/p/d kiln will replace the 1963, previously upgraded 1.450 t/p/d kiln. The project includes a 5-stage pre-heater/pre-calciner, rotary kiln, grate cooler, kiln feed system, clinker silo and dispatch system, a new mill for cement (Horomill ©), a new grinding and drying mill for cement additives, extension of the pre-blending storage hall and upgrading of the existing electrical power distribution system. The project will be executed over 24 months on a turn-key basis.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the

emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

HOLCIM Costa Rica Cartago cement plant is presently operating close to its maximum capacity, which puts constraints on its ability to supply its growing cement market in the future. As consequence, HOLCIM Costa Rica has already been considering expansion opportunities over the last few years. Ongoing marginal improvements could be continued to the existing kiln. Preliminary studies recommended a kiln up-grade to 1,800 t/p/d² of clinker. This expansion would be enough to meet demand growth in Costa Rica for the 7-year crediting period. For Holcim Costa Rica, this would be the Business As Usual (BAU) case.

A more radical (and expensive) departure from separate investment programs would be to replace the existing kiln with a new 3,000 t/p/d state-of-the-art kiln, and expand cement grinding capacity that would be large enough to supply both HOLCIM Costa Rica's growing market share in Costa Rica, as well as Nicaragua. An expansion of the current clinker capacity with a new 3,000 t/p/d state-of-the-art kiln at the Cartago, Costa Rica, plant, will result in a production cost reduction, as well as GHG emissions reductions per ton of cement. Due to capacity constraints in the raw material preparation section the new kiln could be operated at only 2,400 t/p/d throughout the projection period up to 2012³, but could supply both HOLCIM Costa Rica's Costa Rican as well as Nicaraguan cement markets.

The new kiln project that HOLCIM Costa Rica is pursuing offers multiple possibilities to reduce its GHG emissions well and above the BAU case, because the best technology option available allows to substantially influencing the major emissions sources:

- Energy efficiency of clinker production will be increased, from actually 3'800 GJ/ton (or 3'550 GJ/ton in the case of the kiln upgrade) to 3'200 GJ/ton
- The new technology allows change in the composition of input fuel, allowing **an increased proportion** of alternative fuels from presently 5% (10% in the case of the kiln upgrade) to 30% - 35% of total fuel consumption
- Electricity demand for all types of finished product will be reduced from an actual average of 112 kWh/ton of cement % (unchanged in the case of the kiln upgrade) to 102 kWh/t of cement
- In addition, process CO₂ emissions will be significantly reduced per ton of cement produced by blending (mixing) clinker with **an increased proportion** of other products ("additives") into the cement, from actually 71% clinker factor % (unchanged in the case of the kiln upgrade) to an estimated average 63% clinker factor.

The total emission reduction expected is **528'213 tons of CO₂-eq. /ton of cement** over a 7 year period.

A.4.5. Public funding of the project activity:

The only funds from public sources⁴ used for the project amounted to a maximum of EUR 37,500. - , consisting of the following items:

- Costs for validation of the baseline by a DOE lump sum EUR 12,500.-
- Internal costs to HOLCIM Costa Rica for making the baseline, lump sum EUR 25,000.-

² Holderbank Management and Consulting, Ltd., CTS-Thermal Process Technology Report # TPT 00/21'035/E, **14.12.2000/Ga**

³ For full utilization of the 3'000 t/p/d capacity further investment would be needed in the raw material crushing section. The market does not justify this for the time being.

⁴ SENTER Internationaal, Agency of the Dutch Government in charge of CERUPT 2001 tender

B. Baseline methodology

B.1 Title and reference of the methodology applied to the project activity:

Baseline Methodology for Cement Kiln Replacement.

B.2 Justification of the choice of the methodology and why it is applicable to the project activity

Holcim Costa Rica aims to replace its existing kiln with a state-of-the-art cement kiln instead of performing an upgrade of the existing kiln to extend its useful life and to grow in-step with the demand for its product. The New Methodology in Annex 3 describes how a kiln-replacement results in a reduction in the emissions of greenhouse gases in the following ways:

- Energy efficiency of clinker production will be increased
- Using **an increased proportion** of alternative fuels
- Electricity demand will be reduced
- Improved clinker factor by **increasing proportion** of other products (“additives”) into the cement

The Holcim Costa Rica project to replace its existing kiln will result in a reduction of emissions through these different processes.

B.3 Description of how the methodology is applied in the context of the project activity:

The following factors define the cement specific on-site CO₂ emissions

1. Specific caloric consumption (for both clinker production and additive drying),
2. Fuel specific CO₂ emission (for all fuels: kiln & additive drying),
3. Specific electricity consumption (for the whole cement production process),
4. Electricity CO₂ emission factor,
5. The clinker content of its production (clinker emission factor is constant at 507 kg CO₂/ton of clinker)

In terms of assumptions for the calculations the basic emission drivers are compared below:

Assumptions for Project emission calculations

	Cartago Actual	Cartago Up-grade	Cartago New Kiln	
Clinker capacity	1'450	1'800	2'400	tons per day
Clinker factor	74	70	67-63	%
Specific caloric consumption				
Kiln	3'800-4'000	3'550	3'200	MJ/ton clinker
Additives	500	500	500	MJ/ton material
Kiln Fossil Fuel (Coal/Pet Coke)	95	90	66.1	%
Specifics elect. consumption	112	112	102	kwh/ton cement
CO ₂ emissions electricity	Senter for Costa Rica	Senter for Costa Rica	Senter for Costa Rica	t CO ₂ /kWh

clinker	50	50	50 %
cement	50	50	50 %

GHG emissions implications of the baseline

a. Direct emissions

In terms of assumptions for the calculations:

- we assume for the baseline a significant reduction of specific caloric consumption from 3'800 to 3'550 MJ/ton (-6.6%) due to the kiln up-grade,
- Another 0.5 GJ/ton of cement for additive material drying,
- Only a relatively conservative replacement in the use of fossil fuels for AFR (from presently 5% to 10%),
- Electricity demand remains unchanged over the projection period. As argued before, 50% of the electricity used should occur outside of peak demand periods. Although Costa Rica's emission factor during off peak is very low, we are assuming 100% of the Senter projected emission factor,
- Constant clinker factor of 70%.

b. Indirect emissions

A positive indirect effect is expected from the use of AFR from not delivering those fuels to the usual disposal, thereby preventing the emissions of methane. This effect is not included in the calculations.

GHG emissions from the project

The project activity represents the following differences to the Baseline in terms of operational parameters:

1. The project introduces a higher clinker production capacity to deal with the future demand growth. Nevertheless for the calculation of the emission reductions we will keep the capacity of the kiln up-grade. The new Kiln has a rated clinker capacity of 3'000 tpd, but the present raw material section set-up allows throughput only up to 2'400 tpd (i.e. up to 750'000 tons of clinker per year). For purposes of comparison with the Baseline, we will consider only the same clinker output as in the Baseline, or 1'800 t/p/d of clinker, equivalent to approximately 558'000 t/p/y of clinker at 85% of utilization (identical to the Baseline). In the crediting period this value will be adjusted during monitoring and verification by the effective yearly utilization rate of the kiln.
2. The technology the project brings to the Cartago plant is simply the latest in terms of energy efficiency. Significant emission reductions will follow from this higher fuel efficiency. But this new kiln technology also reflect itself in a more stable operation in terms of quality, which make possible two further changes:
 - New kiln has only one state-of-the-art pre-calciner line (instead of the old parallel pre-heater / pre-calciner system of the Baseline). This guarantees a much higher stability of the kiln, resulting in better quality of clinker. Under these new conditions the clinker factor can be improved up to 63% with the locally available natural additives (i.e. 885'000 tons of cement per year). With a better clinker it is possible to reduce the clinker factor and meet the same quality standards.
 - The same is true for AFR: a smoother kiln operation increases the scope for a higher share of AFR in the fuel mix at stable quality output.

B.4. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (*i.e. explanation of how and why this project is additional and therefore not the baseline scenario*)

General

The project responds to the fact that cement demand is growing in HOLCIM Costa Rica's markets over and above its present producing capacity. So it is not feasible to assume the actual delivery system (as is) as the business as usual case and HOLCIM Costa Rica faces inevitable decisions on how to supply this growing demand and different scenarios on how to supply this growing demand imply different levels and risks of investment.

HOLCIM Costa Rica is part of the HOLCIM-group. Although financially less attractive for a specific operation than its own production, importing clinker from other regions can be the least expensive way to cover for higher demand (and more attractive for the company as a whole if the product comes from an excess capacity plant of the same group). Starting with the lowest capital investment strategy, under current market conditions (price level, market volume and structure, poor port facilities) imports would be possible as BAU, but not interesting from the logistic point of view, especially given the natural barriers (distance to sea, roads, mountains), which protect the San Jose area which is HOLCIM Costa Rica main market.

This section shows that the kiln-replacement is not the economically most attractive option for HOLCIM Costa Rica. Rather, keeping the present delivery system, limiting the capital investment to the minimum over the mid term to grow marginally in terms of capacity, generates a higher return on investment for the project.

Decision tree Annex 3

Ad 1 – Assessment of legal requirements

Cement production is in most countries of the world an unregulated private sector activity. Its production process is not particularly dangerous and the energy inputs are commonly fossil fuels. Other than some security measures for employees protection and some regulation on raw material quarry exploitation, there is rarely any specific legal regulation on its operations in non-Annex 1 countries.

In the case of Holcim Costa Rica, there is no legal obligation that would require it to either install the new kiln at this time, or take any other measures to reduce its emission of greenhouse gas. No such regulations exist at this time, nor are any such regulations foreseen in the near future.

Ad 2 – Determine whether the kiln is at the end of its useful life, and whether the existing kiln can be upgraded.

Installations like these normally have an operational lifetime of several decades. The existing factory was originally built in 1961 and its kiln dates from the mid-1960's. While the existing kiln is over 30 ears in operation, the up-grade would cover market demand for another 7-10 years. Expected lifetime of new kiln is well over 20 years, but with present raw material capacity would require substantial further capital expenditure on the raw material side in about 10 years if market develops according to projections.

Routine refurbishment has implications for the lifetime over which a project could accrue emissions benefits. If the potential availability of CER's hastens a modernization project that would otherwise have

occurred later, emission credits should not accrue to the project for its entire life, but only for the number of years that the project was hastened.

Ad 3 – Determine whether demand growth can be met with a gradual upgrade of the existing kiln, instead of replacing the kiln at this time.

Cement demand in the region grew over the last decade at 6.4% (Costa Rica 4.4%, Nicaragua 11.4%), to 300 kg per capita in Costa Rica and 118 kg per capita in Nicaragua. Total demand in the region reached 1.7 Mio t in 2000, with Costa Rica accounting for 1.1 Mio t and Nicaragua 0.6 Mio t. Projected growth over the next 10 years shows a slightly lower growth rate for the region. Internal Holcim Costa Rica market studies show that cement producers in the region will not be able to satisfy demand from 2006 onwards.

