CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

Partial Substitution of Coal by Jatropha Fruits and Biomass Residues in the Production of Portland Cement.
Version 01
Date: 23/09/2008

A.2. Description of the project activity:

Pre project activity
SOCOCIM INDUSTRIES (Senegal), a member of VICAT Group since 1999, has its cement manufacturing facility in Rufisque, 30 km West of Dakar, with an annual installed capacity for clinker production of 1,350,000 tonnes [1]. In the pre project scenario, SOCOCIM INDUSTRIES was using coal as fuel for its clinker production and small quantities of heavy fuel oil (HFO) for start up.
The pre project activity has been identified as the baseline scenario for the fuel mix.

Project scenario
The purpose of the project activity is the partial replacement of a fossil fuel, coal, by Jatropha fruits and biomass residues for combustion in the cement plant.

Jatropha is an endemic tree which will be cultivated locally in dedicated plantations. Jatropha Curcas is a tropical plant which can grow on poor soils which makes it suitable for areas which would otherwise remain uncultivated. The plant can withstand dry conditions, low nutrient levels and exposed conditions. The dropping of leaves generates also compost around the plant which increases in return biologic activity in the soil, thus improving its fertility. During very dry conditions the plant sheds its leaves in order to avoid unnecessary water evaporation. Due to the fact that the Jatropha is a perennial plant which has low demands on its environment, it can fight soil erosion. Jatropha Curcas is traditionally used in Senegal in protecting hedges around arable land and housing. Also due to its toxicity, Jatropha Curcas oil is not edible and is traditionally used for manufacturing soap and medicinal applications.

[1] In this project design document, all weights are expressed in metric tonnes of dry matter.

Contribution to Sustainable Development

The proposed project activity will contribute to sustainable development in many respects.

Upstream, the entire biomass supply chain including planting, cultivating, harvesting, handling and transportation will give employment and income opportunities to rural communities, farmers and biomass dealers thus improving the social and economic situation of rural communities which are facing growing difficulties due to climate change, decrease of agricultural yields and continuous degradation of agricultural soils mainly due to overutilization, excessive grazing and drought. In particular, the new cash crop will complement incomes issued from groundnut production which are highly variable from year to year.

The dedicated Jatropha plantations will contribute to restore the rural environment by creating “green belts” in areas where soils have been severely degraded thus protecting indirectly nearby environment of local rural communities (limitation of erosion by sand winds, better retention of seasonal rains in the underground, etc.). Taking into account the fact that the plantations will only be done in marginal lands after government approval according to a detailed cultivation charter (see annex), there will be no competition with food cultivations such as rice, maize, millet, vegetables or cash crops like cotton or groundnuts.

Downstream, the substitution of imported coal by Jatropha will reduce local pollution around the Rufisque cement plant due to coal dusts and sulfur emissions while it will result in a major reduction of emissions thereby contributing to the global environmental initiative of reducing green house gas emissions. The use of a local renewable energy such as Jatropha or other biomass wastes in substitution to coal will contribute to reduce the critical energy dependency of Senegal over energy imports (about 50% of its exports in value) and open a new government energy strategy focused on the use of local clean energy resources.

Up to now, Jatropha has never been used in the world in cement kilns. Therefore, the project will improve technical know how of the cement industry in mastering a full biomass supply chain and give impetus to the introduction of clean technology in cement manufacturing.

A.3. Project participants:

Name of Parties involved ((hosts) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Senegal (host)	SOCOCIM INDUSTRIES (Private entity)	No
France (Annex 1)	VICAT (Private entity)	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Senegal

A.4.1.2. Region/State/Province etc.:

Dakar region, Cap Vert Peninsula

A.4.1.3. City/Town/Community etc:

SOCOCIM INDUSTRIES
Ancienne route de Thies
BP 29
Rufisque
Senegal

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The project activity is located at the SOCOCIM INDUSTRIES cement plant in Rufisque, 30 km West of Dakar, off the main road N1.
Latitude: 14°42’24.20’’ N – Longitude: 17°14’51.31’’ W

1- Africa

2 - Senegal

3 – Cap-Vert Peninsula

A.4.2. Category(ies) of project activity:

The project activity belongs to sectoral scope 4: Manufacturing industries as per the CDM sectoral scope.

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

Technology used for the production of Jatropha fruit

The production of Jatropha fruit in quality and quantities is the key for project success. To achieve this objective, SOCOCIM INDUSTRIES has developed a unique know-how and organization scheme which involves selection and distribution of Jatropha seeds, technical assistance to farmers under contract, construction of biomass storage centers, logistic organization for biomass collection and transport to the cement plant.

Technology used for biomass fuel feeding in the cement plant

Technology to substitute coal with biomass in the pre-calciner of the cement kilns was developed in conjunction with the VICAT Technical Department in France. In general terms, this consisted in the in-house design of a new and additional fuel feed system which includes conveyors, hoppers, etc. and adjustment of process parameters to meet quality standards and optimized energy efficiency.

Existing technology for coal storing, grinding, kiln feeding, etc. will be kept operational but will be used at a reduced rate.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The chosen crediting period is 3 times 7 years (21 years).
The emission reductions amount to 89,002 tonnes per year during the first 7 years long crediting period:

Years	**Annual estimation of emission reductions in tonnes of CO_2 e**
2009	7,896
2010	11,838
2011	38,515
2012	95,690
2013	144,467
2014	162,306
2015	162,306
Total estimated reductions (tonnes of CO_2 e)	623,018
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	89,002

A.4.5. Public funding of the project activity:

No public funding is involved in the project activity. Investment for plantations will be financed by loans under normal conditions. Investment for cement plant adaptation will be also made by self financing and commercial loans.

SECTION B. Application of a baseline and monitoring methodology

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

ACM0003 / Version 7.2 “Emissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon intensive fuels in cement manufacture”.
Version 02.2 “Combined tool to identify the baseline scenario and demonstrate additionality”.
Version 02 “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”.
Version 01 “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.

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

The methodology is applicable to the project since all the applicability conditions are fulfilled:

i) General Applicability conditions

Applicability conditions	Demonstration of compliances
A significant investment is required to enable the use of the alternative fuel(s) and/or the less carbon intensive fossil fuel(s).	In addition to a large investment upstream in Jatropha production (nurseries, technical assistance, equipment, manpower, etc.) which is estimated at more than 20 million Euros, to be financed by various players, including SOCOCIM INDUSTRIES, significant investment is foreseen at the cement plant itself which will have to invest about 8 million Euros in engineering studies and industrial equipment to store and weigh the biomass (up to 300 tonnes/day) as well as conveyors, injectors and special equipment to feed and supervise the clinker production. In the absence of the project activity, these investments would appear as excessive to project partners and would not be implemented.
During the last three years prior to the start of the project activity, no alternative fuels have been used in the project plant.	The cement plant has been using only coal (and small quantities of heavy fuel for start up) during the last three years.
The CO_2 emissions reduction relates to CO_2 emissions generated from fuel combustion only and is unrelated to the CO_2 emissions from decarbonisation of raw materials (i.e. $CaCO_3$ and $MgCO_3$ bearing minerals).	The method described in part B.6 to calculate CO_2 emissions reduction of the project relates to CO_2 emissions generated from fuel combustion only and is unrelated to the CO_2 emissions from decarbonisation of raw materials.
The methodology is applicable only for installed capacity (expressed in tonnes clinker/year) that exists by the time of validation of the project activity.	The present methodology is applicable for 1,127,600 tonnes of clinker (production 2007).

ii) Applicability conditions related to the use of biomass residues and renewable biomass:

Applicability conditions	Demonstration of compliances
The biomass is not chemically processed (e.g. esterification to produce biodiesel, production of alcohols from biomass, etc.) prior to combustion in the project plant but it may be processed mechanically or be dried at the project site. Moreover, any preparation of the biomass, occurring before use in the project activity, does not cause other significant GHG emissions (such as, for example, methane emissions from anaerobic treatment of waste water or from charcoal production).	The biomass will not be chemically processed prior to combustion. The Jatropha fruits and biomass residues will be simply stored, perhaps mechanically dried, before introduction into the kilns. No significant GHG emissions will occur before the use of the biomass in the project activity.
The biomass used by the project facility is stored under aerobic conditions.	The biomass will always be stored under aerobic conditions to avoid fermentation and risks of self-ignition.

iii) Applicability conditions related to the use of renewable biomass from a dedicated plantation:

Applicability conditions	Demonstration of compliances
The site preparation at the dedicated plantation does not cause longer-term net emissions from soil carbon. Carbon stocks in soil organic matter, litter and deadwood can be expected to decrease more due to soil erosion and human intervention or increase less in the absence of the project activity.	The Jatropha will be cultivated on poor land without significant vegetation (no agriculture, no trees…). The Jatropha plantations will therefore improve the quality of the soil and increase carbon stocks on the cultivated area.
After harvest, regeneration will occur either by direct planting or natural sprouting.	Only the fruits will be collected every year (natural sprouting once or twice a year). Jatropha trees have a life expectancy of approximately 50 years.
Grazing will not occur within the plantation.	Animals will be kept away from the Jatropha fields since their presence would damage the plantations at early age and moreover the Jatropha fruit is not edible.
In the absence of the project activity, natural revegetation would not result in growth of a forest due to natural or human pressures	The land which will be used for the Jatropha plantations is poor land where natural revegetation cannot occur spontaneously.
Prior to the implementation of the project activity, no fuel wood has been collected from the land area where the dedicated plantation will be established	The Jatropha plantations will be implemented on poor lands where no fuel wood has been collected for the last 10 years.
For at least ten years before the implementation of the project activity, no forest was on the land where the dedicated plantation will be established	The Jatropha plantations will be implemented on poor lands without forest for at least 10 years.
If relevant, workers for any activities on the land prior to project implementation continue to be employed for the biomass plantation activity, i.e.	No activities or household will be shifted for the culture of Jatropha since the plantations will be implemented on inhabited lands.

no households are shifted from the project site	No households should be shifted from the project site. If ever, for an unexpected reason, some workers were to be shifted, SOCOCIM INDUSTRIES would make sure to employ them for the biomass plantation activity. For example, SOCOCIM INDUSTRIES has planted 150 ha of Jatropha in 2007 on the limestone quarry of the cement plant in Rufisque employing local labor.
The land area where the dedicated plantation will be established is, prior to project activity, will meet one of the following criteria: a) Either being severely degraded and would in absence of the project activity have not been used for any other agricultural or forestry activity, or; b) Has been used for agricultural purposes, provided the project participants can demonstrate that no natural forest exists in the host country.	The full purpose of this CDM project is to cultivate Jatropha on degraded land which has no agricultural or forestry potential.

iv) Applicability conditions related to the tools used by the methodology

Combined tool to identify the baseline scenario and demonstrate additionality	The project activities consist of making modifications to an existing installation that is operated by the project participant, therefore, all potential alternatives scenarios to the proposed project activities are available options to the project participant
Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site	Non relevant, since alternative scenario B2 (see part B.3. below) hasn't been identified as the most plausible baseline scenario for the use of biomass residues
Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion	CO_2 emissions from fossil fuel combustion for the project activity are calculated based on the quantity of fuel burnt and its properties.
Tool to calculate baseline, project and/or leakage emissions from electricity consumption	This tool is applicable since the electricity used by the cement plant is, so far, produced with fossil fuel.