The increase in demand can be met with a gradual upgrade which would increase potential for output from 1'450 t/p/d of clinker to 1'800 t/p/d of clinker, equivalent to approximately 558'000 t/p/y of clinker at 85% of utilization. In addition, the upgrade would allow for an improvement in clinker factor from the current 74% to 70%. Therefore, with less clinker more cement can be produced by adding mineral components (MIC). Finally, even if the capacity increase is not enough under the BAU case, cement imports can solve the need over the mid-term.

Ad 4 – Assessment of economic attractive course of action.

Holcim performed a financial analysis of both the kiln upgrade (the baseline) and the kiln replacement (the project). Holcim Costa Rica considers this detailed financial analysis confidential, but has provided of a summary of results below. The detailed financial analysis is in possession of the validator (KPMG Certification B.V) and will be provided to the members of the MethPanel and the Executive Board at their request.

The most conservative approach for the Baseline in this specific case would be to keep the present delivery system, limiting the capital investment to the minimum over the mid term to grow marginally in terms of capacity in Cartago, and only as fast as the market proves it necessary (and not earlier). The kiln upgrade represents the BAU case, increasing capacity to face demand for the projection period and bringing (relatively) better energy performance. Capital investment for the baseline is less than in the case of the new kiln, proving as a result that the kiln upgrade would be the economically most attractive course of action. As the table below shows, the upgrade would result in an IRR of 25% while the kiln replacement only an IRR of 13%.

	Cartago Actual	Cartago Up- grade BAU	Cartago New Kiln (project activity)
Clinker capacity	1'450	1'800	2'400 tons per day
Clinker factor	71	70	67 to 63 %
Maximum clinker capacity for emissions calculations of project activity		1'800	1'800 tons per day
Maximum cement output for emissions calculations of project activity	607'432	797'143	885'114 tons per year
Capital expenditure Kiln (only)		7'000	27'500 ('000 USD)
Expected Payback period		5.6	8.2 Years
IRR		25	13 %

Ad 5 – Check whether the baseline scenario is credible.

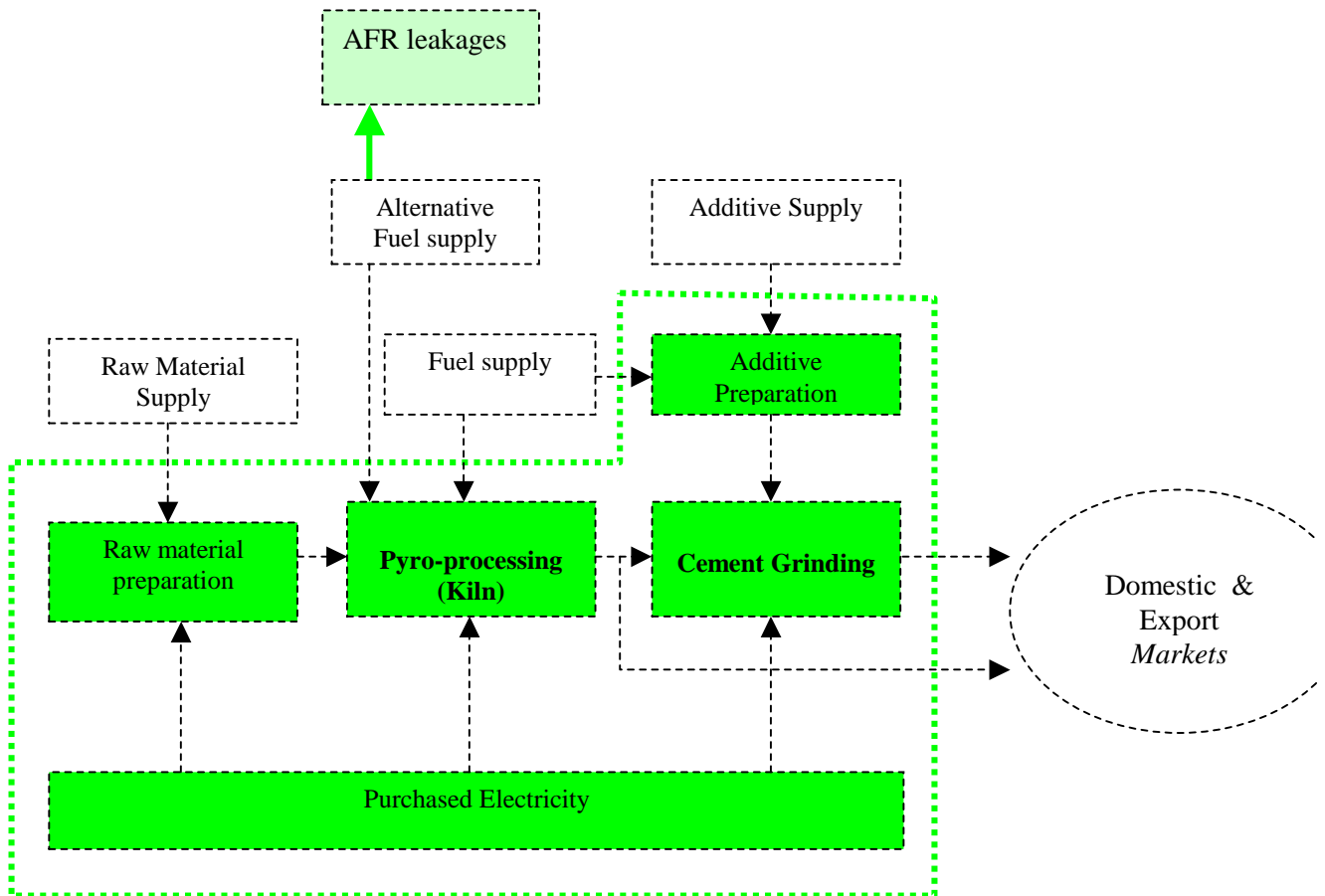
Since current production capacity would not meet regional cement supply starting in 2006, some improvement in output would be necessary. If the kiln would not be replaced with the new 3,000 t/p/d state-of-the-art kiln, the most likely course of action would be the kiln upgrade. Upgrading the existing kiln would comply with all environmental laws and regulations.

Ad 6 – Assessment of other barriers and common practice

As the kiln upgrade is already the economically more attractive than the kiln replacement, this section is not applicable.

B.5. Description of how the definition of the project boundary related to the baseline methodology is applied to the project activity:

A short summary of the project boundaries of this project is summarised below. It includes all anthropogenic emissions by sources of GHG under control of the project participants which are significant and reasonably attributable to the project activity.



Emissions **not** included in the project boundaries (and not to be estimated/measured in the baseline study and during the monitoring phase):

- Emissions from waste treatment of the AFR if it would not be used by HOLLCIM Costa Rica. The market study of AFR didn't take enough attention to this alternative disposal. Further AFR projects in the cement sector should consider using methane gas recovery from landfilling methodologies, as a sub-methodology to the cement sector project activities for analyzing positive leakages from the use of AFR in cement kilns.
- Emissions related to the handling and/or transportation of fuel and raw materials due to specific reasons:
 - Transport of the final product is only to a limited degree under control of the project actors.
 - In the baseline HOLLCIM Costa Rica would have to continue to rely on imports from third parties for the rest of its sales. The respective emissions of those imports, considered indirect off-site emissions or leakages, are not included in the calculations
 - In the case of fuels transportation, the project foresees a substantial displacement in the use of fossil fuels (imported) by alternative fuels provided by local sources. It is obvious that the delivery distance for the alternative fuels will be shorter than for the imported fuels, as the Cartago plant is closer to the main industrial activities which provide alternative fuels in Costa Rica (Central Valley) as to the ports on either coast. To keep the Baseline Study as conservative as possible there is no claim on emission reductions for the shorter alternative fuels transportation.

B.6. Details of baseline development

B.6.1. Date of completing the final draft of this baseline section (05/08/2003)

B.6.2. Name of person/entity determining the baseline: HOLCIM Costa Rica

Contact persons

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C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:**C.1.1.** Starting date of the project activity:

1/1/2003, construction start-up date, 1/1/2005 kiln commissioning date.

C.1.2. Expected operational lifetime of the project activity:

Expected lifetime of new kiln is well over 20 years, but with present raw material capacity would require substantial further capital expenditure on the raw material side in about 10 years if market develops according to projections. While the existing kiln is over 30 ears in operation, the up-grade would cover market demand for another 7-10 years.

C.2 Choice of the crediting period and related information:**C.2.1. Renewable crediting period (*at most seven (7) years per period*)**

C.2.1.1.	Starting date of the first crediting period (<i>1/4/2005</i>)
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C.2.1.2.	Length of the first crediting period: 7 years
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C.2.2. Fixed crediting period (*at most ten (10) years*): N/A

C.2.2.1.	Starting date (<i>DD/MM/YYYY</i>):	N/A
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C.2.2.2.	Length (max 10 years):	N/A
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D. Monitoring methodology and plan

D.1. Name and reference of approved methodology applied to the project activity:

GHG emissions monitoring methodology and reporting protocol for cement kiln replacement projects⁵

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

Under the umbrella of the Working Group Cement of the World Business Council for Sustainable Development (WGC-WBCSD), ten cement companies have developed and agreed upon a methodology for monitoring and reporting CO₂ emissions from cement manufacturing: the Cement CO₂ Protocol. It allows the monitoring and reporting of all direct and indirect CO₂ emissions from the cement manufacturing process in an absolute (tonnes of CO₂ per year) and a specific, unit-based (kg CO₂ per tonne of product) way.

The protocol was designed to meet a number of criteria:

1. be consistent, transparent, and credible;
2. cover all relevant emission sources;
3. be applicable at different levels (plant, company, group, industry);
4. avoid double-counting (or failure to count) at plant, company, group, national, and international levels;
5. allow to distinguish between different drivers of emissions (technological improvement, internal and external growth);
6. be compatible with IPCC guidelines;
7. allow to report emissions in absolute as well as specific (unit-based) terms;
8. allow to report the full range of CO₂ abatements achieved;
9. include performance indicators which do not distort the markets for cement and cementitious products, nor endanger fair trading;
10. provide a flexible tool suiting the needs of different monitoring and reporting purposes, such as: internal management of environmental performance, public corporate environmental reporting, reporting under CO₂ taxation schemes, reporting under CO₂ compliance schemes (voluntary or negotiated agreements, emissions trading), industry benchmarking, and product life-cycle analysis.

KPMG has undertaken an independent review of the Cement Protocol and found that it meets the above criteria (see validation report, KPMG 2001). The Cement CO₂ Protocol has been designed as a flexible tool to satisfy different reporting purposes, and is structured in such a way that it can be aggregated and disaggregated according to different reporting scopes. The aggregation of the information is normally governed by conventions, which can be unilateral in case of environmental reporting, or bilateral or

⁵ This methodology closely follows the WRI/WBCSD Cement CO₂ Protocol: CO₂ emissions monitoring and reporting protocol for the cement industry, October 2001. Although a specific CDM project module is planned by the WRI / WBCSD is planned for the near future, its official publication is still pending. For detail all documents can be found under www.ghgprotocol.org.

multilateral in case of negotiated agreements, compliance and taxation regimes and emission trading regimes. As of the project start HOLCIM Costa Rica will be able to follow any new recommendations of the still to be published JI/CDM project module of the WRI / WBCSD CO₂ Protocol planned for early 2004.