B.3. Description of the sources and gases included in the project boundary

Project boundary

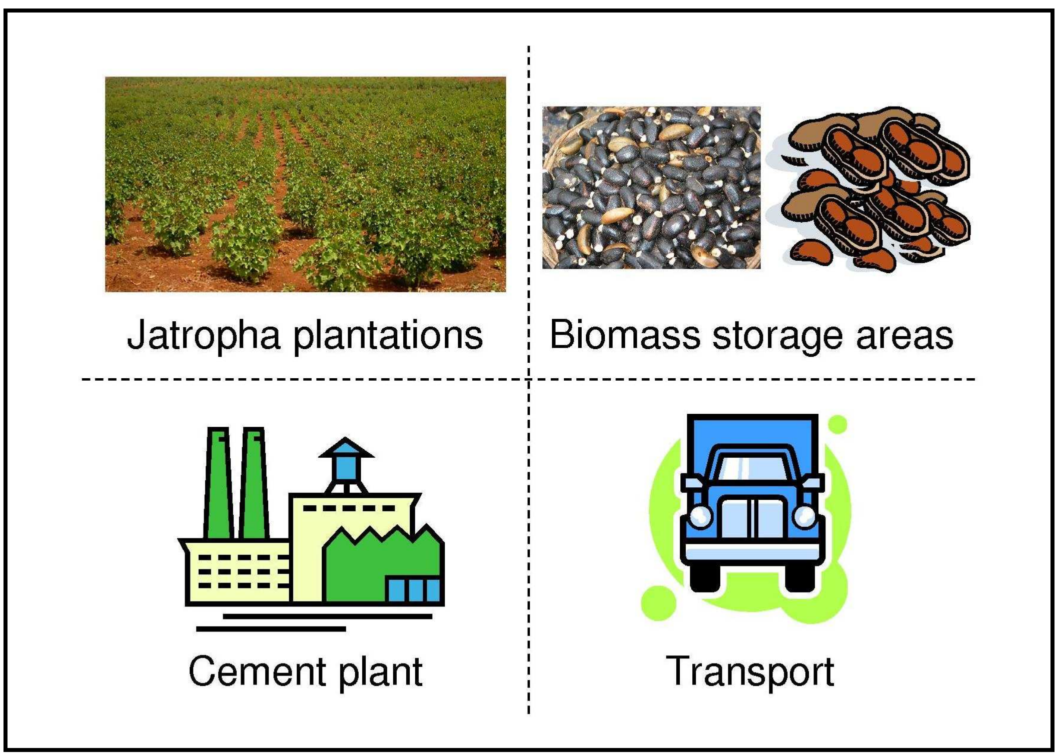
The project boundary includes:

- the lands where the Jatropha is cultivated;

- the Jatropha fruit and biomass residues (rice husks, cotton shells, cashew nut shells…) storage centers;

- the vehicles used for transportation of alternative fuels to the cement plant;

- the cement plant (including on-site storage of alternative fuels).



Description of the sources and gases

	Source	Gas	Included?	Justification/Explanation
Baseline	Emissions from fossil fuels displaced in the project plan ($BE_{FF,y}$)	CO_2	Yes	Main emission source
		CH_4	No	Minor source. Neglected for simplicity.
		N_2O	No	Minor source. Neglected for simplicity.
	Methane emissions avoided from preventing disposal or uncontrolled burning of biomass residues	CO_2	No	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector (Land Use, Land-Use Change and Forestry).
		CH_4	No	Not included because no or little fermentation of the concerned biomass residues
		N_2O	No	Minor source. Neglected for simplicity.

	Source	Gas	Included?	Justification/Explanation
Project Activity	Emissions from the use of alternative fuels and/or less carbon intensive fossil fuels ($PE_{k,y}$)	CO_2	Yes	Main emission source
		CH_4	No	Minor source. Neglected for simplicity.
		N_2O	No	Minor source. Neglected for simplicity.
	Emissions from additional electricity and/or fossil fuel consumption as a result of the project activity ($PE_{FC,y}$ and $PE_{EC,y}$)	CO_2	Yes	Main emission source
		CH_4	No	Minor source. Neglected for simplicity.
		N_2O	No	Minor source. Neglected for simplicity.
	Emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant ($PE_{T,y}$)	CO_2	Yes	Main emission source
		CH_4	No	Minor source. Neglected for simplicity.
		N_2O	No	Minor source. Neglected for simplicity.
	Emissions from the cultivation of renewable biomass at the dedicated plantation ($PE_{BC,y}$)	CO_2	Yes	Minor source since very little use of mechanization and watering.
		CH_4	No	No field burning before Jatropha plantation.
		N_2O	Yes	Is accounted for because of possible use of fertilizers.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The baseline scenario is identified and additionality is assessed using the most recent approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 02.2). This section highlights how specific sections of this tool are applied to this project activity.

Baseline identification for the fuel mix for cement manufacturing

Step 1. Identification of alternative scenarios

This step serves to identify all alternative scenarios for SOCOCIM INDUSTRIES to the proposed CDM project activity which might be the baseline scenario through the following sub-steps:

Step 1a. Define alternative scenarios to the proposed CDM project activity

This step identifies all alternative scenarios that are available to SOCOCIM INDUSTRIES and that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity. The alternatives to be analyzed for the fuel mix for the cement plant include:

F1	The proposed project activity is not undertaken as a CDM project activity. Under this scenario, the SOCOCIM INDUSTRIES cement plant is partially fuelled by Jatropha fruits from dedicated plantations and, to a much lesser extent, by biomass wastes such as rice husks, cashew nut shells, cotton shells, Jatropha shells and Jatropha cakes issued from Jatropha oil producers, when such waste products are effectively available in large quantity, are not already commonly used in Senegal and are not competing with other activities.
F2	The continuation of the current practice, i.e., a scenario in which SOCOCIM INDUSTRIES continues cement production using the existing technology, materials and fossil fuel mix (coal + HFO in minor quantities).
F3	The continuation of using only fossil fuels and no alternative fuels in SOCOCIM INDUSTRIES, however, with a different fuel mix portfolio (coal, petcoke, heavy fuel oil and/or natural gas), taking into account relative prices of fuels available.
F4	The currently used fuels are partially substituted by SOCOCIM INDUSTRIES with alternative fuels and/or less carbon intensive fossil fuels other than those used in the CDM project activity and/or any other fuel types, without using the CDM: used tires, used oil, plastics…
F5	The construction and operation of a new cement plant.

For scenarios F1 and F2, a fuel mix table is presented hereafter giving the annual quantities of the different fossil or biomass fuels burnt by the cement plant during the crediting period:

	Scenario F1	Scenario F2
Yearly fuel consumption from 2009 to 2029	Charcoal: 102,782 t HFO: 3,369 t Jatropha fruit: 89,277 t Other biomass: 7,000 t	Charcoal: 154,629 t HFO: 3,208 t

Sub-step 1b. Consistency with mandatory applicable laws and regulations:

F1	SOCOCIM INDUSTRIES cement plant is authorized to co-process any 100% biomass fuel issued from plantations or biomass wastes: Jatropha fruits, rice husks, cashew nut shells, cotton shells, Jatropha shells or cakes when they are available and without alternative uses on biomass production site. Jatropha plantations will be implemented only on authorized lands. Like the project activity, this alternative scenario complies with all mandatory applicable legal and regulatory requirements.
F2	SOCOCIM INDUSTRIES is currently in compliance with all mandatory applicable legal and regulatory requirements. In particular, the SOCOCIM INDUSTRIES plant must comply with an Environmental Scheme (“Plan d’actions environnemental”) elaborated with the Ministry of Environment. Two meetings are organized every year to make sure that the scheme is properly carried out.
F3	The use of heavy fuel oil in the cement kilns would comply with all mandatory applicable legal and regulatory requirements. In fact, SOCOCIM INDUSTRIES plant has been using such fuel for many years. The switch to coal in year 2004 was decided by the cement plant management for economical reasons only. Likewise, the use of natural gas would comply with all mandatory applicable legal and regulatory requirements, as long as the cement plant respects all the handling and storage regulations linked to natural gas. On the other side, the use of petcoke, which contains necessarily high levels of sulphur (4% minimum), would lead to high levels of SO_2 emissions at the kilns’ chimneys, probably above authorized limits. High level of sulphur causes concretions in fans, source of important breakdowns and lost of productivity. Indeed, the raw materials used in the cement plant contain already high levels of sulphur. Therefore, fuels containing high levels of sulphur cannot be used in the Rufisque cement plant. Petcoke aside, this alternative scenario complies with all mandatory applicable legal and regulatory requirements.
F4	Today, the cement plant hasn’t got the authorisation to co-process any non-biomass waste fuel for the good reason that SOCOCIM INDUSTRIES hasn’t asked the authorities to burn such fuels. Considering that SOCOCIM INDUSTRIES could possibly be authorized to use such fuels if the request was made, we will suppose in this document that this scenario complies with all legal and regulatory requirements.
F5	The construction and operation of a new cement plant would be implemented in compliance with all mandatory applicable legal and regulatory requirements.

Outcome of Step 1b: All alternative scenarios for SOCOCIM INDUSTRIES comply (petcoke aside) with mandatory legislation and regulation in force in Senegal.

Step 2. Barrier analysis

This step serves to identify existing barriers and to assess which alternative scenarios for SOCOCIM INDUSTRIES are prevented by these barriers.

Sub-step 2a. Identify barriers that would prevent the implementation of alternative scenarios:

The following tables identify the investment, economical, technological and availability barriers faced by the five alternative scenarios related to the fuel mix for the cement plant.

Sub-step 2b. Eliminate alternative scenarios which are prevented by the identified barriers:

Scenario F1: Project activity without CDM using Coal / HFO + Jatropha fruits + other biomass residues

Investment barriers	Yes	The scenario requests high investment upfront in Jatropha plantations, transport, storage and also in cement plant process. Total investment upfront for 11 000 ha is estimated at 20 million Euros, and the plant process adaptation will require an additional 8 million Euros. For implementing this activity, SOCOCIM INDUSTRIES has to face a major Investment Barrier taking into account the fact that commercial, long-term credit is not available for large projects in this region. Senegal[2] has a Standard & Poor's credit rating of B+, and has been qualified in February 2000 for debt relief as part of the Heavily Indebted Poor Countries (HIPC) initiative, demonstrating that it is not attractive to private lenders for large, long-term loans. Loans for projects in export sectors are able to achieve some private loans in Senegal. However, projects to provide goods for Senegal do not have access to such loans because of the poor credit histories of the country. Thus, large national projects requiring multi-million dollar loans face a significant barrier since they do not have access to commercial, long-term credit.
Economical barrier	Yes	The biomass fuel is not cost competitive with imported coal in terms of relative energy costs.
Technological barrier	Yes	The organization on a large scale of Jatropha plantations (about 11 000 ha) is totally new in Senegal. The transport and process of 300 t/day of Jatropha fruits and other biomass is a major challenge for SOCOCIM INDUSTRIES. Indeed, it is the first time that a cement plant in the world intends to substitute about 40% of its coal consumption by biomass from dedicated plantations. Significant risks are consequently existing at all steps. Main technical risks are linked to the smooth operation of the kiln combustion to ensure the quality standards for the clinker, the logistic organization for storage of biomass at

[2] pp 44-45, *Africa Investor Magazine*, March-May 2004

		production and plant levels, the incertitude on yields of Jatropha under variable soil and rain conditions.
Availability barriers	Yes	There are significant risks that the supply of 300 t/day of Jatropha fruits to SOCOCIM INDUSTRIES is not ensured on a regular basis, at least in the first years. The availability of other biomass residues is subject to significant annual variations and must take into account various constraints.

Scenario F2: Continuation of the current practice, i.e. a scenario in which SOCOCIM INDUSTRIES continues cement production using the existing technology, materials and fossil fuel mix (coal + HFO in minor quantities)

Investment barriers	No	
Economical barrier	No	Imported coal remains the least cost energy solution. Improvements in harbor handling for coal and the installation of a nearby large coal power plant (150 MW at Bargny, near Rufisque) by the national utility SENELEC may improve the competitiveness of coal in front of other energies.
Technological barrier	No	Modern cement manufacturing technology is already used
Availability barriers	No	Coal imports are easy, in particular from South Africa. The plant is close to a deep harbor.