D.3. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

The proposed monitoring methodology involves a monitoring scheme that uses data already collected to feed HOLCIM Costa Rica's integral management system.

The reporting of the project related direct and indirect on-site GHG emissions will be done on a monthly basis, using the data that is available and already collected in the Cartago plant. In terms of framework HOLCIM Costa Rica utilizes an internal standardized Accounting and Reporting Manual (HARP) applied in all companies of the HOLCIM Group. Of special interest are its chapter 7. Management Accounting (7.3 Clinker and Cement Production), as well as chapter 8. Performance Indicators (8.2.2 Technical Indicators for clinker and Cement). The manual defines the methodology and formulae used for all relevant data.

In terms of tools, the Cartago plant is driven by an "Intelligent process control" (supplied by Foxboro) that controls all production process steps from raw meal preparation to cement production, reporting most relevant production parameters needed for all on-site CO₂ emission calculations in real time. The Foxboro system reports all relevant parameters on an hourly basis and keeps data series for the last 240 hours of operation. Every 24 hours a daily report is consolidated for accounting and reporting purposes. This report is transferred manually in the plant to the integrated management information system of HOLCIM Costa Rica that runs on SAP.

As of 2003 a state-of-the-art Continuous Emission Monitoring system will be installed to measure all relevant direct emission from the kiln stack (including CO₂) allowing to cross check the emissions calculated from material and fuel inputs to the kiln. Only direct emissions of fuel consumption for additive preparation could not be measured at the stack. As this section will be replaced through the project, exact measurement systems are expected to be in place by project begin.

.3. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived (contd.)

ID #	Data Type	Data Variable	Units		Recording frequency	Proportion monitored	Archive	For how long	Comments
7.3.8.4	Volumes	Raw meal preparation volume	(t)	m	Continuous	100%	Electronic	9 yr	Transports of materials are done on belt scales. The mathematical integration of the corresponding speed of each belt, multiplied by the weight of the materials, allows an electrical impulse to be translated into the tonnage that is handled by the FOXBORO equipment.
7.3.8.5	Volumes	Clinker production volume	(t)	m	Continuous	100%	Electronic	9 yr	
7.3.8.6	Volumes	Clinker purchase/transferred	(t)	m				9 yr	
7.3.8.7	Volumes	Cement grinding volume	(t)	m	Continuous	100%	Electronic	9 yr	
7.3.8.8	Volumes	Cement purchase/transferred	(t)	m	Per truck load			9 yr	
7.3.8.10	Volumes	Mineral components processed	(t)	m	Continuous	100%	Electronic	9 yr	
7.3.8.14	Volumes	Fuels Volume	(t),m ³	m	Continuous	100%	Electronic	9 yr	
7.3.8.15	Volumes	Thermal energy consumption	MJ	m	Continuous	100%	Electronic	9 yr	
7.3.8.16	Volumes	Traditional thermal energy consumption	MJ	m	Continuous	100%	Electronic	9 yr	
7.3.8.17	Volumes	Alternative thermal energy consumption	MJ	m	Continuous	100%	Electronic	9 yr	
7.3.8.18	Volumes	Electrical energy consumption	kWh	m	Continuous	100%	Electronic	9 yr	
7.8.9.2	Volumes	Clinker shipped (intra company)	(t)	m	Per truck load	100%	Electronic	9 yr	
7.8.9.3	Volumes	Cement shipped (intra company)	(t)	m	Per truck load	100%	Electronic	9 yr	



D.3. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived (contd.):

ID # HARP	Data Type	Data Variable	Units		Recording frequency	Proportion monitored	Archive	For how long	Calculations
8.2.2.1	Performance indicator	Clinker factor	%	C	Monthly	100%	Electronic	9 yr	Clinker consumption in cement grinding (t) ÷ Cement Grinding volume (t) * 100
8.2.2.6	Performance indicator	Specific electric energy consumption up to clinker production	kWh/t cement	C	Monthly	100%	Electronic	9 yr	Electric energy consumed up to clinker (kWh) ÷ [Clinker volume produced ÷ Clinker factor (%)]
8.2.2.7	Performance indicator	Specific electric energy consumption cement grinding	kWh/t cement	C	Monthly	100%	Electronic	9 yr	Electric energy consumed (kWh) in cement grinding ÷ Cement grinding volume (t)
8.2.2.8	Performance indicator	Specific electric energy consumption cement	kWh/t cement	C	Monthly	100%	Electronic	9 yr	8.2.2.6 + 8.2.2.7 as per above
8.2.2.9	Performance indicator	Specific thermal energy consumption	MJ/ton clinker	C	Monthly	100%	Electronic	9 yr	Total thermal energy consumed in the process step clinker production (MJ) ÷ Clinker production volume (t)
8.2.2.12	Performance indicator	Thermal substitution rate	%	C	Monthly	100%	Electronic	9 yr	Alternative thermal energy consumption (MJ) ÷ total thermal energy consumption (MJ)
8.2.2.14	Performance indicator	Kiln Net Availability Index (%)	%	C	Monthly	100%	Electronic	9 yr	Actual operating time (h) ÷ Net available time (h) * 100 Net Available time = Available time (h) – Net external downtime (h)
8.2.2.16	Performance indicator	Net Overall Equipment Efficiency	%	C	Monthly	100%	Electronic	9 yr	Net Availability Index (%) * Production Rate Index (%) * Quality Index (%) / 10.000

D.4. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources.

No leakage was identified in the baseline study. Data on this will therefore not be collected.

D.5. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHG within the project boundary and identification if and how such data will be collected and archived.

Given the baseline methodology that has been used, the baseline carbon emission factor will be fixed and will not be monitored. The following default values will be used:

- Baseline Kiln capacity [1'800 t/p/d]
- IPCC default clinker process emissions [507 kg CO₂/ton clinker]
- Standard fuel emission factors for Traditional and Alternative Fuels
- In the case of traditional (fossil-) fuels, a fixed proportion of 20% Pet Coke, 70% Coal and 10% Bunker Fuel (equivalent to 93.8 ton CO₂/TJ) is assumed over the whole projection period and no credits can be claimed from a shift within the fossil fuels
- National electricity grid carbon emission values [SENER projected values taken for the Baseline calculations]

D.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored.

The monitoring of the project related CO₂ emissions will be done on a monthly basis using the data collected for the integral management system of INCSA. As of 2003 a state-of-the-art Continuous Emission Monitoring system will be install to measure all relevant direct emission from the kiln stack (including CO₂) allowing to cross check the emissions calculated from material and fuel inputs to kiln. Only direct emissions of fuel consumption for additive preparation could not be measured at the stack. As this section will be replaced trough the project, exact measurement systems are expected to be in place by project begin.

Data (Indicate table and ID number e.g. D.4-1; D.4-2.)	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
D4: All volumes except Electrical energy	Medium/Low	Yes	<p>In the case of calibration controls for the different equipment, the following program has been established:</p> <p>PFISTER: For the raw materials that feed the kiln, Pfister equipment is calibrated every six months, verifying zero and maximum weight. Additionally, the kiln operator control deviations automatically.</p> <p>Equipment precision is between 1% and 2% (±) and when it exceeds 5%, a corrective process is carried out. The lack of material deposits obstructing the Pfister dosifiers is verified daily.</p> <p>The carbon and coke dosifiers are calibrated manually as part of the basic six-month maintenance program or when each kiln is closed down.</p> <p>If there are any doubts about irregular input or related to the carbon and coke inventories, calibration is performed. Additionally, every 12 hours the equipment automatically calibrates itself.</p> <p>In the case of other solid fuels, calibration is performed at least every six months, when the kilns are closed down, or as required.</p> <p>MASS FLOW: In the case of the bunker dosifiers, at least every six months their calibration is verified. In the case of the alternative fuel injection systems, calibration is performed every two month or earlier if required.</p>

			<p>BELT SCALES: Calibration of the belt scales used for feeding raw materials into the vertical grinder, the grinding of coal and alternative solid fuels (AFR), is performed monthly, verifying zero and maximum weight.</p>
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D.7 Name of person/entity determining the monitoring methodology

HOLCIM Costa Rica

Contact persons

Job Titles	Róger Solano Cartago Plant Manager
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E. Calculation of GHG emissions by sources

E.1 Description of formulae used to estimate anthropogenic emissions by sources of greenhouse gases of the project activity within the project boundary: *(for each gas, source, formulae/algorithm, emissions in units of CO₂ equivalent)*

After identifying the baseline, project emissions are compared with baseline emissions. Although the production capacity of the project is higher than the baseline, comparison is made based on the capacity of clinker production in the baseline scenario. The GHG emissions of CO₂-eq./ton of cement both in the baseline scenario as in case of the project are calculated. The total emission reduction equals the difference between the specific emissions per ton multiplied with the amount cement than can be produced in case of the project, based on the capacity of clinker production of the baseline.

The following describes the different formulae to calculate the emissions by sources. This section is complemented by the spreadsheet “HolcimPDD_xls”.

Process emissions

The same emission factor for process emissions is used throughout all calculations.

Process emissions	= Emissions from clinker production = 0.5071 ton CO ₂ /ton clinker * tons clinker produced
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The absolute CO₂ emission from raw material calcination remains constant with the clinker production limited to the Baseline capacity. Due to the decrease in the clinker factor, the volume of cement production will be higher than in the case of the baseline.

Fuel Combustion

The specific CO₂ emission from fuel consumption is obtained by multiplying the specific caloric consumption (expressed in MJ/ton of clinker) with an average fuel specific CO₂ emission. The average specific CO₂ emission is calculated in by a weighted average of the used fuels specific CO₂ emission.

Emissions from fuel Combustion CO ₂ /GJ	=	Quantity of fuel(s) used (GJ) * Fuel emission factor(s) (t CO ₂ /GJ)
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Electricity use

The electricity emission factors proposed by have been used for the Baseline as well as for the Project calculations (Standardized baselines and streamlined monitoring procedures for selected small-scale Clean Development Mechanism Project Activities, Volume 2c, December 2001).

Emissions from electricity use	=	Quantity of electricity used (MWh) * Electricity Emission factor electricity use (t CO ₂ /MWh)
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It is assumed that 50% of electricity is consumed on the clinker production and the rest on the cement production.

E.2 Description of formulae used to estimate leakage, defined as: the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and that is

measurable and attributable to the project activity: *(for each gas, source, formulae/algorithm, emissions in units of CO₂ equivalent)*

Not applicable.

E.3 The sum of E.1 and E.2 representing the project activity emissions:

An Excel calculation sheet is added.

E.4 Description of formulae used to estimate the anthropogenic emissions by sources of greenhouse gases of the baseline: *(for each gas, source, formulae/algorithm, emissions in units of CO₂ equivalent)*

Same as E1.

E.5 Difference between E.4 and E.3 representing the emission reductions of the project activity:

An Excel calculation sheet is added.

E.6 Table providing values obtained when applying formulae above:

		Estimation of emission reduction						
		2005	2006	2007	2008	2009	2010	2011
Cement produced	tm	845,455	885,714	885,714	885,714	885,714	885,714	885,714
Specific values								
Baseline Emissions	kg CO2/ton	621	624	627	629	632	634	637
Project Emissions	kg CO2/ton	556	536	538	540	543	545	547
Net Difference	kg CO2/ton	66	88	89	89	89	89	90
Total Difference	ton CO2	55,540	78,267	78,470	78,674	78,878	79,090	79,294

F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts

An EIA is condition by the Environment Ministry's SETENA in terms of: activity, size, location, environmental situation, costs, needs of natural resources, etc. Most multilateral financial institutions require an EIA, because of the local and regional policy. Word Bank, BCIE and others need a full social-economical-technical-environmental evaluation. Since HOLCIM Costa Rica is not relying on those sources of financing, it is applying the local standards. The local standards are based on actual Spanish regulations.

Potential environmental impacts are: - Air Pollution during construction and operation process; - Wastewater production and management; - Safety plan; - Materials and equipment uses; - Relation between flora, fauna and Project; Geological and structural issues; - Social relationships, and others.

The Environmental Impact Assessment (EIA) proceeded as two separate approval processes:

EIA for the AFR Project:

The objective of the AFR Project is to put in service a facility dedicated to prepare the alternative fuels and raw material to the cement kiln. The equipment consists in a mill series making little pieces of tires, plastic bags, and other wastes with high calorific power. The procedure to get the public permissions starts in the College of Engineers and Architects (this office approves the blue prints), followed by the Health Ministry (approves the security and health aspects) and the National Environmental Technical Council (SETENA) (approves the Environmental Impact Assessment). Finally, all these permissions are important to get the building permission from the Municipality, who is responsible to control the work's execution in Town. The public offices control in its own way the construction and operating processes.

EIA was approved by SETENA on 24 February 2003, resolution # 155-2003

EIA for the Plant Expansion Project:

The objective of the Plant Modernization & Expansion Project is to put in service a new cement kiln and other facilities. The activities are: Civil works with traditional construction methods, heavy structures based on precast driven piles followed by the tower and silos construction. Also, the equipment and electrical installation are other important issues. The new kiln Project looks for a new strategy to use AFR more efficiently, increasing the AFR – traditional fuels ratio. The public permission procedure is the same to AFR procedure. In this case, the Plant Modernization & Expansion Project requires a full Environmental Impact Assessment, because of the complexity and construction size.

Both Projects have to fulfil three conditions:

- 1- A legal compromise from HOLCIM Costa Rica and Reciterm for environmental protection.
- 2- Nominate an Environmental Responsible.
- 3- Pay the Environmental Fee.

The stakeholders are taken in account by different ways: publications, meetings, information program and personal interview using a sample selected by statistical protocol (part of the EIA)

EIA was approved by SETENA on 14 February 2003, resolution # 164-2003

F.2. If impacts are considered significant by the project participants or the host Party: *please provide conclusions and all references to support documentation of an environmental impact assessment that has been undertaken in accordance with the procedures as required by the host Party.*

G. Stakeholders comments

G.1. Brief description of the process on how comments by local stakeholders have been invited and compiled:

This section has been carried out by Holcim Costa Rica, but has not been included for this exercise. It will be submitted once the project applies for registration with the Executive Board.

G.2. Summary of the comments received:

N/A

G.3. Report on how due account was taken of any comments received:

N/A

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Represented by:	
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ANNEX 2

Information regarding public funding

The only funds from public sources used for the project are from the CERUPT 2001 tender by the Dutch Government and amounted to a maximum of EUR 37,500.- , consisting of the following items:

- Costs for validation of the baseline by a DOE lump sum EUR 12,500.-
- Internal costs to HOLCIM Costa Rica for making the baseline, lump sum EUR 25,000.-

All are from non-ODA Dutch Government funds and CERUPT is also funded from non-ODA resources.

ANNEX 3

New Baseline Methodology

SECTION 1. TITLE OF THE PROPOSED METHODOLOGY

Baseline Methodology for Cement Kiln Replacement

SECTION 2. DESCRIPTION TO THE METHODOLOGY

2.1 GENERAL APPROACH

- Existing actual or historical emissions, as applicable;
- Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;
- The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

2.2 OVERALL DESCRIPTION⁶

The Baseline Methodology for Cement Kiln Replacement is applicable to project activities where a cement kiln is replaced for purposes of capacity increase of the producing facility and to apply best practice technology in terms of energy efficiency and product quality **before** the end of its technical useful life (i.e. in the BAU case, a gradual up-grade will delay the kiln-replacement enabling the existing kiln to meet demand in the mid term). As the cement kiln is one of the most important sections of a cement producing facility and has a very long lifetime, this methodology is based on the determination of the economic attractive course of action, taking barriers into account. As the kiln replacement is not per definition the most likely course of action, the project can be seen as an alternative investment to a cement kiln up-grade what would have occurred other wise.

This baseline methodology entails three steps:

1. Project additionality should be proven by showing that project activity is not the economically most likely course of action, in terms of cost and financial indicators;
2. A baseline scenario should be described which should represent the most likely way to expand capacity and improve efficiency in absence of the project activity;
3. The GHG emission reductions are calculated by comparing the emissions of the baseline scenario with the emissions of the proposed project activity.

This methodology describes in detail what sources of greenhouse gases are affected by the proposed project. There are three major components to the emissions from cement manufacturing. The direct sources of greenhouse gases emissions are:

- CO₂ process emissions from raw material calcination (i.e. clinker production);

⁶ For a brief explanation of the cement manufacturing process, please consult Annex 3.2 in the back of this document

- on-site fuel combustion (CO₂, CH₄ and N₂O production);

The indirect sources of greenhouse gases emissions are:

- emissions from the electric power purchased or generated for the whole manufacturing process (which can also produce CO₂, CH₄ and N₂O, but off-site instead of in-plant).

The majority of fuel inputs, which are typically coal or fuel oil, are used mainly in the production of clinker (pyre-processing stage), whereas electricity is mainly used for crushing/grinding in both clinker and cement production. Pyro-processing also results in process CO₂ emissions from the de-carbonization of limestone.

The rationale behind this new methodology is that the proposed project's predominant effect is to improve energy efficiency of the operation of the existing cement plant by replacing its kiln. To develop a picture of what would have happened without the proposed project activity, key factors, such as technological developments, fuel options; legislative developments, etc. are used to determine the emissions of the baseline scenario. For example, if a large scale energy efficiency project would not happen (the proposed CDM activity); a strategy of minimal capital outlay to incrementally upgrade capacity to meet increasing demand would be implemented.

The carbon emission factor is expressed in kg CO₂/tonne cement. The total CO₂ emissions reductions are calculated by subtracting the project carbon emission factor from the baseline carbon emission factor and multiply the difference with the project activity level.

One of the distinctive features of the Baseline Methodology for Cement Kiln Replacement is that the baseline carbon emission factor is considered fixed for the crediting period of 7 or 10 years, only the project activity level and project carbon emission factor must be monitored. This feature will lead to less variance in the baseline calculation, while lowering monitoring costs and efforts.

Section 3. Key parameters/ assumptions (including emission factors and activity levels), and data sources considered and used

All energy and process emissions related to cement manufacturing, as covered by the following equation:

$$\begin{aligned} \text{Total cement direct emissions} = & \text{Process Emissions production} \\ & + \text{Emissions from fuel combustion} \\ & + \text{Emissions associated with additive preparation} \\ & + \text{(Indirect) emissions from electricity consumed} \end{aligned}$$

The production of the cement at the facility should be described in detail. It should describe following parameters:

- Production capacity (in tm of clinker)
- Utilization level
- Energy consumed (expressed in MJ/ton of clinker) by clinker process
- Energy consumed (MJ/ton of additive) by preparing additives
- Average clinker factor (last five years)
- Electricity demand for clinker production (kWh/ton of clinker)
- Electricity demand for cement production (kWh/ton of cement)
- Types of fuel used
- Technology

It is assumed that the production level of the project is equal or higher than the baseline scenario. The increase of production capacity itself doesn't involve emission reductions (or reductions that can be monitored). Comparison of the baseline with the project should therefore be based on the capacity level of the baseline scenario. The production level is the actual demand for cement, if not all capacity is being used.

- Activity level: market data, per capita consumption, market share. Total demand for cement is derived from using a market analysis.
- Activity level: cement sales and sales projection over the project time horizon from the company
- Basic technical performance today, of the BAU case, and of the project as per internal reporting
- Clinker emission factor as reported by IPCC
- All fuel emission factors for fuels, as reported by IPCC
- Carbon emission factor of the electricity grid for indirect emissions as reported by national authorities or baseline studies of the grid

In principle, all greenhouse gases included in Annex A of the Kyoto Protocol are to be included in the boundary if significant emissions occur. Greenhouse gas emissions from a source are considered to be significant if they account to at least one percent of the total baseline emissions expressed in kton CO₂ equivalent. Determining the significance is therefore an iterative process. All sources of greenhouse gases are mentioned in the baseline study, as well as the assessment of significance. In general, excluded can be:

- Indirect emissions⁷
- Emissions from production, transport and distribution of primary fuels like oil, coal, natural gas, as they are outside control and measuring capacity of the project developer.
- Emissions that are non-significant, this is account yearly for less than 1% of the yearly CO₂eq. emissions in the baseline situation. As the baseline emissions are not known in this part of the baseline study, it is an iterative process to determine this. Rough calculations can be made at this point to determine the significance of the emissions. Expressing in CO₂eq. should be carried out by using the conversion factors of their Global Warming Potentials (GWP), as defined by the IPCC and agreed by the CoP of UNFCCC.

Section 4. Definition of the project boundaries related to the baseline methodology:

The project boundary is defined by the emissions targeted or directly affected by the project activities, construction and operation. It excludes emissions from activities beyond the control or influence of the project. The project activity is the measure, operation or action that aims at reducing greenhouse gases emissions. Similar project boundaries must be used for both the calculation of the baseline emissions and monitoring of the project emissions.