Scenario F3: Continuation of using only fossil fuels and no alternative fuels, however, with a different fuel mix portfolio (coal, petcoke, heavy fuel oil and/or natural gas)

Investment barriers	Yes	Heavy investments would be necessary to install a new crusher to grind petcoke. Rufisque cement plant is not equipped to use natural gas since it has never used this source of energy. Heavy investments would have to be undertaken to be able to use natural gas.
Economical barrier	Yes	Heavy fuel oil and natural gas are much more expensive fuels than coal. Furthermore this price gap is likely to increase in coming years due to the long term evolution of world oil market.
Technological barrier	Yes	The coal crusher of the cement plant is not adapted to grind petcoke which is harder than coal. The high sulfur content in petcoke would lead to continuous concretions in the cement kilns, reducing clinker production and obliging the plant to frequently stop for maintenance.
Availability barriers	Yes	Natural gas is not available in Senegal in significant quantities, so far. Importation and handling of such a fuel would implicate heavy investments.

Scenario F4: Currently used fuels partially substituted with alternative fuels and/or less carbon intensive fossil fuels others than those used in the CDM project activity and/or any other fuel types, without using the CDM: used tires, used oil, plastics…

Investment barriers	No	Some alternative fuels such as whole tires or shreddered plastics require heavy investments to prepare, store, feed and inject the waste in the cement kilns. Nevertheless, to be conservative, we will consider that there is no investment

		barrier.
Economical barrier	No	To be conservative, we will consider that there is no economic barrier since alternative fuels are usually cheaper than conventional fossil fuels.
Technological barrier	No	The use of alternative fuels is common in cement industry.
Availability barriers	Yes	Tires can be used in cement kilns. But in Senegal, used tires are so worn out that there is barely any rubber left on them, reducing very significantly their calorific potential. Moreover, there is no existing logistics scheme to recover significant quantities of used tires. Therefore SOCOCIM INDUSTRIES would have to organize collection centers and transport, thus annihilating the economical interest for this fuel. Not to mention also that used tires are partially recycled locally into various objects: sandals, outsoles, etc. Waste engine oils (hazardous waste) could also be of interest for the cement plant. The possibility of co-processing waste oils in cement plants has only been very recently allowed by the Senegalese authorities (decree released at the end of 2007). SOCOCIM INDUSTRIES hasn't got the authorization yet. Today, all the waste oils are either regenerated in Dakar by SRH (Société de Régénération des Huiles) or directly used by households (mixed with car petrol). Available quantities for the cement plant in the coming years are negligible. Other waste streams classically used in cement plants in other countries have been studied (solvents, sewage sludge, animal meal, plastics, etc.). But these wastes either don't exist in Senegal (or in too little quantities), or the logistics to recover such wastes would be too onerous considering that nobody is ready to pay to treat the wastes.

Scenario F5: Construction of a new cement plant

Investment barriers	Yes	The construction of a new cement plant is not envisaged. Large investment has been made in recent years in the existing SOCOCIM INDUSTRIES plant to increase its capacity, improve its economic performances and reduce its environmental impact.
Economical barrier	Yes	
Technological barrier	No	SOCOCIM INDUSTRIES, as a subsidiary of the VICAT Group of France, has access to latest technologies and know-how.
Availability barriers	No	

Outcome of step 2b: Scenario F2 is the only alternative scenario for SOCOCIM INDUSTRIES to the project activity that is not prevented by any barrier.

The scenario F2, with the continuation of using only coal, is not facing any significant barrier whether technical, economic or environmental. This scenario would be even more likely with planned improvements for coal unloading, transport and storage at Dakar harbour, and the project of a new coal power plant in Sendou (Bargny), close to the cement plant.

Baseline identification for biomass residues

In addition to Jatropha fruits issued from dedicated plantations under the supervision of SOCOCIM INDUSTRIES, the cement plant envisage to use, on a limited scale other biomass residues such as rice husks, cashew nut and cotton shells and possibly later Jatropha shells or cakes issued from Jatropha oil production.

Step 1. Identification of alternative scenarios

Step 1a. Define alternative scenarios regarding biomass residues to the proposed CDM project activity

According to the ACM0003 Version 7.2 methodology, the alternatives to be analyzed for the use of biomass residues include:

B1	The biomass residues are dumped or left to decay under mainly aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.
B2	The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.
B3	The biomass residues are burnt in an uncontrolled manner without utilizing them for energy purposes.
B4	The biomass residues are sold to other consumers in the market and used by these consumers, such as for heat and/or electricity generation, for the generation of biofuels, as feedstock in processes (e.g. the pulp and paper industry), as fertilizer, etc.
B5	The biomass residues are used for other purposes at the project site, such as for heat and/or electricity generation, for the generation of biofuels, as feedstock in processes (e.g. the pulp and paper industry), as fertilizer, etc.
B6	The proposed project activity, not undertaken as a CDM project activity, i.e. the use of the biomass residue in the project plant.

Regarding rice husks, in Senegal, the biomass residue has presently no alternative use and is left to decay on large stacks, dumped over the fields under aerobic conditions or burnt in an uncontrolled manner in the fields or on the outskirts of rice mills which are usually too small to envisage their use in local steam power plants like in Thailand, for example.

Similarly, it is envisaged also to use cashew nuts shells from Casamance region which have no use after nut extraction and are either burnt in the open air or left to decay.

It is also envisaged to use cotton shells issued from cotton plants which have no oil production facilities. Cotton shells are not edible by the cattle and are so far not used as a fertilizer due to phytosanitary guidelines.

In the medium/long term the cement plant may burn also Jatropha cakes or shells issued from Jatropha oil production in other locations if such products have no alternative uses.

Other biomass residues could possibly be used (groundnut shells, palm kernel shells…), depending on their availability –unpredictable today- during the project activity.

In the present case, the only plausible scenarios for SOCOCIM INDUSTRIES are B1, B3 and B6.

Sub-step 1b. Consistency with mandatory applicable laws and regulations:

B1	No law forbids the storage of biomass residues on fields.
B3	Uncontrolled burning of biomass residues in the fields is not forbidden by law. Senegalese National Forest Act punishes forest/bush fires with imprisonment and severe fines.
B6	SOCOCIM INDUSTRIES cement plant is authorized to use any biomass fuel including biomass residues.

Outcome of Step 1b: All alternative scenarios comply with mandatory legislation and regulation in force in Senegal.

Step 2. Barrier analysis

Sub-step 2a. Identify barriers that would prevent SOCOCIM INDUSTRIES to implement these alternative scenarios for biomass residues:

The use of biomass residues by SOCOCIM INDUSTRIES is not an obvious option (Business As Usual); several market studies and investigations in recent years have demonstrated that the use of alternative biomass residues such as rice husks, cotton shells, groundnut shells, etc. was hampered by serious difficulties regarding the availability of the biomass residues characterized by small and often irregular quantities, spread over a large area generating high transport costs, and high unit costs compared to imported coal. The adaptation of the cement plant to process these alternative fuels was delayed due to high investment costs and lack of visibility regarding their supply in significant quantities.

Sub-step 2b. Eliminate alternative scenarios which are prevented by the identified barriers:

Rice husk residues are available in quantities close to large and small existing rice mills. Large deposits have been made during past years in open air and these residues have not found useful utilization so far. Usually they generate pollution through partial burning and soil contamination. The main barrier is economic taking into account the distances between these rice plants and potential users such as the SOCOCIM INDUSTRIES cement plant. The same apply to cashew nut shells or cotton shells generated in areas rather far from SOCOCIM cement plant.

Groundnut shells are partially used as fuel in existing peanut oil plants such as SONACOS. The main barrier is the strong irregularity of groundnut production which makes it impossible to forecast the availability of surplus of groundnut shells.

The use of Jatropha residues such as shells or cakes resulting from oil production as alternative fuels is envisaged by SOCOCIM INDUSTRIES as a complement to Jatropha fruits issued from dedicated plantations, but so far no Jatropha oil plant has been set up in Senegal. In the absence of the CDM activity, these residues would be very likely left aside the plant to decay taking into account the fact that these Jatropha residues are not edible by animals due to their toxicity.

In summary,

The reference scenario for **rice husk** is its absence of valorization, the residue being burnt or left to decay in the open air. Its transport cost and low density is a major barrier for its use as fuel in a cement factory. The same apply to **cashew nut and cotton shells**.
The reference scenario for **groundnut shells** is its use as fuel in groundnut oil factory.

The reference scenario for Jatropha shells or cakes issued from future Jatropha oil plants would be likely the storage in open air nearby the plants taking into account existing economic barrier for its use in cement industry (transport costs) and its toxicity for animal feeding.

The scenario where SOCOCIM INDUSTRIES would use biomass residue is facing significant economic barriers mainly due to high transport costs to the cement plant making these biomass fuels more expensive than coal for the same energy content. In addition, significant barriers exist in terms of residue availability, so far. This scenario is not the reference scenario consequently.

Baseline identification for renewable biomass from a dedicated plantation

Step 1. Identification of alternative scenarios

Step 1a. Define alternative scenarios to the proposed CDM project activity

According to ACM 0003 Version 7.2, the alternatives to be analyzed for the use of renewable biomass by SOCOCIM INDUSTRIES from a new dedicated plantation include:

R1	No establishment of dedicated Jatropha plantations and thus no generation of renewable biomass.
R2	Establishment of a new dedicated Jatropha plantations and sale of the renewable biomass from the plantation to other consumers in the market, which may use the renewable biomass for heat and/or electricity generation, for the generation of biofuels, as feedstock in processes (e.g. the pulp and paper industry), as fertilizer, etc.
R3	The proposed project activity, not undertaken as a CDM project activity, i.e. the establishment of new dedicated plantations and use of the renewable biomass (Jatropha fruits) from that plantation in the project plant.

The scenario R2 is considered as not feasible by SOCOCIM INDUSTRIES which intends to secure its supply of Jatropha fruits in very large quantities through direct production in its own plantations or through exclusive contracts with individuals or organizations which will be committed to supply all their production to SOCOCIM INDUSTRIES through detailed specifications aimed at guaranteeing the quality and regularity of supply while ensuring that these plantations are fully meeting the applicability conditions of ACM0003 Version 7.2, so to ensure environmental protection, absence of competition with food production, minimization of greenhouse gas leakages and economic and social promotion in rural areas through fair additional income distribution within a partnership approach.

So far, SOCOCIM INDUSTRIES is the first Senegalese company to have launched large Jatropha plantations and having established close links with government relevant administrations and research centers (Eaux & Forêts, ISRA, Ministry of Agriculture...). The initiative of SOCOCIM INDUSTRIES is highly supported by the Senegalese Government. Other initiatives for plantations of Jatropha are under consideration for production of biofuels but their scope is less ambitious and advanced.

Therefore, only the scenarios R1 and R3 are plausible.

Sub-step 1b. Consistency with mandatory applicable laws and regulations:

The two alternative scenarios comply with mandatory legislation and regulation in force in Senegal.

Step 2. Barrier analysis

Sub-step 2a. Identify barriers that would prevent the implementation of alternative scenarios:

The scenario R3 (activity without CDM) is hampered by economic, technical and organizational barriers. The development of 11 000 ha of Jatropha plantations is involving high technical risks regarding the productivity, the crop resistance, the climate variations, the level of appropriation of this new culture by local population, the quality of the technical assistance, etc. In addition to these barriers, the Jatropha fruits do not appear competitive in term of cost by energy content in comparison with imported coal and SOCOCIM would not consider organizing a large scale biomass production in the absence of CDM incentives to reduce its economic and technical risks.

Sub-step 2b. Eliminate alternative scenarios which are prevented by the identified barriers:

The baseline scenario is consequently scenario R1 where no Jatropha plantation is envisaged.