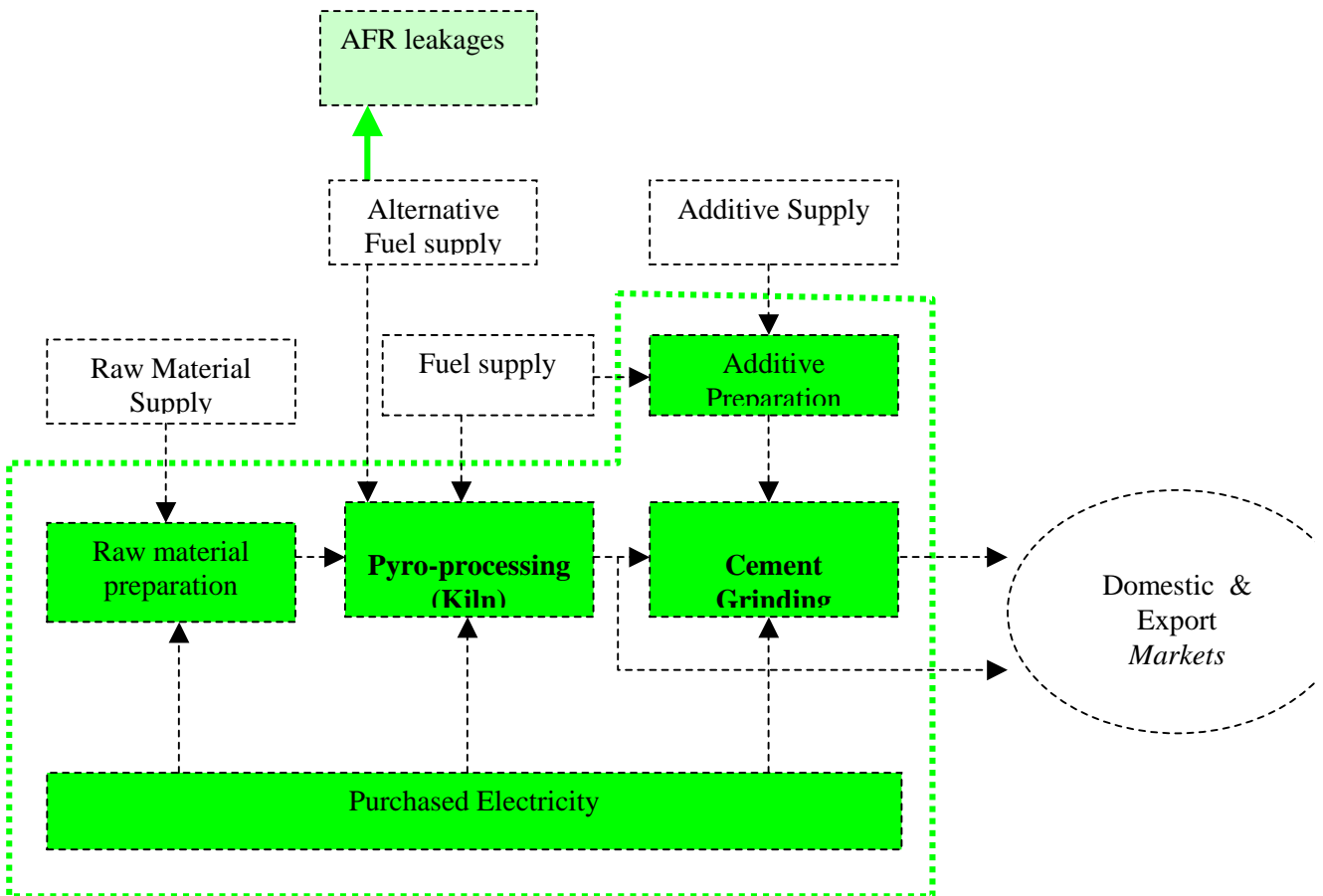
To achieve consistency in defining the project boundaries, the principle of control should be respected, which implies that the project boundaries should be set in a way that they comprise all relevant emissions sources that, can either be controlled or influenced by the project participants and that are reasonably

⁷ Cement companies use AFR to substitute conventional fossil fuels in the kiln in most cases the global emissions impact of AFR will be positive, i.e. reduce GHG emissions. This methodology only allows for including emissions reduction as a result from the direct impact at the kiln stack. While it is acknowledged that there are also positive indirect impacts (or leakages), to be conservative such impacts are not considered in this baseline methodology.

attributable to project activities. Following the ‘principle of control’ implies that the project boundaries should be set in a way that they contain all relevant emission effects that can either be controlled or influenced by the project participants, and that are reasonably attributable to the project. So emissions from production, transport and distribution of primary fuels (oil, coal, natural gas) will usually not be included in the project boundary as they are outside control, influence and measuring capacity of the project participants.

Step 4.1. Make Flowchart

Make a flowchart describing which components of the current system are influenced by the project. The project developer should make a flowchart of the project, describing which components are introduced by the project and to which components they are attached. The boundary should include all emissions selected in the previous step. Equivalent boundaries should be used for both the calculations of the baseline emissions and of the project emissions. A flowchart of a cement kiln replacement project could look like the next figure:



Step 4.2. Determine Project boundaries

Make a selection which emissions are included in the project boundary. Pyro-processing includes process-related emissions and energy related emissions, including the energy related emissions associated to traditional as well as alternative fuel preparation. Project boundaries include all relevant emissions that will need to be estimated / measured in the baseline study and during the monitoring phase, among which:

- Emissions generated by the production process of clinker. Process emissions would certainly need to be included in a blending-type project, because this type of project creates GHG benefits by reducing process CO₂ emissions per ton of cement produced.
- Emissions resulting from burning of fossil energy carriers for clinker production. Any project that claims emission credits for changing the proportion of clinker in the cement produced would also need to include the energy-related emissions associated to additive preparation, since some of the clinker additives used can have significant GHG impacts.
- Emissions related to the use of electricity produced off-site and consumed during all of the stages of the manufacturing process, not only clinker (including such as raw material preparation and cement grinding). The proposed project activity will have considerable effect on upstream electricity emissions, and those are placed within of the project boundaries as indirect on-site emissions.

Step 4.3. Determine emissions sources clearly

Determine if the emissions are direct or indirect. Direct emissions are under direct influence and control of the project developer, indirect emissions are not.

List all the on-site emissions or absorption in the project and in the current situation. This includes e.g.:

- Emissions generated by the production process of clinker,
- Emissions resulting from burning of fossil fuel for clinker production,
- Emissions resulting burning of fossil fuel for additive preparation.

List all the relevant off-site emissions in the project and in the current situation. This includes at least:

- Emissions related to the use of electricity produced off-site and consumed during all of the stages of the manufacturing process, not only clinker (including such as raw material preparation and cement grinding),
- Emissions from supply of fuel additives, AFR, and raw materials,
- Emissions during construction of the project

All Kyoto Protocol greenhouse gases (CO₂, CH₄, N₂O, SF₆, HFCs and PFCs) should be separately listed.

The following tables can be drawn:

Project	Current situation	Direct or indirect	Include or exclude
On-site emissions			
CO ₂ eq from emissions from raw material calcination (process emissions)	Process emissions are standard 507kgCO ₂ /t clinker	Direct	Include
CO ₂ eq from emissions from raw material calcination (fuel emissions – incl. non-biomass AFR)		Direct	Include

CO ₂ eq emissions from additive preparation <i>(fuel emissions)</i>	<i>Direct</i>	<i>Include</i>
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Project	Current situation	Direct or indirect	Include or exclude
Off-site emissions			
CO ₂ emissions from electricity use for pyro processing, material preparation, and additive preparation (no separate metering required)		Direct	Include
CO ₂ emissions from supply of fuel, additives, AFR, and raw materials		Indirect	Exclude if < 1%
CO ₂ eq emissions from AFR leakage		Indirect	Exclude

Section 5. Assessment of uncertainties:

Because a baseline is per definition counterfactual, assumptions need to be made about what would have happened in the absence of the project activity. To address the issue of uncertainty, the user of this methodology must use conservative assumptions in establishing the baseline in particular in terms of its market assumptions, which is the largest variable out of its control. All technical assumptions regarding project activity and the project carbon emissions factor will be monitored, including the use of AFR, production levels, fuel use, and electricity consumption.

Section 6. Description of how the baseline methodology addresses the calculation of baseline emissions and the determination of project additionality.

This section has two parts: first, the determination of the additionality of the project activity; and second, a detailed description on how the emissions reductions must be calculated.

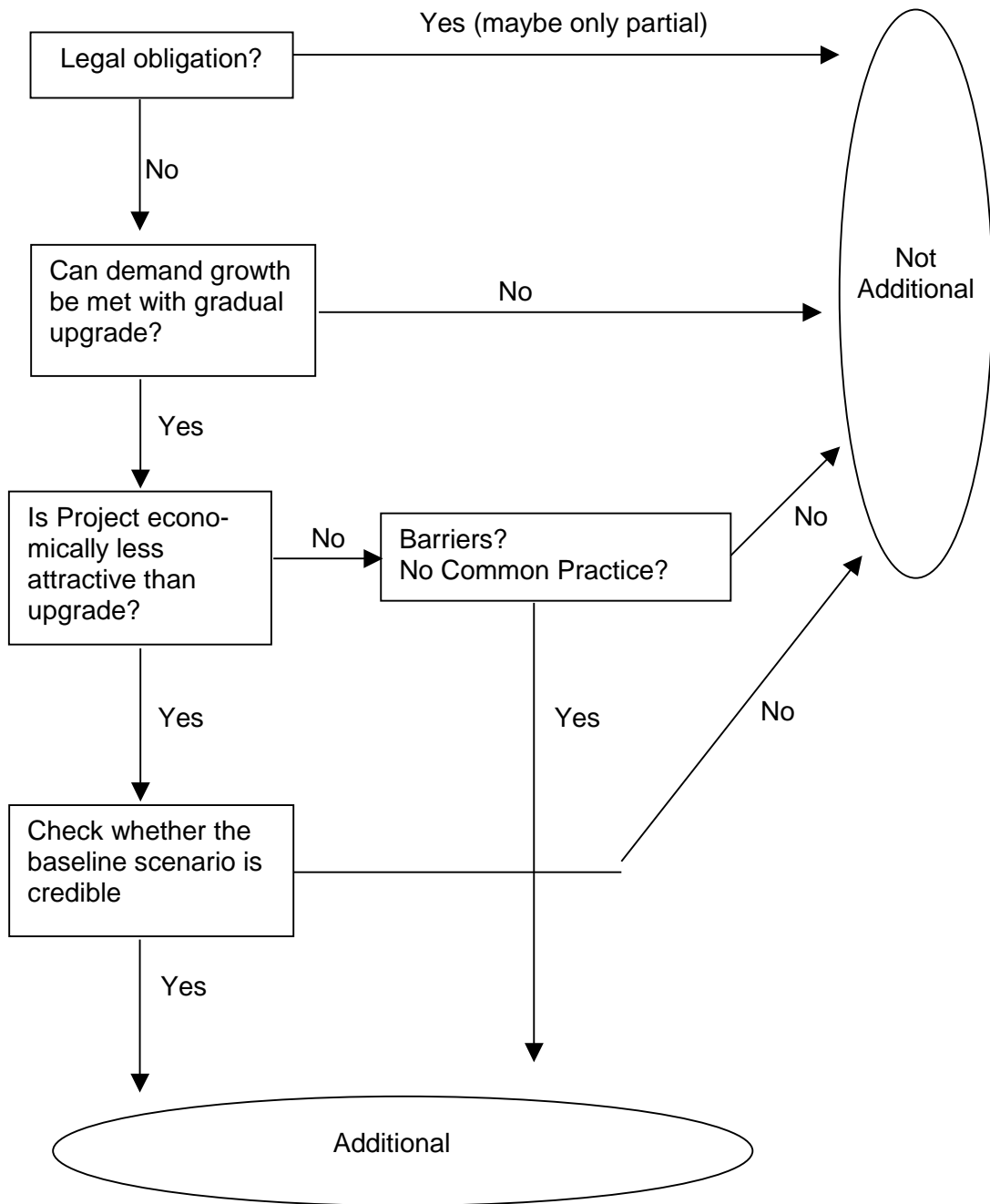
6.A. Additionality determination

Paragraph 43 of the Marrakech accords describes how to determine project additionality: A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity.

Additionality testing for cement kiln replacement projects entails three steps:

- a. Assessment of legal requirements
- b. Assessment of economic attractive courses of action
- c. Assessment of barriers and common practice.

The scheme visualises additionality testing in this methodology.



Ad 1 – Assessment of legal requirements

Do legal requirements exist that would lead to an obligation to reduce the greenhouse gas emissions. Project participants should make clear is there no valid regulations on greenhouse gas emissions for industrial activities, or any plans to introduce such regulations in the near future.

Ad 2 – Determine whether the kiln is at the end of its useful life, and whether the existing kiln can be upgraded.

The useful life, or a gradual upgrade, must be at least as long as the crediting period the project supplier intends to use.

Ad 3 – Determine whether demand growth can be met with a gradual upgrade of the existing kiln, instead of replacing the kiln at this time.

Provide demand figures for the time of the crediting period. It is possible that cement imports can solve the need over the mid term.

Ad 4 – Assessment of economic attractive course of action

Consistent with the chosen general approach for establishing the Baseline (paragraph 48 (b) of the Marrakech Accords) the project has to be additional in terms of its costs and financial indicators, excluding the potential income from the sale of CER's.

As for additionality a BAU scenario should be tested as the most attractive course of action in terms of costs of the project and financial indicators over shorter periods of time (10 years or less), as major pieces of equipment will be considered for potential replacement after 20-30 years, and kilns sometimes much longer.

Ad 5 – Check whether the baseline scenario is credible.

A baseline scenario may be counter-factual, it still must be credible in the sense that it can happen if the proposed CDM project activity is not implemented. This means that there should not be any legal, social, cultural, or other barriers that would prevent the baseline from ever being realized. For example, if the baseline foresees in a gradual upgrade of the kiln, but that upgrade would not meet environmental standards, it cannot be considered as a baseline scenario.

Ad 6 – Assessment of other barriers and common practice

Financial analysis might point out that the project scenario has higher IRR than one of the other scenarios. However, situations exist that justify that “the proposed CDM project activity” is additional even if it is the most attractive course of action based on the economic or financial analysis. This methodology identifies two procedures to determine that without the ability to register under the CDM, the proposed project activity is not the baseline.

Barriers

Barriers to investment can require that it can be demonstrated that certain risks of the proposed project are expected to be mitigated due to CDM. Such barriers can be identified in countries where no developed markets exist. Barriers must be clearly identified, justified, and documented.

Project activities in non-Annex I countries normally discount with a higher interest rate to reflect a higher investment risk and these conditions would castigate the IRR of projects with higher capital expenditure and longer payback periods, making them additional in terms of the CDM.

Possible barriers are:

- (a) Investment barrier: the absence of access to capital in undeveloped markets to finance the proposed project activity would have led to higher emissions;
- (b) Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;
- (c) Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;
- (d) Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

Common Practice

A project that is economically the most attractive course of action can be additional if there is an indication that the project type is not common practice (e.g. occurs in less than 5 percent of similar cases) in the proposed area of implementation, and is not required by recent/pending legislation/regulations.

6.B. BASELINE EMISSIONS

Once the baseline scenario is established, the proposed project has been defined, a detailed quantification of the greenhouse reductions must be carried out. As the proposed project generally comprises more than one element, each element will be defined, and then explained and quantified step-by-step. Each step will also describe exactly how to quantify the emission reductions. For example, the cement kiln including the pre-calciner must be replaced or upgraded in order to claim emission reductions from improved clinker factor. The project activity can involve multiple improvements on the cement production site. For this methodology we have identified the following sources of emission reductions:

- Improve the fuel efficiency of the kiln (in caloric consumption)
- Changing the fuel mix by adding alternative fuels and raw materials (AFR).
- Reducing the clinker factor by increasing the proportion of other products (“additives”) into the cement
- Reducing electricity demand (in electrical consumption)

The formulae are explained in a detailed spreadsheet “Emissions.xls” which is annexed to this Annex 3.

6.B.1. Improvement of fuel efficiency (in caloric consumption)

Fuel costs typically account for 30-40% of the cement production costs. The cement industry traditionally uses various fossil fuels (conventional fuels) to operate the kilns, including coal, petroleum coke (petcoke), fuel oil and natural gas. The types of fuels usage depends mainly on their market price and availability. The combustion of both conventional and alternative fuels, in order to obtain the necessary heat for the clinker production process, results in CO₂ emissions through the kiln stack.

This methodology is applicable to energy savings measures at cement plants. Such measures can include upgrading or replacing the kiln which has a higher thermal efficiency. The calcination process itself needs a specific amount of energy, but losses of heat to the environment can be improved.

Emissions from fuel combustion = Quantity of fuel(s) used (MJ/ton clinker) * fuel emission factor(s) (t CO₂/MJ)

The energy consumed in the kiln is expressed in MJ/ton clinker. In addition, energy is consumed by drying the additives to the clinker, for example limestone and puzzolana. This caloric consumption is expressed in GJ/ton MIC. The heating value depends on the type of fuel used. The spreadsheet attached to this document details the necessary calculations to express the emissions reductions in kgCO₂/ton clinker as a result from the energy savings.

6.B.2. Change in the fuel mix by adding alternative fuels and raw materials (AFR).

From the formula mentioned as per above it can be concluded that emissions from fuel combustion do not only depend upon heat demand, but also the types of fuel that are being used: the fuel mix. Using fuels with a lower fuel emission factor will lead to lower emissions.

As with the improved clinker factor, a new kiln technology offers opportunities for the increased use of AFR (Alternative Fuels and Raw Materials, also called Waste derived fuel WDF) which have lower CO₂ emission factors than traditional fossil fuels.

Cement industry increasingly uses a variety of waste-derived alternative fuels and raw materials (AFR) which, without this use or other recovery options, would have to be disposed of in some other way, usually by landfilling or incineration. AFR include fossil-based fractions (such as e.g. fossil based rubber, waste oil, plastics and others) and biomass fractions (such as e.g. (waste) wood, sewage sludge and others). AFR serve as a substitute for conventional fossil fuels. IPCC Guidelines require the following for national greenhouse gas inventories:

- **Biomass:** biomass means “the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste”. This definition corresponds to the IPCC definition where biomass is defined as “non-fossilised organic material both above ground and below ground, and both living and dead, e.g. trees, crops, grasses, tree litter, roots etc... When burned for energy purposes, these are referred to as biomass fuels. Biomass fuels also include gases recovered from the decomposition of organic material.” Biomass is considered CO₂ –neutral. CO₂ from biomass fuel is reported as a memo item but excluded from the national emissions total.
- **CO₂ from fossil fuel-derived wastes (fossil AFR),** in contrast, is not *a priori* climate-neutral. According to IPCC guidelines, GHG emissions from industrial waste-to-energy conversion are reported in the „energy“ source category of national inventories, while GHG emissions from conventional waste disposal (landfilling, incineration) are reported in the „waste management“ category.

To ensure consistency with IPCC guidelines as well as completeness of the inventory, there is thus a need to report direct CO₂ emissions and indirect GHG savings resulting from AFR combustion in cement installations.

With this background, the Methodology should handle AFR as follows:

- Direct CO₂ from combustion of biomass AFR is reported as a memo item (or supporting information), but excluded from emission totals. The IPCC default emission factor of 110 kg CO₂/ GJ is used.

- Direct CO₂ from combustion of fossil AFR is calculated and included in the total of direct CO₂ emissions: the gross emissions. CO₂ emission factors are a function of the nature of the AFR and should therefore be specified at installation level where possible.

This methodology acknowledges that indirect GHG savings result from the utilization of waste as a fuel. However, it is recommended not to include such savings at this time.

Some AFR, for instance impregnated saw dust, contain both fossil and biomass carbon. Ideally, a weighted emission factor should be calculated here, based on the share of the fossil impregnating substance in the fuel's overall carbon content. However, since this share varies considerably, companies are advised to use a conservative approach where carbon from impregnated saw dust is assumed to be of 100% fossil origin.

6.B.3. Reducing the clinker factor by increasing the proportion of other products (“additives”) into the cement

A significant source of emissions in the cement industry is so-called CO₂ process emission from raw material (limestone) calcination. For a more detailed description, please see Appendix I to Annex 3 in the back of this document.

CO₂ from actual clinker production is proportional to the lime (calcium oxide) and magnesium oxide content of the clinker, which in turn varies very little in time or between different cement plants. According to IPCC a default factor of 507 kg CO₂ /t clinker should be used for the calculation of CO₂ released during the calcination process.

Process emissions = Emissions from clinker production

*Emissions from clinker production = 0.507 t CO₂/t cli * tons clinker produced*

Cement kiln dust lost during the calcination process, is partly or totally acclimated, CO₂ emissions are not always negligible. If no data is available about cement kiln dust the IPCC recommends to use a percentage between 2 and 6 percent and multiply the percentage by the estimate of CO₂ emissions from clinker production. This yields an estimate of CO₂ from the lost, claimed cement kiln dust.

CO₂ reductions can be achieved if the proposed project, for example a new kiln or a kiln-upgrade, will result in a lower clinker factor in the cement. Under these conditions more mineral additives (MIC) are added to the cement. Examples of MIC include gypsum and natural puzzling (natural MIC), blast furnace slag and fly ash (artificial MIC). MIC typically has a lower emissions rate than clinker. Natural MIC can involve grinding and drying before using. Artificial MIC are waste products from other production processes; CO₂ emissions from these processes do not have to be calculated for, because they are attached to the products and not to the waste materials. Lowering the clinker factor leads to an equivalent reduction of direct CO₂ emissions associated with clinker production, both from calcination and fuel combustion.

Establishing clinker factor:

The user of the Baseline Methodology for Kiln Replacement calculates what the improvement is (expressed in percentage reduction of the clinker factor) as a result of the proposed project and the baseline. For example, the historical (and verifiable) clinker factors was 75 percent and decreased to 65 percent. The clinker factor can easily be monitored.

6.B.4. Reducing electricity demand, for example at the kiln, the cement grinding facility, and additive grinding facility (in electrical consumption)

A cement plant uses electricity on-site in a variety of processes; for example in grinding facilities and cement blenders. Electricity usage, and therefore the change in electricity use, can be easily monitored.

Electricity is generally supplied by the grid. If the total savings in electricity use by the proposed project is substantial, i.e. more than 15 GWh per year, the project supplier must develop a project specific baseline study to determine total CO₂ savings of the grid using on the approved methodologies or propose a new methodology. It must be considered if the project might influence developments in the grid. If total savings are less than 15 GWh, the project can qualify for simplified procedures for small scale CDM projects.

The specific electric consumption is expressed in kWh/t cement.

$$\begin{array}{l} \text{Emissions from} \\ \text{Electricity use} \end{array} = \begin{array}{l} \text{Quantity of electricity used (MWh)} \\ * \text{Electricity Emission factor electricity use (t CO}_2\text{/MWh)} \end{array}$$

6.B.5. Baseline emissions factor determination

Specific CO₂ baseline emissions factor is expressed in kg CO₂/t cement. The baseline emissions factor is fixed.

6.B.6. Project emissions and project emissions factor determination

Specific CO₂ baseline emissions factor is expressed in kg CO₂/t cement. The baseline emissions factor is varies and must be monitored. The same production capacity level of clinker as in the baseline scenario must be used.