STEP 3. Investment analysis

The scenario based on Jatropha nursing, plantation, cultivation, transport and processing in the cement plant to replace about 40% of the imported coal requests a high investment at all steps of the Jatropha production chain which amounts to about 30 million Euros (25% for the nurseries, 47% for the plantations, and 28% for additional investment for biomass handling in the existing cement plant). The project profitability is very low without the sale of CER (Certified Emission Reduction) with a payback of 9.1 years and a Return on Capital Employed (ROCE) of 6.3%, and modest with the inclusion of CER sale (payback of 7.9 years and ROCE of 7.6%). This anticipated performance is significantly below the average payback and ROCE expected from normal investment projects in the VICAT Group in its other cement plants such as in India, Turkey, Egypt, Kazakhstan, USA, France or Switzerland.

A detailed sensitivity analysis (see hereafter) demonstrates that in the absence of CER commercialization the profitability of the Jatropha supply option is always low. The key parameters utilized in the economic model[3] for sensitivity analysis are the price of imported coal, the yield per hectare of Jatropha fruits, the maintenance costs of plantations per hectare and the interest rate of necessary loans. The investment analysis confirms that the Jatropha option is not the reference scenario taking into account its own risks, barriers and estimated production costs.

[3] The financial model with all its conservative assumptions and the sensivity analysis will be made available to the EOD experts.

Sensibility analysis for jatropha production and utilization in SOCOCIM cement plant

	Payback (years)		Return on Capital Employed	
	without CER	with CER	without CER	with CER
Reference case (CER at 10€/t ; loan interest rate at 10.5%)	**9,1**	**7,9**	**6,3%**	**7,6%**
Sensibility to cost of imported coal				
- 25% over project activity duration	15,0	11,1	4,1%	4,8%
+ 25% over project activity duration	7,0	6,4	8,9%	9,9%
+ 50% over project activity duration	5,9	5,5	11,0%	12,1%
Sensibility to jatropha yields in ton/ha				
- 25% over project activity duration, corresponding to 6 t/ha at maturity	12,2	10,2	4,3%	5,5%
+ 25% over project activity duration, corresponding to 10 t/ha at maturity	7,7	6,8	7,8%	9,1%
Sensibility to jatropha maintenance cost / ha				
+ 25% over project activity duration	9,9	8,5	5,6%	7,0%
- 25% over project activity duration	8,5	7,5	7,0%	8,2%
Sensibility to loan interest rate				
+ 25%, corresponding to 13.1% / year	9,7	8,4	6,0%	7,2%
- 25% , corresponding to 7.9% / year	8,6	7,5	6,7%	8,0%
Price of CER €/tCO2eq				
- 50% over project activity duration, 5.0 €/t	9,1	8,5	6,3%	7,0%
- 25% over project activity duration, 7.5 €/t	9,1	8,2	6,3%	7,3%
+ 25% over project activity duration, 12.5 €/t	9,1	7,7	6,3%	7,9%
+ 50% over project activity duration, 15.0 €/t	9,1	7,5	6,3%	8,2%
+ 100% over project activity duration, 20.0 €/t	9,1	7,1	6,3%	8,8%

STEP 4. Common practice analysis

So far, the proposed activity would be a world unique event as there are no cement factories in the world which have established large scale biomass plantations for their own use. The overall organization of this activity is highly complex at this scale of production (300 tonnes of Jatropha fruits/day) and extremely innovative in terms of plantation organization, social promotion of rural population, partnership with Jatropha producers, protection of local environment by utilization of degraded soils, adjustment of the cement process, etc. The initiative is highly risky in financial and technical terms due to the lack of former experience by SOCOCIM INDUSTRIES or other cement plants.

B.5. 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 (assessment and demonstration of additionality):

The above utilization of the combined tool for demonstration of baseline and additionality is leading to the conclusion that the baseline is definitely the continuation of the present situation based on the utilization of imported coal which is not hampered by any barrier.
The alternative scenarios for fuel supply using other fossil fuels such as petcoke, HFO or natural gas are all facing major technical, environmental or economic barriers as justified above. Similarly, it appears that the use of substitute fuels such as plastics, tires, used lubricating oils, is addressing other major barriers due to insufficient availability, prevailing regulations or excessive costs for processing in small quantities.
The exclusive use of other biomass waste such as rice husk or cashew nut shells as fuel for the cement plant without the large quantities of Jatropha fruits issued from dedicated plantations is also hampered by availability (too small quantities) and economic barriers (an expensive process modification is only justified if the alternative fuel is in significant quantity compared to coal consumption).

The large use of Jatropha fruits (equivalent to 40 % of coal consumption) issued from dedicated plantations would never be implemented in the absence of the project activity taking into account of the different barriers identified previously and the associated risks to this first world pilot experience for the cement industry. The economics of Jatropha use compared to coal imports has confirmed that coal, even with reasonable price increases, is cheaper that the biomass solution. In consequence, the project activity cannot be considered as the baseline.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Project emissions

Project emissions include project emissions from the use of Jatropha fruits or other biomass residues defined as alternative fuels ($PE_{k,y}$), project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity ($PE_{EC,y}$ and $PE_{FC,y}$), project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant ($PE_{T,y}$), and, project emissions from the cultivation of renewable biomass at the dedicated plantation ($PE_{BC,y}$):

$$PE_y = PE_{k,y} + PE_{FC,y} + PE_{EC,y} + PE_{T,y} + PE_{BC,y} \qquad \textbf{(1)}$$

Where:
PE_y = Project emissions during the year *y* (tCO_2e)
$PE_{k,y}$ = Project emissions from combustion of alternative fuels in the project plant in year *y* (tCO_2)
$PE_{FC,y}$ = Project emissions from additional fossil fuel combustion as a result of the project activity in year *y* (tCO_2)
$PE_{EC,y}$ = Project emissions from additional electricity consumption as a result of the project activity in year *y* (tCO_2)
$PE_{T,y}$ = CO_2 emissions during the year *y* due to transport of alternative fuels to the project plant (tCO_2)
$PE_{BC,y}$ = Project emissions from the cultivation of renewable biomass at the dedicated plantation in year *y* (tCO_2e)
Project emissions are calculated in the following steps:
Step 1. Calculate project emissions from the use of alternative fuels

Step 2. Calculate project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity
Step 3. Calculate project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant
Step 4. Calculate project emissions from the cultivation of renewable biomass at the dedicated plantation

Step 1: Calculate project emissions from the use of alternative fuels
Project emissions from the use of alternative fuels in the project plant are calculated as follows:

$$PE_{k,y} = \sum_k FC_{PJ,k,y} \times NCV_{k,y} \times EF_{CO2,k,y} \qquad \textbf{(2)}$$

Where:
$PE_{k,y}$ = Project emissions from combustion of alternative fuels in the project plant in year *y* (tCO_2)
$FC_{PJ,k,y}$ = Quantity of alternative fuel type *k* used in the project plant in year *y* (tonnes)
$EF_{CO2,k,y}$ = Carbon dioxide emissions factor for alternative or less carbon intensive fossil fuels type *k* in year *y* (tCO_2/GJ)
$NCV_{k,y}$ = Net calorific value of the alternative or less carbon intensive fossil fuel type *k* in year *y* (GJ/tonne)
k = Alternative fuel types used in the project plant in year *y*

Step 2: Calculate project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity
The use of alternative fuels results in additional fossil fuels consumption due to the on-site transportation of the fuels.
CO_2 emissions from on-site combustion of fossil fuels ($PE_{FC,y}$) is calculated using the latest approved version of the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”.
For each fossil emission source *j*, the fuel consumption of each fuel type *i* ($FC_{i,j,y}$) is monitored, consistent with the guidance in the tool.
CO_2 emissions from on-site electricity consumption ($PE_{EC,y}$) is calculated using the latest approved version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.
Electricity consumption from each relevant source is monitored and summed up to $EC_{PJ,y}$.

Step 3: Project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant
The transportation is undertaken by vehicles. As the project may use the services of other good transporters, an approach based on distance and vehicle type (option 1 of ACM0003) is more suitable. Emissions are calculated on the basis of distance and the number of trips (or the average truck load):

$$PE_{T,y} = N_y \cdot AVD_y \cdot EF_{km,CO2,y} \qquad \textbf{(3)}$$

Where:
$PE_{T,y}$ = CO_2 emissions during the year *y* due to transport of alternative fuels to the project plant (tCO_2/yr)
N_y = Number of truck trips during the year *y*
AVD_y = Average round trip distance (from and to) between the alternative fuel supply sites and the site of the project plant during the year *y* (km)
$EF_{km,CO2,y}$ = Average CO_2 emission factor for the trucks measured during the year *y* (tCO_2/km)

Step 4: Calculate project emissions from the cultivation of Jatropha at the dedicated plantation
As the jathropha is cultivated from a dedicated plantation, project emissions from the cultivation of this renewable biomass ($PE_{BC,y}$) shall be calculated as:

$$PE_{BC,y} = PE_{FC,PL,y} + PE_{FP,y} + PE_{FA,y} + PE_{BB,y} + PE_{IR,y} \qquad \textbf{(4)}$$

Where:

$PE_{BC,y}$ = Project emissions from the cultivation of this renewable biomass at the dedicated plantation in year *y* (tCO_2e)
$PE_{FC,PL,y}$ = Project emissions related to fossil fuel consumption at the plantation during agricultural operations in year *y* (tCO_2/yr). This emission source should be calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"
$PE_{FP,y}$ = Project emissions related to the production of synthetic fertilizer that is used at the dedicated plantation in year *y* (tCO_2e/yr). This emission source is expected to be negligible for this proposed project activity, as the cultivation of Jatropha will not need significant amount of synthetic fertilizer. This emission will be taken as negligible in the ex ante project emissions calculation. However, to be conservative, we include in the monitoring plan the monitoring of potential use of synthetic fertilizer. The monitoring of the quantity of synthetic fertilizer is calculated using the procedures provided in the latest approved version of the baseline and monitoring methodology AM0042. In case of using organic fertilizers (compost), emissions from production of organic fertilizers are negligible and assumed to be zero.
$PE_{FA,y}$ = Project emissions related to the application of fertilizers at the plantation in year *y* (tCO_2e/yr). This emission source is expected to be negligible for this proposed project activity, as the cultivation of Jatropha will not need significant amount of fertilizer. This emission will be taken as negligible in the ex ante project emissions calculation. However, to be conservative, we include in the monitoring plan the monitoring of potential use of fertilizer. This emission source is calculated using the procedures provided in the latest approved version of the baseline and monitoring methodology AM0042.
$PE_{BB,y}$ = Project emissions arising from field burning of biomass at the plantation site (tCO_2e/yr) is expected to be negligible as the Jatropha cultivation will be done in the severely degraded land of Thies region and in the former 'bassin arachidier' region characterized by vegetation and soil degradation. This emission will be taken as negligible in the ex ante project emissions calculation. However, to be conservative, we include in the monitoring plan the monitoring of potential emission sources arising from field burning of biomass in the plantation site which is calculated using the procedures provided in the latest approved version of the baseline and monitoring methodology AM0042. No land that has been previously used for agriculture in the recent years will be used for the Jatropha plantation.
$PE_{IR,y}$ = Project emissions from irrigation of the plantation is estimated as per the procedure given in step 2 above. Emissions from fuel combustion due to irrigation ($PE_{FC,IR,y}$) are estimated as per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" while emissions from electricity consumption due to irrigation ($PE_{EC,IR,y}$) are estimated as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".
The project will lead to the conversion of land from degraded land to forest land, and soil carbon is likely to increase. However, to be conservative in the proposed project activity, the change in soil carbon is assumed to be zero and no CERs are claimed for such increase.

Baseline emissions
The project reduces CO_2 emissions by using Jatropha fruits or biomass residues as alternative fuels in the pre-calciner and the kiln for the production of clinker in cement manufacture. When biomass residues as rice husk are used, the project will reduce CH_4 emissions from preventing disposal or uncontrolled burning of biomass residues.
Baseline emissions are calculated as follows:

$$BE_{y} = BE_{FF,y} + BE_{CH4,biomass,y} \qquad \textbf{(5)}$$

Where:
BE_y = Baseline emissions in year *y* (tCO_2)
$BE_{FF,y}$ = Baseline emission from the coal displaced by alternative fuels in year *y* (tCO_2)
$BE_{CH4,biomass,y}$ = Baseline methane emissions avoided during the year *y* from preventing disposal or uncontrolled burning of biomass residues (tCO_2e)
Baseline emissions are determined in the following steps:

Step 1. Estimate the project specific “fuel penalty”
Step 2. Calculate baseline emissions from the coal displaced by the alternative fuel(s)
Step 3. Calculate baseline emissions from decay, dumping or burning of biomass residues

Step 1. Estimate the project specific “fuel penalty”

A project specific fuel “penalty” is applied because the combustion of typically coarser biomass or other alternative fuels will reduce the heat transfer efficiency in the cement manufacturing process. The use of alternative fuels will therefore require a greater heat input to produce the same quantity and quality of cement clinker. The chemical content and ease of absorption into cement clinker of all fuel ashes also differs, and this also contributes to the need for a project specific “fuel penalty”.

This project specific fuel penalty (FP_y) should be determined as follows:

$$FP_y = P_{clinker,y} \times (SEC_{clinker,PJ,y} - SEC_{clinker,BL}) \quad \textbf{(6)}$$

Where:
FP_y = Fuel penalty in year *y* (GJ)
$P_{clinker,y}$ = Production of clinker in year *y* (tonnes)
$SEC_{clinker,PJ,y}$ = Specific energy consumption of the project plant in year *y* (GJ/t clinker)
$SEC_{clinker,BL}$ = Specific energy consumption of the project plant in the absence of the project activity (GJ/t clinker)

The specific energy consumption in the project is calculated based on the quantity of all fuels used in the project plant and the quantity of clinker produced in year *y*, as follows:

$$SEC_{clinker,PJ,y} = \left(\sum_i \left(FC_{PJ,i,y} \times NCV_{i,y}\right) + \sum_k \left(FC_{PJ,k,y} \times NCV_{k,y}\right)\right) / P_{clinker,y} \quad \textbf{(7)}$$

Where:
$SEC_{clinker,PJ,y}$ = Specific energy consumption of the project plant in year *y* (GJ/t clinker)
$FC_{PJ,i,y}$ = Quantity of fossil fuel type *i* fired in the project plant in year *y* (tonnes) (the fuel can be coal or diesel)
$NCV_{i,y}$ = Net calorific value of the fossil fuel type *i* in year y (GJ/tonne)
$FC_{PJ,k,y}$ = Quantity of alternative fuel type *k* used in the project plant in year *y* (tonnes)
$NCV_{k,y}$ = Net calorific value of the alternative fuel type *k* in year y (GJ/tonne)
$P_{clinker,y}$ = Production of clinker in year *y* (tonnes)
k = Jatropha or biomass residues used in the project plant in year *y*
i = Baseline fossil fuel types that are still used in the project plant in year *y*

As a conservative approach, the specific energy consumption in the absence of the project activity is calculated as the lowest annual ratio of fuel input per clinker production among the most recent three years prior to the start of the project activity, as follows:

$$SEC_{clinker,BL} = MIN\,(HG_x / P_{clinker,x};\ HG_{x-1} / P_{clinker,x-1};\ HG_{x-2} / P_{clinker,x-2}) \quad \textbf{(8)}$$

With

$$HG_x = \sum FC_{i,x} \times NCV_i \quad \textbf{(9)}$$

Where:
$SEC_{clinker,BL}$ = Specific energy consumption of the project plant in the absence of the project activity (GJ/t clinker)
HG_x = Heat generated from fuel combustion in the project plant in the historical year *x* (GJ)
$FC_{i,x}$ = Quantity of fossil fuel type *i* used in the project plant in year *x* (tonnes)
NCV_i = Net calorific value of the fossil fuel type *i* (GJ/tonne)
$P_{clinker,x}$ = Production of clinker in year *x* (tonnes)
x = Year prior to the start of the project activity

i = Fossil fuel types used in the project plant in the last three years prior to the start of the project activity.

Step 2. Calculate baseline emissions from the fossil fuels displaced by the alternative or less carbon intensive fuel(s)

Baseline emissions from displacement of fossil fuels are calculated as follows:

$$BE_{FF,y} = \left(\sum_k \left(FC_{PJ,k,y} \times NCV_{k,y}\right) - FP_y\right) \times EF_{CO2,BL,y} \qquad \textbf{(10)}$$

Where:

$BE_{FF,y}$ = Baseline emission from fossil fuels displaced by alternative fuels in year *y* (tCO_2)
$FC_{PJ,k,y}$ = Quantity of alternative fuel type *k* used in the project plant in year *y* (tonnes)
$NCV_{k,y}$ = Net calorific value of the alternative type *k* in year y (GJ/tonne)
FP_y = Fuel penalty in year *y* (GJ)
$EF_{CO2,BL,y}$ = Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels in the project plant in year *y* (tCO_2/GJ)
k = Alternative fuel types and less carbon intensive fossil fuel types used in the project plant in year *y*
The baseline emissions factor ($EF_{CO2,BL,y}$) is estimated as the lowest of the following CO_2 emission factors:

A. The weighted average CO_2 emission factor for the fossil fuel(s) consumed during the most recent three years before the start of the project activity, calculated as follows:

$$EF_{BL,CO2,y} = \left(\sum_i \left(FC_{i,x-2} + FC_{i,x-1} + FC_{i,x}\right) \times NCV_i \times EF_{CO2,FF,i}\right) / \sum_i \left(FC_{i,x-2} + FC_{i,x-1} + FC_{i,x}\right) \times NCV_I \qquad \textbf{(11)}$$

Where:

$EF_{CO2,BL,y}$ = Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels in the project plant in year *y* (tCO_2/GJ)
$FC_{i,x}$ = Quantity of fossil fuel type *i* used in the project plant in year *x* (tonnes)
NCV_i = Net calorific value of the fossil fuel type *i* (GJ/tonne)
$EF_{CO2,FF,i}$ = CO_2 emission factor for fossil fuel type *i* (tCO_2/GJ)
x = Year prior to the start of the project activity
i = Fossil fuel types used in the project plant in the last three years prior to the start of the project activity

B. The weighted average annual CO_2 emission factor of the fossil fuel(s) that are not less carbon intensive fossil fuels and that are used in the project plant in year *y*, calculated as follows:

$$EF_{BL,CO2,y} = \left(\sum_i FC_{PJ,i,y} \times NCV_{i,y} \times EF_{CO2,FF,i,y}\right) / \sum_i FC_{PJ,i,y} \times NCV_i \qquad \textbf{(12)}$$

Where:

$EF_{CO2,BL,y}$ = Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels in the project plant in year *y* (tCO_2/GJ)
$FC_{PJ,i,y}$ = Quantity of fossil fuel type *i* fired in the project plant in year *y* (tonnes)
$NCV_{i,y}$ = Net calorific value of the fossil fuel type *i* in year y (GJ/tonne)
$EF_{CO2,FF,i,y}$ = Carbon dioxide emission factor for fossil fuel type *i* in year *y* (tCO_2/GJ)
i = Fossil fuel types used in the project plant in year *y* that are not less carbon intensive fossil fuel types

As F2 is the baseline scenario of the proposed project activity, option C of ACM0003 Version 7.2 is not to be considered.

Step 3. Calculate baseline emissions from decay, dumping or burning of biomass residues

The project aims to utilize all type of available biomass residues, but more specifically rice husk. For this type of biomass, leakage can be ruled out by using either approach L_1 or L_2 proposed in ACM0003 Version 7.2. So the project can claim methane emissions avoidance from decay, dumping or uncontrolled burning of that biomass. The baseline scenarios for the biomass are B1 and B3. Part of the biomass is left to decay on fields in

an aerobic manner. The other part is burnt in an uncontrolled manner. No emissions reductions are claimed for anaerobic decay of the biomass.
So, the baseline emissions from decay, dumping or burning of biomass residues are calculated as follows:

$$BE_{CH4,biomass,y} = BE_{CH4,B1/B3,y} \qquad \textbf{(13)}$$

Where:
$BE_{CH4,biomass,y}$ = Baseline methane emissions avoided during the year *y* from preventing disposal or uncontrolled burning of biomass residues (tCO_2e)
$BE_{CH4,B1/B3,y}$ = Baseline methane emissions avoided during the year *y* from aerobic decay and/or uncontrolled burning of biomass residues (tCO_2e)

Uncontrolled burning or aerobic decay of the biomass residues (cases B1 and B3)
The baseline scenario for the use of the biomass residue, used as alternative fuel in the project plant, is that the biomass residue would be dumped or left to decay under mainly aerobic conditions (B1) or burnt in an uncontrolled manner without utilizing them for energy purposes (B3). So, baseline emissions are calculated assuming, for both scenarios viz., natural decay and uncontrolled burning, that the biomass residues would be burnt in an uncontrolled manner.
Baseline emissions avoided from aerobic decay and/or uncontrolled burning of biomass residues are calculated as follows:

$$BE_{CH4,B1/B3,y} = GWP_{CH4} \cdot \sum_k FC_{PJ,k,y} \cdot NCV_{k,y} \cdot EF_{burning,CH4,k,y} \qquad \textbf{(14)}$$

Where:
$BE_{CH4,B1/B3,y}$ = Baseline methane emissions avoided during the year *y* from aerobic decay and/or uncontrolled burning of biomass residues (tCO_2e)
GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
$FC_{PJ,k,y}$ = Quantity of alternative fuel *k* used in the project plant in year *y* (tonnes)
$NCV_{k,y}$ = Net calorific value of the alternative or less carbon intensive fuel type *k* in year *y* (GJ/tonne)
$EF_{burning,CH4,k,y}$ = CH_4 emission factor for uncontrolled burning of the biomass residue type *k* during the year *y* (tCH_4/GJ).
k = Jatropha, rice husk or other biomass residues used as alternative fuel in the project plant in year *y* for which the identified baseline scenario is B1 or B3 and for which leakage effects could be ruled out with one of the approaches L_1, L_2 or L_3 described in the leakage section of ACM0003 Version 7.2.
To determine the CH_4 emission factor, the project activity use as recommended by ACM0003 Version 7.2, 0.0027 t CH_4 per tonne of biomass as default value for the product of $NCV_{k,y}$ and $EF_{burning,CH4,k,y}$, with an conservative assumption that the estimated uncertainty range is higher than 100%. Thus, this value will be multiplied by the conservativeness factor of 0.73 leading to an emission factor of 0.001971 tCH4/T biomass.

Leakage
No leakage is to be considered for the proposed project activity. Two type of biomass are used by the proposed project activity: Jatropha fruits that come from a dedicated plantation and agricultural residues, mainly rice husk. The use of the biomass residues will not result in increased fossil fuel consumption elsewhere. The monitoring plan will assess the supply situation for all the types of biomass residues that will be used in the project plant. The following pictures shows stockpiled rice husk at the sites where the project activity is supplied from with this biomass residue and the biomass burnt in fields without energy generation.


Rice husk stock


Rice husk stock burning

This demonstrates that the biomass residues have not been collected or utilized but have been dumped and left to decay or burnt in an uncontrolled manner, prior to the implementation of the project activity. In the specific sites that supply the project activity, it is expected that this practice will continue in the absence of the CDM project activity. The monitoring plan will verify whether no market has emerged for each of the biomass residues k considered in the site. The biomass supply and demand will be monitored if new markets have emerged and leakage will be ignored only if there is an abundant surplus of biomass (supply 25% higher than demand). Otherwise, a leakage penalty is applied to this type of biomass residues k, for which we cannot demonstrate that its use by the project does not result in leakage. The leakage penalty aims at adjusting emission reductions for leakage effects in a conservative manner, assuming that this quantity of biomass residue is substituted by the most carbon intensive fuel in the country.