6.B.7. Carbon Emission Factor Determination

The Carbon Emission Factor (CEF) is based on the net difference between the baseline emissions factor and the project emissions factor, and is expressed in kg CO₂/t cement. The carbon emission factor of the baseline is fixed during the crediting period. The project carbon emission factor will be monitored during the crediting period. The total annual tons of CO₂ reductions (the Certified Emission Reduction – CER) is based on multiplying the CEF with the tons of cement produced.

Section 7. Description of how the baseline methodology addresses any potential leakage of the project activity:

Indirect effects are usually referred to as leakages, because they are considered to occur outside the project boundary. Leakage is the unanticipated loss or gain of net greenhouse gas benefits beyond a project boundary. Initiatives established to reduce GHG must safeguard the integrity of the resulting emission reductions credits by striving to control and account for leakage to produce accurate estimates of the GHG benefits being accrued. Leakages are considered to occur outside the project boundary, and still will need to be estimated/measured in the baseline study and during the monitoring phase.

Indirect GHG savings resulting from the utilization of waste as a fuel is the most commonly expected case of positive leakages.

Section 8. Criteria used in developing the proposed baseline methodology, including an explanation of how the baseline methodology was developed in a transparent and conservative manner:

In order to be transparent, this methodology requires that the data and assumptions underlying the baseline and project carbon emission factor calculation are based on official and publicly available information. The model, data and assumptions must be verifiable by third parties. If in any case, an assumption must be made which can result in an outcome that can either increase or decrease the amount of emission reductions, the assumption that leads to the lower outcome must be used.

Section 9. Assessment of strengths and weaknesses for the baseline methodology

Since there are no methodologies approved by the UNFCCC at this time specific to this type of projects, the strengths and weaknesses of the methodology need to be evaluated on their own merits.

The following strengths of the methodology are identified:

- Because the baseline emissions are determined in a conservative manner, the yearly baseline carbon emission factors are fixed, leading to static carbon emissions factors. Monitoring efforts and costs are reduced by this.
- The methodology results in just one –realistic, credible and probable - baseline scenario.
- Investments in a cement facility often affect more than one GHG emissions source. The proposed methodology takes into account all the relevant sources.

The following weaknesses of the methodology are identified:

- Not all Key Factors identified can be quantified within a 95 percent confidence range. Until now, conservativeness is assured by choosing the Key Factor value leading to the most conservative baseline carbon emission factor.
- Different reports might be available, reflecting different visions and opinions of experts. This will make it more difficult to determine the range for a Key Factor value within a 95 percent confidence range. The DOE has a role in assessing the data provided.

Section 10. Other considerations, such as the description of how national and/or sectoral policies and circumstances have been taken into account

The feasibility of other potential emission reductions derived from this project types in cement manufacture (e.g. increase in blending and fuel input changes due to the new technology) can change significantly over a short period of time because of policy changes. For example, changes in legislation regarding waste disposal may mean that waste cannot be landfilled. This may make waste incineration more common and/or profitable than it was before. This will affect the additionality of cement plants that use waste as alternative sources of fuel (AFR). The feasibility of blending cements can also change for policy of for other reasons.

Consistent with the Annexes of Decision 17/CP.7 of the Marrakech accords, including paragraph 45 (e) which states that “A baseline shall be established ... taking into account relevant national and/or sectoral policies and circumstances, such as sectoral reform initiatives, local fuel availability, power sector expansion plans, and the economic situation in the project sector”. This methodology requires that all aspects that can influence baseline and project emissions are taken into consideration. In this way

national and/or sectoral policies that affect the emissions profile of a country are a core component of its analysis.

Baselines for these projects types would need to be revised at regular intervals to take into account policy changes, and other potential changes that impact actual or potential supply of alternative fuels or mineral additions, in order to ensure that they remained credible.

ANNEX 3.1

Glossary of Terms

Activity level:

Output level per year of the proposed project, expressed in e.g. ton cement/yr

Baseline:

The baseline for a CDM project activity is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity. A baseline shall cover emissions from all gases(of gases), sectors and source categories listed in Annex A (of the Kyoto Protocol) within the project boundary. A baseline shall be deemed to reasonably represent the anthropogenic emissions by sources that would occur in the absence of the proposed project activity if it is derived using a baseline methodology referred to in paragraphs 37 and 38 of the CDM modalities and procedures.

Baseline approach:

A baseline approach as described in para. 48 MA is the basis for a baseline methodology.

Baseline carbon emission factor (cef):

Greenhouse gas emissions per output unit in a certain year that would occur in the absence of the proposed project activity, usually expressed in kton kg CO₂/t cement (or other unit of output)

Baseline emissions

Greenhouse gas emissions per year that would occur in the absence of the proposed project activity, usually expressed in kton CO₂eq/yr.

Baseline methodology

A methodology is an application of an approach or a combination of approaches as defined in paragraph 48 of the CDM modalities and procedures, to an individual project activity, reflecting aspects such as sector and region.

Fixed carbon emission factor

A baseline carbon emission factor that is not recalculated during the crediting period. The level of the carbon emission factor can vary over time, so fixed does not mean constant.

Global warming potential

The ratio of global warming from one unit mass of a greenhouse gas to that of one unit mass of carbon dioxide over hundred years

Key Factor

Those factors that significantly influence the future situation within a sector/country/project, thus determining the baseline scenario

Leakage:

Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity.

Measurable and attributable

In an operational context, the terms measurable and attributable in paragraph 51 (project boundary) of the CDM modalities and procedures should be read as “which can be measured” and “directly attributable”, respectively

Monitoring of a CDM project activity:

Monitoring refers to the collection and archiving of all relevant data necessary for determining the baseline, measuring anthropogenic emissions by sources of greenhouse gases within the project boundary of a CDM project activity and leakage, as applicable.

Off-site

Not on the physical location of the project

On-site

On the physical location of the project

Project activity:

A project activity is a measure, operation or an action that aims at reducing greenhouse gases emissions. The Kyoto Protocol and the CDM modalities and procedures use the term “project activity” as opposed to “project”. A project activity could, therefore, be identical with or a component or aspect of a project undertaken or planned.

Project boundary:

The project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

Scenario

An account or synopsis of a possible course of action or events.

Significant

Greenhouse gas emissions from a source are considered to be significant if they account to at least one percent of the total baseline emissions expressed in kton CO₂ equivalent.

Small Scale Project electricity project:

Renewable energy project activities with a maximum output capacity equivalent of up to 15 MW (or an appropriate equivalent)

Transparent and conservative:

Establishing a baseline in a transparent and conservative manner (paragraph 45 (b) of the CDM modalities and procedures) means that assumptions are made explicitly and choices are substantiated. In case of uncertainty regarding values of variables and parameters, the establishment of a baseline is considered conservative if the resulting projection of the baseline does not lead to an overestimation of emission reductions attributable to a CDM project activity (that is, in the case of doubt, values that generate a lower baseline projection shall be used).

ANNEX 3.2**Greenhouse Gas Sources and Abatement Options in Cement Production¹****Overview of Cement Manufacturing Process**

Cement manufacture includes three main process steps:

1. preparing of raw materials;
2. producing clinker, an intermediate, through pyroprocessing of raw materials;
3. grinding and blending clinker with other products („mineral components“) to make cement.

There are two main sources of direct CO₂ emissions in the production process: combustion of kiln fuels, and calcination of raw materials in the pyroprocessing stage. These two sources are described in more detail below. Other CO₂ sources include direct emissions from non-kiln fuels (e.g. dryers, room heating, on-site transports), and indirect emissions from e.g. external power production and transports. Non-CO₂ greenhouse gases covered by the Kyoto Protocol⁸ are not relevant in the cement context, in the sense that direct emissions of these gases are negligible.

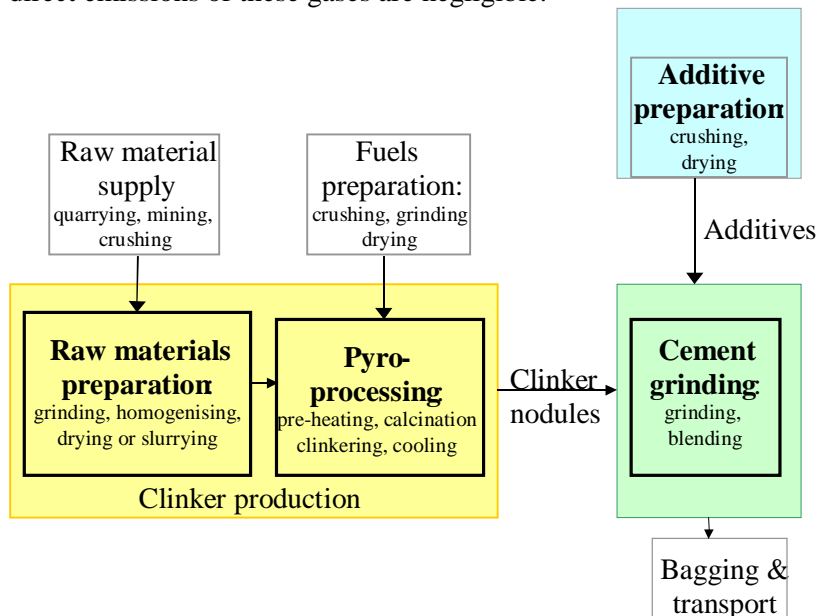
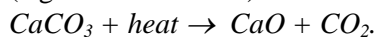


Figure 1: Process steps in cement manufacture.

Source: Ellis 2000, based on Ruth et al. 2000

CO₂ from Calcination of Raw Materials

In the clinker burning process, CO₂ is released due to the chemical decomposition of calcium carbonates (e.g. from limestone) into lime:



This process is called „calcining“ or „calcination“. It results in direct CO₂ emissions through the kiln stack. When considering CO₂ emissions due to calcination, two components can be distinguished:

¹ From The Cement CO₂ Protocol, WBCSD Working Group Cement, published October 19, 2001. See www.ghgprotocol.org

⁸ methane (CH₄), nitrous oxide (N₂O), sulfur hexafluoride (SF₆), and fluorinated hydrocarbons (PFCs, HFCs)

- CO₂ from actual clinker production;
- CO₂ from raw materials discarded (landfilled) as partly calcined cement kiln dust (CKD), or as fully calcined bypass dust.

CO₂ from actual clinker production is proportional to the lime content of the clinker,⁹ which in turn varies little in time or between different cement plants. As a result, the CO₂ emission factor per tonne of clinker is fairly stable (IPCC default: 510 kg CO₂/t clinker).

Landfilling of kiln dust varies greatly with kiln types and cement quality standards, ranging from practically zero to over one hundred kilograms per tonne of clinker. The associated emissions are likely to be relevant in some countries.

CO₂ from Fuels for Kiln Operation

The cement industry traditionally uses various fossil fuels to operate cement kilns, including coal, petroleum coke, fuel oil, and natural gas. In recent years, fuels derived from waste materials have become important substitutes. These alternative fuels and raw materials (AFR) include fossil fuel-derived fractions such as e.g. waste oil and tires, as well as biomass-derived fractions such as waste wood and dried sludges from wastewater treatment.