If for a certain type of biomass residue *k* used in the project activity, leakage effects cannot be ruled out as described above, leakage effects for the year *y* shall be calculated as follows:

$$LE_{BR,y} = EF_{CO2,LE} * \sum_k FC_{PJ,k,y} * NCV_{k,y} \quad \textbf{(15)}$$

Where:

$LE_{BR,y}$ = Leakage emissions during the year *y* (tCO_2/yr)

$EF_{CO2,LE}$ = CO_2 emission factor of the most carbon intensive fuel used in the country (tCO_2/GJ)

$FC_{PJ,k,y}$ = Quantity of biomass residue type *k* used in the project plant in year *y* (tonnes)

$NCV_{k,y}$ = Net calorific value of the biomass residue type *k* in year y (GJ/tonne of dry matter)

k = Types of biomass residues for which leakage effects could not be ruled out as described above.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$FC_{c,x}$, $FC_{c,x-1}$ and $FC_{c,x-2}$
Data unit:	tonnes
Description:	Quantity of coal used in the project plant in year *x*, *x-1* and *x-2* where *x* is the year prior to the start of the project activity and *c* indicate the coal used in the project plant in the last three years prior to the start of the project activity
Source of data used:	Three years data from coal consumption data logs at the project site
Value applied:	179,219; 167,393 and 151,855
Justification of the choice of data or description of measurement methods	Bridge weight measurement will be used. The consistency of metered coal consumption quantities should be crosschecked by an annual mass balance that is based on purchased quantities and stock changes. Where the purchased coal invoices can be identified specifically for the CDM

and procedures actually applied :	project, the metered coal consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Any comment:	

Data / Parameter:	$FC_{hf,,x}$, $FC_{hf,x-1}$ and $FC_{hf,,x-2}$
Data unit:	tonnes
Description:	Quantity of heavy fuel used in the project plant in year *x*, *x-1* and *x-2* where *x* is the year prior to the start of the project activity and *hf* indicate the heavy fuel used in the project plant in the last three years prior to the start of the project activity
Source of data used:	Three years data from heavy fuel consumption data logs at the project site
Value applied:	3,710; 2,421;3494.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	Cumulative mass flow meter will be used. The consistency of metered heavy fuel consumption quantities should be crosschecked by an annual mass balance that is based on purchased quantities and stock changes. Where the purchased heavy fuel invoices can be identified specifically for the CDM project, the metered heavy fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Any comment:	

Data / Parameter:	$P_{clinker,x}$, $P_{clinker,x-1}$ and $P_{clinker,x-2}$
Data unit:	tonnes
Description:	Production of clinker in year *x*, *x-1* and *x-2* where *x* is the year prior to the start of the project activity
Source of data used:	Three years data from production data logs at the project site
Value applied:	1,127,647; 1,066,330;1,037,623
Justification of the choice of data or description of measurement methods and procedures actually applied :	Use of appropriate mass meters
Any comment:	

Data / Parameter:	NCV_c
Data unit:	GJ/tonne of coal
Description:	Net calorific value of the coal used in the project plant in the last three years prior to the start of the project activity
Source of data used:	Values provided by the coal supplier in invoices and/or measurements by the project participants
Value applied:	25.1208
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measurements have been undertaken in line with international fuel standards.
Any comment:	

Data / Parameter:	NCV_{hf}
Data unit:	GJ/tonne of heavy fuel
Description:	Net calorific value of the heavy fuel used in the project plant in the last three years prior to the start of the project activity
Source of data used:	Values provided by the heavy fuel supplier in invoices and/or measurements by the project participants
Value applied:	40.1933
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measurements have been undertaken in line with international fuel standards.
Any comment:	

Data / Parameter:	$EF_{CO2,FF,c}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor for the coal used in the project plant in the last three years prior to the start of the project activity
Source of data used:	Values provided by the coal supplier in invoices and/or measurements by the project participants
Value applied:	0.0946
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$EF_{CO2,FF,hf}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor for heavy fuel used in the project plant in the last three years prior to the start of the project activity
Source of data used:	Values provided by the heavy fuel supplier in invoices and/or measurements by the project participants
Value applied:	0.0774
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Project emissions

Project emissions include project emissions from the use of Jatropha fruits or other biomass residues defined as alternative fuels ($PE_{k,y}$), project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity ($PE_{EC,y}$ and $PE_{FC,y}$), project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant ($PE_{T,y}$), and, project emissions from the cultivation of renewable biomass at the dedicated plantation ($PE_{BC,y}$):

$$PE_{y} = PE_{k,y} + PE_{FC,y} + PE_{EC,y} + PE_{T,y} + PE_{BC,y} \quad \textbf{(1)}$$

Where:
PE_y = Project emissions during the year *y* (tCO_2e)
$PE_{k,y}$ = Project emissions from combustion of alternative fuels in the project plant in year *y* (tCO_2)
$PE_{FC,y}$ = Project emissions from additional fossil fuel combustion as a result of the project activity in year *y* (tCO_2)
$PE_{EC,y}$ = Project emissions from additional electricity consumption as a result of the project activity in year *y* (tCO_2)
$PE_{T,y}$ = CO_2 emissions during the year *y* due to transport of alternative fuels to the project plant (tCO_2)
$PE_{BC,y}$ = Project emissions from the cultivation of renewable biomass at the dedicated plantation in year *y* (tCO_2e)
Project emissions are calculated in the following steps:
Step 1. Calculate project emissions from the use of alternative fuels
Step 2. Calculate project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity
Step 3. Calculate project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant
Step 4. Calculate project emissions from the cultivation of renewable biomass at the dedicated plantation

Step 1: Calculate project emissions from the use of alternative fuels
Project emissions from the use of alternative fuels in the project plant are calculated as follows:

$$PE_{k,y} = \sum_{k} FC_{PJ,k,y} \times NCV_{k,y} \times EF_{CO2,k,y} \quad \textbf{(2)}$$

Where:
$PE_{k,y}$ = Project emissions from combustion of alternative fuels in the project plant in year *y* (tCO_2)
$FC_{PJ,k,y}$ = Quantity of alternative fuel type *k* used in the project plant in year *y* (tonnes)
$EF_{CO2,k,y}$ = Carbon dioxide emissions factor for alternative or less carbon intensive fossil fuels type *k* in year *y* (tCO_2/GJ)
$NCV_{k,y}$ = Net calorific value of the alternative or less carbon intensive fossil fuel type *k* in year *y* (GJ/tonne)
k = Alternative fuel types used in the project plant in year *y*
$FC_{PJ,k,y} = 0$
$PE_{k,y} = 0$
No alternative fossil fuel is planned to be used by the project activity. However, to account for all the possible cases, this scenario has been considered in the monitoring plan.

Step 2: Calculate project emissions from additional electricity and/or fossil fuel consumption as a result of the project activity

The use of alternative fuels results in additional fossil fuels consumption due to the on-site transportation of the fuels.

CO_2 emissions from on-site combustion of fossil fuels ($PE_{FC,y}$) is calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

For each fossil emission source *j*, the fuel consumption of each fuel type *i* ($FC_{i,j,y}$) is monitored, consistent with the guidance in the tool.

CO_2 emissions from on-site electricity consumption ($PE_{EC,y}$) is calculated using the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

Electricity consumption from each relevant source is monitored and summed up to $EC_{PJ,y}$.

In principle, no increase of fossil fuel consumption due to the project activity is foreseen. However, to account for all the possible future scenarios in the monitoring plan, a provision for an increase of 5% of the current heavy oil consumption has been considered.

The average heavy fuel consumption during the three last years before the project activity is:

Year	HFO consumption in tonnes
2005	3494.4
2006	2421
2007	3710

Average Heavy fuel oil consumption = (3494.4+2421+3710)/3
= 3208 tonnes

The project emissions due to this additional fuel consumption are:

$PE_{FC,y}$ = FC hf,y * NCV_{hf} * $EF_{CO2,FF,hf}$
= 0.05*3208*40.1933*0.0774
= 499 tonnes CO_2 per year

For the additional electricity consumption, it will be mainly related to the biomass transportation. **This additional electricity consumption is much less than the electricity consumption avoided due to reduction of coal consumption and that is related to the coal preparation. However, to be conservative, it is accounted for.**

We assume that a 50 kW power motor operating 7200 hours per year will be needed for the biomass preparation.

The electricity will be provided by the captive power plant in the cement plant. The emission factor of the Captive Power Plant (CPP) is calculated based on the specific fuel consumption and the emission coefficient of the fuel.

The average specific fuel consumption of the CPP (Wärtsilä group, Mirless tranche 1 and Mirless tranche 2) for the last three years is SFC cpp = 0.2204 tonnes of fuel per MWh.

The project emissions due to the additional electricity consumption are:

$EC_{PJ,y}$ = 50*7200/1000* SFC cpp* NCV_{hf} * $EF_{CO2,FF,hf}$
=50*7200/1000*0.2204*40.1933*0.0774
= 247 tonnes CO_2 per year

Step 3: Project emissions from combustion of fossil fuels for transportation of alternative fuels to the project plant

40% of the heat needed to the kiln will be produced using Jatropha fruit as alternative fuel.
The transportation is undertaken by vehicles. As the project may use the services of other good transporters, an approach based on distance and vehicle type (option 1 of ACM0003) is more suitable. Emissions are calculated on the basis of distance and the number of trips (or the average truck load):

$$PE_{T,y} = N_y \cdot AVD_y \cdot EF_{km,CO2,y} \qquad \textbf{(3)}$$

Where:
$PE_{T,y}$ = CO_2 emissions during the year *y* due to transport of alternative fuels to the project plant (tCO_2/yr)
N_y = Number of truck trips during the year *y*
AVD_y = Average round trip distance (from and to) between the alternative fuel supply sites and the site of the project plant during the year *y* (km)
$EF_{km,CO2,y}$ = Average CO_2 emission factor for the trucks measured during the year *y* (tCO_2/km)

The number of truck trips is calculated based on the total mass of Jatropha fruit to be transported during year y $FC_{j,y}$ and on an average truck load TL_y:
$Ny = FC_{j,y} / TL_y$
The mass of Jatropha fruit to be transported during year y is considered to be equal to the mass needed to substitute 40% of the heat energy currently provided by the coal to the kilns:

The heat provided to the kiln during year y is calculated based on the average specific energy consumption SEC_{3x} of the last three years before the project activity in Gj per tonne of clinker, the planned clinker production for year y in tonnes and the net calorific value of the coal and the heavy fuel:

Clinker production during the 3 last years before the project activity:
$P_{clinker,3x}$ = 1037623+1066330+1127647
= 3231600 tonnes
Coal consumption during the 3 last years before the project activity:
$FC_{c,3x}$ = 149559+154002+160326
= 463887 tonnes
Heavy fuel consumption during the 3 last years before the project activity:
$FC_{hf,3x}$ = 3494.4+2421+3710
= 9625.4 tonnes
The average specific energy consumption at the kiln during the 3 last years before the project activity is:
$SEC_{3x} = (FC_{c,3x} * NCV_c + FC_{hf,3x} * NCV_{hf}) / P_{clinker,3x}$
= (463887*25.1208 +9625.4*40.1933)/ 3231600
= 3.726 GJ/tonnes clinker
The average specific coal consumption at the kiln during the 3 last years before the project activity is:
$SCC_{3x} = FC_{c,3x} / P_{clinker,3x}$
= 463887/ 3231600
= 0.1435 tonnes coal/tonne clinker

The experiences conducted on the use of solid biomass in the kiln have demonstrated that there is a decrease of the kiln performance of 5% if solid biomass is used instead of coal. The heat to be provided to the kiln by the Jatropha fruit for year y is:
$Heat_{j,y} = SCC_{3x} * P_y * NCV_c * 40\% * 1.05$
= 0.1435*1,234,000*25.1208*40%*1.05
= 1,868,928 GJ

The quantity of Jatropha that will be consumed at the kiln is:

$FC_{j,y} = Heat_{j,y} / NCV_j$

$= 1,868,928/20.934$

$= 89,277$ tonnes

For a truck load of 15 tonnes for the Jatropha fruits, the number of trips to deliver the Jatropha to the project site will be:

$N_{y,j} = FC_{j,y} / TL_y$

$= 89277/15$

$= 5952$

For a truck load of 5 tonnes for the rice husk, the number of trips to deliver the rice husk to the project site will be:

$N_{y,j} = FC_{j,y} / TL_y$

$= 7000/10$

$= 700$

The average distance considered for a return trip is 300 km. The Jatropha will be cultivated in dedicated plantations at a maximum distance of 250 km from the project site.