Both conventional and alternative fuels result in direct CO₂ emissions through the kiln stack. However, biomass fuels can be considered „climate-neutral“. Use of alternative (biomass- or fossil-derived) fuels may, in addition, lead to important emission reductions elsewhere, for instance from waste incineration plants or landfills.

CO₂ Abatement Options

CO₂ emissions in the cement industry can be tackled by different measures. The main categories of CO₂ abatement potentials include:

- energy efficiency: technical and operational measures to reduce fuel and power consumption per unit clinker or cement produced;
- fuel switching: for instance, use of natural gas or AFR instead of coal;
- reduction of dust landfilling (cement kiln dust, bypass dust), where relevant landfilling occurs;
- MIC: use of mineral components to substitute clinker.

Mineral components (MIC) are natural and artificial materials with latent hydraulic properties. Examples of MIC include gypsum and natural pozzolanas, blast furnace slag, and fly ash. MIC are added to clinker to produce blended cement. In some instances, pure MIC are directly added to the concrete mixer. MIC use leads to an equivalent reduction of direct CO₂ emissions associated with clinker production, both from calcination and fuel combustion. Artificial MIC are waste materials from other production processes such as, e.g. steel and coal-fired power production. Related GHG emissions are monitored and reported by the corresponding industry sector. Utilization of these MIC's for clinker or cement substitution does not entail additional GHG emissions at the production site. As a consequence, indirect emissions must not be included in the cement production inventory.

⁹ A second, but much smaller factor is the CaO- and MgO content of the raw materials and additives used.

ANNEX 3.3

Spreadsheet “Emissions.xls”

Annex 4**NEW MONITORING METHODOLOGY****Proposed new monitoring methodology***GHG emissions monitoring and reporting protocol for cement kiln replacement projects***1. Brief description of new methodology¹⁰**

The monitoring protocol considers all possible sources of GHG emissions according to the WRI / WBCSD classification structure, independently of the credits claimed by a specific project activity. The information is structured in such a way that it can be aggregated and disaggregated according to different reporting scope, i.e. the specific project activity.

WRI / WBCSD Classification**Relevant Cement Protocol Sections****Scope 1: Direct GHG emissions**

Stationary combustion sources

§ 3.3 and § 3.4: CO₂ from kiln fuels

Process emissions

§ 3.5: CO₂ from non-kiln fuels

Mobile combustion sources

§ 3.2: CO₂ from raw material calcination§ 3.5.2: CO₂ from transports§ 4.2: Non-CO₂ greenhouse gases**Scope 2: GHG emissions from imports and exports of electricity, heat, or steam**

§ 4.1: Indirect emissions from grid electricity

§ 5.2.1: Heat and power exports

Scope 3: Other indirect emissions

§ 4.1: Indirect emissions from bought clinker

Separate module:

§ 5.1: Indirect savings from AFR

Accounting for reduction projects

§ 5.2: Other indirect savings

¹⁰ **WRI/WBCSD Cement CO₂ Protocol: CO₂ emissions monitoring and reporting protocol for the cement industry**, October 2001. Although a specific CDM project module is planned by the WRI / WBCSD is planned for the near future, its official publication is still pending. For detail, all documents can be found under www.ghgprotocol.org.

2. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID #	Data Type	Data Variable	Units	M/C/ E*	Recordin g frequenc y	Propo rtion monit ored	Archive	For how long	Comments
V – 1	Volumes	Raw meal preparation volume	(t)	M	Continu ous	100%	Electronic	9 yr	
V – 2	Volumes	Clinker production volume	(t)	M	Continu ous	100%	Electronic	9 yr	
V – 3	Volumes	Clinker purchase/transferred	(t)	M				9 yr	
V – 4	Volumes	Cement grinding volume	(t)	M	Continu ous	100%	Electronic	9 yr	
V – 5	Volumes	Cement purchase/transferred	(t)	M	Per truck load			9 yr	
V – 6	Volumes	Mineral components processed	(t)	M	Continu ous	100%	Electronic	9 yr	
V – 7	Volumes	Fuels Volume	(t), m ³	M	Continu ous	100%	Electronic	9 yr	
V – 8	Volumes	Thermal energy consumption	MJ	M	Continu ous	100%	Electronic	9 yr	
V – 9	Volumes	Traditional thermal energy consumption	MJ	M	Continu ous	100%	Electronic	9 yr	
V – 10	Volumes	Alternative thermal energy consumption - AFR - Biomass Waste - Non-kiln Fuels	MJ	M	Continu ous	100%	Electronic	9 yr	
V – 11	Volumes	Electrical energy consumption	kWh	M	Continu ous	100%	Electronic	9 yr	

V – 12	Volumes	Clinker shipped (intra company)	(t)	M	Per truck load	100%	Electronic	9 yr
V – 13	Volumes	Cement shipped (intra company)	(t)	M	Per truck load	100%	Electronic	9 yr

* Measured (M), Calculated (C), or Estimated (E).

2. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived (contd.):

ID #	Data Type	Data Variable	Units	M /C /E	Recording frequency	Proportion monitored	Archive	For how long	Comments
P – 1	Performance indicator	Clinker factor	%	C	Monthly	100%	Electronic	9 yr	Clinker consumption in cement grinding (t) ÷ Cement Grinding volume (t) * 100
P – 2	Performance indicator	Specific electric energy consumption up to clinker production	kWh/t cement	C	Monthly	100%	Electronic	9 yr	Electric energy consumed up to clinker (kWh) ÷ [Clinker volume produced ÷ Clinker factor (%)]
P – 3	Performance indicator	Specific electric energy consumption cement grinding	kWh/t cement	C	Monthly	100%	Electronic	9 yr	Electric energy consumed (kWh) in cement grinding ÷ Cement grinding volume (t)
P – 4	Performance indicator	Specific electric energy consumption cement	kWh/t cement	C	Monthly	100%	Electronic	9 yr	P – 2 + P – 3, as per above
P – 5	Performance indicator	Specific thermal energy consumption	MJ/ton clinker	C	Monthly	100%	Electronic	9 yr	Total thermal energy consumed in the process step clinker production (MJ) ÷ Clinker production volume (t)
P – 6	Performance indicator	Thermal substitution rate	%	C	Monthly	100%	Electronic	9 yr	Alternative thermal energy consumption (MJ) ÷ total thermal energy consumption (MJ)
P – 7	Performance indicator	Kiln Net Availability Index	%	C	Monthly	100%	Electronic	9 yr	Actual operating time (h) ÷ Net available time (h) * 100

		(%)							Net Available time = Available time (h) – Net external downtime (h)
P – 8	Performance indicator	Net Overall Equipment Efficiency	%	C	Monthly	100%	Electronic	9 yr	Net Availability Index (%) * Production Rate Index (%) * Quality Index (%) / 10.000

3. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources.

No leakage is identified in this baseline methodology. Data on this will therefore not be collected.

4. Assumptions used in elaborating the new methodology:

IPCC recommends to calculate calcination CO₂ based on the CaO content of the clinker produced (0.785 t CO₂/t CaO, multiplied with the CaO content in clinker). A default CaO content in clinker of 65% is recommended, corresponding to 510 kg CO₂/t clinker.

CO₂ from discarded kiln dust should be calculated separately, taking into account its degree of calcination. Where preciser data is not available, IPCC recommends to account for discarded dust by adding 2% to clinker CO₂ by default, acknowledging that emissions can range much higher in some instances. IPCC does not distinguish between bypass dust and cement kiln dust (CKD).

The IPCC default for clinker is similar to the recommendations of the Australian Cement Industry Federation (518 kg CO₂/t cli) and the American Portland Cement Association (522 kg CO₂/ t cli), as well as to the older data on the “Holderbank” Group average (524 kg CO₂/t cli). The difference is probably due to the fact that IPCC neglects CO₂ from decomposition of MgCO₃ (MgO content in clinker is usually about 2%). WGC recommends a default emission 15 factor of 525 kg CO₂/t clinker, which is the IPCC default corrected for MgCO₃.

5. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored.

The monitoring of the project related CO₂ emissions must be done on a monthly basis. This data is collected for the integral management system of the company. To measure direct emissions from the kiln-stack (including CO₂), a Continuous Emission Monitoring system must be installed to allow for cross checking the emissions calculated from material and fuel inputs to kiln. Only direct emissions of fuel consumption for additive preparation can not be measured at the stack.

Data (Indicate table and ID number e.g.3.-1;3.-2.)	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
All volumes (V 1 – V13), except Electrical energy (V – 11)	Medium/Low	Yes	<p>Regarding calibration controls for the different equipment:</p> <p>For the raw materials that feed the kiln, equipment must be calibrated every six months, verifying zero and maximum weight.</p> <p>Equipment precision is between 1% and 2% (\pm) and when it exceeds 5%, a corrective process must be carried out.</p> <p>The carbon and coke dosifiers must be calibrated manually as part of the basic six-month maintenance program or when each kiln is closed down.</p> <p>If there are any doubts about irregular input or related to the carbon and coke inventories, calibration must be performed.</p> <p>In the case of other solid fuels, calibration must be performed at least every six months, when the kilns are closed down, or as required.</p>
All Performance Indicators (P 1 – P8)	Medium/Low	Yes	<p>MASS FLOW: In the case of the bunker dosifiers, at least every six months their calibration must be verified. In the case of the alternative fuel injection systems, calibration is performed every two month or earlier if required.</p> <p>BELT SCALES: Calibration of the belt scales used for feeding raw materials into the vertical grinder, the grinding of coal and alternative solid fuels (AFR), must be performed monthly, verifying zero and maximum weight.</p>

6. What are the potential strengths and weaknesses of this methodology?

The strength of this methodology is based on the use of standard internal operational data. This results in relatively low costs for monitoring.

On the other hand the protocol has not fully developed a methodology for the indirect GHG savings through alternative fuels (AFR), so it will lead to an underestimation of the actual emission reductions.

7. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

The WRI / WBCSD GHG Protocol has been used as base for the guidelines for monitoring and reporting of GHG emissions by a consortium of consultancy companies (Ecofys, TÜV, KPMG and FIELD) asked to draft proposals for monitoring and reporting for the EU Commission Trading System. But to our knowledge, no other cement sector methodology has been submitted so far to the EB of the CDM so far.

Annex 5

TABLE: BASELINE DATA

Emissions factors

Clinker	
Carbon emissions factor:	kg CO2/t clinker
Cement	
Carbon emissions factor:	kg CO2/t cement
Fossil Fuels	
Fossil fuel CO2 emissions:	kg CO2/GJ
AFR	
AFR specific CO2 emissions:	kg CO2/GJ
Electricity	
Electricity CO2 emissions factor:	t CO2/kWh
Specific caloric consumption:	GJ/t clinker

Data Sources

Intergovernmental Panel on Climate Change (IPCC)
 WRI / WBCSD GHG Protocol

Variables

Specific CO2 from raw meal decarbonation
 CO2 from raw meal decarbonation
 Specific caloric consumption
 Alternative Fuel (AFR) percentage
 AFR specific CO2 emissions
 Traditional (Fossil) Fuel percentage
 Traditional Fuel CO2 emission
 Average fuel specific CO2 emission
 Electricity CO2 emission factor
 Specific electric consumption
 Specific CO2 emission from electricity production

Clinker content of cement
Volume of clinker produced