The diesel specific consumption of the truck is 38 l per 100 km. From IPCC data, the following parameters can be obtained:

Diesel oil density: 0.985

Diesel oil emission coefficient: 20.2 tC/TJ

Diesel oil NCV: 43.33 GJ/tonne

$EF_{km,CO2,y} = 20.2/1000*43.33*44/12*38*0.985/100$

$= 0.00120$ t CO_2 /km

$PE_{T,y} = N_y \cdot AVD_y \cdot EF_{km,CO2,y}$

$= (5952+700)*300*0.0012$

$= 2397$ tonnes CO_2

Step 4: Calculate project emissions from the cultivation of Jatropha at the dedicated plantation

As the jathropha is cultivated from a dedicated plantation, project emissions from the cultivation of this renewable biomass ($PE_{BC,y}$) shall be calculated as:

$$PE_{BC,y} = PE_{FC,PL,y} + PE_{FP,y} + PE_{FA,y} + PE_{BB,y} + PE_{IR,y} \quad \textbf{(4)}$$

Where:

$PE_{BC,y}$ = Project emissions from the cultivation of this renewable biomass at the dedicated plantation in year *y* (tCO_2e)

$PE_{FC,PL,y}$ = Project emissions related to diesel consumption at the plantation during agricultural operations in year *y* (tCO_2/yr). This emission source should be calculated using the latest approved version of the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”

$PE_{FP,y}$ = Project emissions related to the production of synthetic fertilizer that is used at the dedicated plantation in year *y* (tCO_2e/yr).

$PE_{FA,y}$ = Project emissions related to the application of fertilizers at the plantation in year *y* (tCO_2e/yr).

$PE_{BB,y}$ = Project emissions arising from field burning of biomass at the plantation site (tCO_2e/yr).

$PE_{IR,y}$ = Project emissions from irrigation of the plantation.

A specific diesel consumption of 0.00723 tonnes of diesel per tonne of Jatropha is considered for the project emissions related to fossil fuel consumption at the plantation during agricultural operations. This consumption is mainly related to the soil preparation at the beginning of the operation and to irrigation the first 6 months of the plantation.

$PE_{FC,PL,y} = SEC_{FC,PL,y} * FC_{j,y} * NCV_d * CEF_d$
$= 0.00723*89,277*43.33*20.2/1000*44/12$
$= 2072$ tonnes CO_2

No synthetic fertilizer is foreseen to be used : $PE_{FP,y} = 0$

The project emissions related to the application of fertilizers at the plantation in year *y*

$PE_{FA,y} = PE_{N2O\text{-}N,dir,y} + PE_{N2O\text{-}N,ind,ATD,y} + PE_{N2O\text{-}N,ind,L,y}$
$= (F_{SN,y} * EF_{N_2O\text{-}N,dir} + F_{SN,y} * EF_{N2O\text{-}N,ATD} * Frac_{GASF} + F_{SN,y} * EF_{N2O\text{-}N,L} * Frac_{LEACH}) * GWP_{N_2O}$
$= (1674*0.01 + 1674*0.01*0.1+1674*0.0075*0.3)*310$
$= 6876$ tonnes CO_2

There is no field burning of biomass at the plantation site: PEBB,y = 0

$PE_{IR,y}$ = Project emissions from irrigation of the plantation is accounted for in $PE_{FC,PL,y}$

$PE_{BC,y} = PE_{FC,PL,y} + PE_{FP,y} + PE_{FA,y} + PE_{BB,y} + PE_{IR,y}$
$= 2072 + 6876$
$= 8947$ tonnes CO_2

The total project emission is:

$PE_y = PE_{k,y} + PE_{FC,y} + PE_{EC,y} + PE_{T,y} + PE_{BC,y}$
$= 0 + 499 + 247 + 2397 + 8947$
$= 12090$ tonnes CO_2

Baseline emissions

Baseline emissions are calculated as follows:

$BE_y = BE_{FF,y} + BE_{CH4,biomass,y}$ **(5)**

Where:
BE_y = Baseline emissions in year *y* (tCO_2)
$BE_{FF,y}$ = Baseline emission from the coal displaced by alternative fuels in year *y* (tCO_2)
$BE_{CH4,biomass,y}$ = Baseline methane emissions avoided during the year *y* from preventing disposal or uncontrolled burning of biomass residues (tCO_2e)
Baseline emissions are determined in the following steps:
Step 1. Estimate the project specific "fuel penalty"
Step 2. Calculate baseline emissions from the coal displaced by the alternative fuel(s)
Step 3. Calculate baseline emissions from decay, dumping or burning of biomass residues

Step 1. Estimate the project specific "fuel penalty"

A project specific fuel "penalty" is applied because the combustion of typically coarser biomass or other alternative fuels will reduce the heat transfer efficiency in the cement manufacturing process. The use of alternative fuels will therefore require a greater heat input to produce the same quantity and quality of cement clinker. The chemical content and ease of absorption into cement clinker of all fuel ashes also differs, and this also contributes to the need for a project specific "fuel penalty".
This project specific fuel penalty (FP_y) should be determined as follows:

$$FP_y = P_{clinker,y} \times (SEC_{clinker,PJ,y} - SEC_{clinker,BL}) \qquad \textbf{(6)}$$

Where:
FP_y = Fuel penalty in year *y* (GJ)
$P_{clinker,y}$ = Production of clinker in year *y* (tonnes)
$SEC_{clinker,PJ,y}$ = Specific energy consumption of the project plant in year *y* (GJ/t clinker)
$SEC_{clinker,BL}$ = Specific energy consumption of the project plant in the absence of the project activity (GJ/t clinker)

$$SEC_{clinker,PJ,y} = \left(\sum_i \left(FC_{PJ,i,y} \times NCV_{i,y}\right) + \sum_k \left(FC_{PJ,k,y} \times NCV_{k,y}\right)\right) / P_{clinker,y} \qquad \textbf{(7)}$$

Where:
$SEC_{clinker,PJ,y}$ = Specific energy consumption of the project plant in year *y* (GJ/t clinker)
$FC_{PJ,i,y}$ = Quantity of fossil fuel type *i* fired in the project plant in year *y* (tonnes) (the fuel can be coal or diesel)
$NCV_{i,y}$ = Net calorific value of the fossil fuel type *i* in year y (GJ/tonne)
$FC_{PJ,k,y}$ = Quantity of alternative fuel type *k* used in the project plant in year *y* (tonnes)
$NCV_{k,y}$ = Net calorific value of the alternative fuel type *k* in year y (GJ/tonne)
$P_{clinker,y}$ = Production of clinker in year *y* (tonnes)
k = Jatropha or biomass residues used in the project plant in year *y*
i = Baseline fossil fuel types that are still used in the project plant in year *y*

A decrease of the energy performance of the kiln in relation with the use of biofuels (Jatropha fruits and rice husk) estimated to be 5% has been considered.

SEC clinker,PJ,y = (102782*25.1208 + 3208.3*40.1933 + 89277*20.934*(1+0.05) + 7000*12.56*(1+0.05))/1234000
= 3.7862 GJ/tonne clinker

$$SEC_{clinker,BL} = MIN\,(HG_x / P_{clinker,x};\ HG_{x-1} / P_{clinker,x-1};\ HG_{x-2} / P_{clinker,x-2}) \qquad \textbf{(8)}$$

With

$$HG_x = \sum FC_{i,x} \times NCV_i \qquad \textbf{(9)}$$

Where:
$SEC_{clinker,BL}$ = Specific energy consumption of the project plant in the absence of the project activity (GJ/t clinker)
HG_x = Heat generated from fuel combustion in the project plant in the historical year *x* (GJ)
$FC_{i,x}$ = Quantity of fossil fuel type *i* used in the project plant in year *x* (tonnes)
NCV_i = Net calorific value of the fossil fuel type *i* (GJ/tonne)
$P_{clinker,x}$ = Production of clinker in year *x* (tonnes)
x = Year prior to the start of the project activity
i = Fossil fuel types used in the project plant in the last three years prior to the start of the project activity.

$HG_{x-2} / P_{clinker,x-2}$ = (149559*25.1208 + 3494.4*40.1933)/1037623
= 3.7562 GJ/tonne clinker
$HG_{x-1} / P_{clinker,x-1}$ = (154002*25.1208 + 2421*40.1933)/1066330
= 3.7192 GJ/tonne clinker
$HG_x / P_{clinker,x}$ = (160326*25.1208 + 3710*40.1933)/1077200
= 3.7038 GJ/tonne clinker

$SEC_{clinker,BL} = MIN\,(HG_x / P_{clinker,x};\ HG_{x-1} / P_{clinker,x-1};\ HG_{x-2} / P_{clinker,x-2})$
= 3.7038 GJ/tonne clinker

Fuel penalty in year y (GJ) FP_y is calculated as:

$FP_y = P_{clinker,y} \times (SEC_{clinker,PJ,y} - SEC_{clinker,BL})$
$= 1{,}234{,}000 \times (3.7862-3.7038)$
$= 101623$ GJ

Step 2. Calculate baseline emissions from the fossil fuels displaced by the alternative or less carbon intensive fuel(s)

Baseline emissions from displacement of fossil fuels are calculated as follows:

$$BE_{FF,y} = \left(\sum_k \left(FC_{PJ,k,y} \times NCV_{k,y}\right) - FP_y\right) \times EF_{CO2,BL,y} \qquad \textbf{(10)}$$

Where:
$BE_{FF,y}$ = Baseline emission from fossil fuels displaced by alternative fuels in year y (tCO_2)
$FC_{PJ,k,y}$ = Quantity of alternative fuel type k used in the project plant in year y (tonnes)
$NCV_{k,y}$ = Net calorific value of the alternative fuel type k in year y (GJ/tonne)
FP_y = Fuel penalty in year y (GJ)
$EF_{CO2,BL,y}$ = Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels in the project plant in year y (tCO_2/GJ)
k = Alternative fuel types and less carbon intensive fossil fuel types used in the project plant in year y
The baseline emissions factor ($EF_{CO2,BL,y}$) is estimated as the lowest of the following CO_2 emission factors

A. The weighted average CO_2 emission factor for the fossil fuel(s) consumed during the most recent three years before the start of the project activity, calculated as follows:

$$EF_{BL,CO2,y} = \left(\sum_i \left(FC_{i,x-2} + FC_{i,x-1} + FC_{i,x}\right) \times NCV_i \times EF_{CO2,FF,i}\right) / \sum_i \left(FC_{i,x-2} + FC_{i,x-1} + FC_{i,x}\right) \times NCV_I \qquad \textbf{(11)}$$

Where:
$EF_{CO2,BL,y}$ = Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels in the project plant in year y (tCO_2/GJ)
$FC_{i,x}$ = Quantity of fossil fuel type i used in the project plant in year x (tonnes)
NCV_i = Net calorific value of the fossil fuel type i (GJ/tonne)
$EF_{CO2,FF,i}$ = CO_2 emission factor for fossil fuel type i (tCO_2/GJ)
x = Year prior to the start of the project activity
i = Fossil fuel types used in the project plant in the last three years prior to the start of the project activity that is coal and heavy fuel as start up fuel.

$$EF_{BL,CO2,y} = ((149559+154002+160326)*25.1218*0.0946 + (3494.4+2421+3710)*40.1933*0.0774) / ((149559+154002+160326)*25.1218 + (3494.4+2421+3710)*40.1933)$$
$$= 0.0940 \ tCO_2 \text{ per GJ}$$

B. The weighted average annual CO_2 emission factor of the fossil fuel(s) that are not less carbon intensive fossil fuels and that are used in the project plant in year y, calculated as follows:

$$EF_{BL,CO2,y} = \left(\sum_i FC_{PJ,i,y} \times NCV_{i,y} \times EF_{CO2,FF,i,y}\right) / \sum_i FC_{PJ,i,y} \times NCV_i \qquad \textbf{(12)}$$

Where:
$EF_{CO2,BL,y}$ = Carbon dioxide emissions factor for the fossil fuels displaced by the use of alternative fuels in the project plant in year y (tCO_2/GJ)
$FC_{PJ,i,y}$ = Quantity of fossil fuel type i fired in the project plant in year y (tonnes)
$NCV_{i,y}$ = Net calorific value of the fossil fuel type i in year y (GJ/tonne)
$EF_{CO2,FF,i,y}$ = Carbon dioxide emission factor for fossil fuel type i in year y (tCO_2/GJ)

i = Fossil fuel types used in the project plant in year *y* that are not less carbon intensive fossil fuel types that is coal and heavy fuel as start up fuel.

$EF_{BL,CO2,y}$ = (102782*25.1218*0.0946 + 3208.3*40.1933*0.0774)/ (102782*25.1218 + 3208.3*40.1933)
= 0.0938 tCO_2 per GJ

$$BE_{FF,y} = \left(\sum_k \left(FC_{PJ,k,y} \times NCV_{k,y}\right) - FP_y\right) \times EF_{CO2,BL,y} \qquad \textbf{(13)}$$

= (89277*20.934+7000*12.5604- 101623)* 0.0938
= 174396 tCO_2

Baseline emissions avoided from aerobic decay and/or uncontrolled burning of biomass residues are calculated as follows:

$$BE_{CH4,B1/B3,y} = GWP_{CH4} \times \sum_k FC_{PJ,k,y} \times NCV_{k,y} \times EF_{burning,CH4,k,y} \qquad \textbf{(14)}$$

Where:
$BE_{CH4,B1/B3,y}$ = Baseline methane emissions avoided during the year *y* from aerobic decay and/or uncontrolled burning of biomass residues (tCO_2e)
GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
$FC_{PJ,k,y}$ = Quantity of alternative fuel *k* used in the project plant in year *y* (tonnes)
$NCV_{k,y}$ = Net calorific value of the alternative or less carbon intensive fuel type *k* in year *y* (GJ/tonne)
$EF_{burning,CH4,k,y}$ = CH_4 emission factor for uncontrolled burning of the biomass residue type *k* during the year *y* (tCH_4/GJ).
k = Jatropha, rice husk or other biomass residues used as alternative fuel in the project plant in year *y* for which the identified baseline scenario is B1 or B3 and for which leakage effects could be ruled out with one of the approaches L_1, L_2 or L_3 described in the leakage section of ACM0003 Version 7.2.
To determine the CH_4 emission factor, the project activity uses as recommended by ACM0003 Version 7.2, 0.0027 t CH_4 per tonne of biomass as default value for the product of $NCV_{k,y}$ and $EF_{burning,CH4,k,y}$, with a conservative assumption that the estimated uncertainty range is higher than 100%. Thus, this value will be multiplied by the conservativeness factor of 0.73 leading to an emission factor of 0.001971 tCH4/T biomass.
Among the alternative fuel to be used, only the rice husk utilized by the project activity has been ex-ante foreseen as biomass residue that would have been burnt in an uncontrolled manner in the absence of this proposed project activity. 7000 tonnes of rice husk are foreseen to be used per year.

$$BE_{CH4,B1/B3,y} = GWP_{CH4} \cdot \sum_k FC_{PJ,k,y} \cdot NCV_{k,y} \cdot EF_{burning,CH4,k,y}$$

= 23* 7000*0.00197
= 317 t CO_2 per tonne of rice husk

This emission has been neglected to be conservative.

No leakage effect is foreseen for this proposed project activity.
There is no upstream emission

$$LE_{BR,y} = EF_{CO2,LE} * \sum_k FC_{PJ,k,y} * NCV_{k,y}$$

= 0

The emission reduction ER y of the project is calculated as:
ER y = $BE_y - PE_y - LE_y$
= 174396 – 12090 -0

= 153648 tonnes CO_2

B.6.4 Summary of the ex-ante estimation of emission reductions:

The ex ante estimation of the emission reductions is summarized at the following table:

Year	**Estimation of project activity emissions (tonnes of CO_2 e)**	**Estimation of baseline emissions (tonnes of CO_2 e)**	**Estimation of leakage emissions (tonnes of CO_2 e)**	**Estimation of overall emission reduction (tonnes of CO_2 e)**
2009	302	8,198	0	7,896
2010	602	12,440	0	11,838
2011	2,632	41,152	0	38,515
2012	6,990	102,680	0	95,690
2013	10,721	155,188	0	144,467
2014	12,090	174,396	0	162,306
2015	12,090	174,396	0	162,306
Total (tonnes of CO2 e)	45,427	668,450	0	623,018
Average (tonnes of CO2 e)	6,489	95,492	0	89,002

B.7 Application of the monitoring methodology and description of the monitoring plan:

The proposed monitoring plan is based on two tools developed by the French cement industry, and used locally by the cement plant of Rufisque:
1. The CITEPA (Centre Interprofessionnel Technique de l'Etude de la Pollution Atmosphérique – a French atmospheric pollution technical center) procedure developed in accordance with the methodological guide of the French Ministry of Environment (Guide méthodologique du MEDD, section "Industrie cimentière", ayant pour objet : « Calcul des émissions de CO2 des installations destinées à la production de ciment et de clinker ») ;
2. The ATILH (Association Technique de l'Industrie des Liants Hydrauliques – The French cement technical association) position note which describes the method for greenhouse gas emission quantification in cement plants.
The two tools above are currently used by cement plants located in Kyoto protocol Annex 1countries for greenhouse gas emissions monitoring.

B.7.1 Data and parameters monitored:

(Copy this table for each data and parameter)

Data / Parameter:	$FC_{j,y}$
Data unit:	Tonnes
Description:	Quantity of Jatropha used in the project plant during year *y*
Source of data to be used:	Measurements in the manufacturing plant
Value of data applied for the purpose of calculating expected emission reductions in section B.5	89277
Description of measurement methods and procedures to be applied:	A weighing bridge will be used. The consistency of metered Jatropha consumption quantities will be crosschecked by an annual mass balance that is based on quantities provided to the cement plant and stock changes. The purchased Jatropha invoices from the financial records will be used to cross-check the metered Jatropha consumption quantities. Continuously measured, aggregated at least annually.
QA/QC procedures to be applied:	Instrument should be calibrated regularly according to manufacturer's guidelines.
Any comment:	

Data / Parameter:	$FC_{rh,y}$
Data unit:	Tonnes
Description:	Quantity of rice husk used in the project plant during year *y*
Source of data to be used:	Measurements in the manufacturing plant
Value of data applied for the purpose of	7000

calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	A weighing bridge will be used. The consistency of metered rice husk consumption quantities will be crosschecked by an annual mass balance that is based on quantities provided to the cement plant and stock changes. The purchased rice husk invoices from the financial records will be used to cross-check the metered rice husk consumption quantities. Continuously measured, aggregated at least annually.
QA/QC procedures to be applied:	Instrument should be calibrated regularly according to manufacturer's guidelines.
Any comment:	

Data / Parameter:	$FC_{c,y}$
Data unit:	Tonnes
Description:	Quantity of coal used in the project plant during year *y*
Source of data to be used:	Measurements in the manufacturing plant
Value of data applied for the purpose of calculating expected emission reductions in section B.5	102782
Description of measurement methods and procedures to be applied:	A weighing bridge will be used. The consistency of metered coal consumption quantities will be crosschecked by an annual mass balance that is based on quantities provided to the cement plant and stock changes. The purchased coal invoices from the financial records will be used to cross-check the metered coal consumption quantities.
QA/QC procedures to be applied:	Instrument should be calibrated regularly according to manufacturer's guidelines.
Any comment:	

Data / Parameter:	$FC_{hf,y}$
Data unit:	Tonnes
Description:	Quantity of heavy fuel used in the project plant during year *y*
Source of data to be used:	Measurements in the manufacturing plant
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3208.3
Description of measurement methods and procedures to be	A flow meter totalizer will be utilized. The consistency of metered heavy fuel consumption quantities will be crosschecked by an annual mass balance that is based on quantities provided to the cement plant

applied:	and stock changes. The purchased heavy fuel invoices from the financial records will be used to cross-check the metered heavy fuel consumption quantities.
QA/QC procedures to be applied:	Instrument should be calibrated regularly according to manufacturer's guidelines.
Any comment:	

Data / Parameter:	$EF_{CO2,c,y}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor for coal during year *y*
Source of data to be used:	Measurements by SOCOCIM INDUSTRIES or use of the IPCC default values at the upper/lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0946
Description of measurement methods and procedures to be applied:	In case during year y SOCOCIM INDUSTRIES can undertake the measurement locally in line with international fuel standards, the measurement will be the option otherwise the IPCC guidelines will be used.
QA/QC procedures to be applied:	According to ISO 9000 or similar quality systems Data Archived: Entire Crediting Period + 2 years
Any comment:	If measurements are made, the CO_2 emission factor will be determined for each fuel delivery, from which weighted average annual values should be calculated if measurement. If the IPCCC values are used then any future revision of the IPCC Guidelines will be taken into account.

Data / Parameter:	$EF_{CO2,hf,y}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor for heavy fuel during year *y*
Source of data to be used:	Measurements by the project participants or use of the IPCC default values at the upper/lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0774
Description of measurement methods and procedures to be applied:	In case during year y SOCOCIM INDUSTRIES can undertake the measurement locally in line with international fuel standards, the measurement will be the option otherwise the IPCC guidelines will be used.
QA/QC procedures to	According to ISO 9000 or similar quality systems

be applied:	Data Archived: Entire Crediting Period + 2 years
Any comment:	If measurements are made, the CO_2 emission factor will be determined for each fuel delivery, from which weighted average annual values should be calculated if measurement. If the IPCCC values are used then any future revision of the IPCC Guidelines will be taken into account.

Data / Parameter:	$NCV_{c,y}$
Data unit:	GJ/tonne
Description:	Weighted average net calorific value of the coal during year y.
Source of data to be used:	Values provided by the fuel supplier in invoices
Value of data applied for the purpose of calculating expected emission reductions in section B.5	25.1208
Description of measurement methods and procedures to be applied:	Measurements are undertaken in line with international fuel standards.
QA/QC procedures to be applied:	According to ISO 9000 or similar quality systems Data Archived: Entire Crediting Period + 2 years
Any comment:	The NCV will be obtained for each coal delivery, from which weighted average annual values should be calculated

Data / Parameter:	$NCV_{hv,y}$
Data unit:	GJ/tonne
Description:	Weighted average net calorific value of the heavy fuel during year y.
Source of data to be used:	Values provided by the fuel supplier in invoices
Value of data applied for the purpose of calculating expected emission reductions in section B.5	40.1933
Description of measurement methods and procedures to be applied:	Measurements are undertaken in line with international fuel standards.
QA/QC procedures to be applied:	According to ISO 9000 or similar quality systems Data Archived: Entire Crediting Period + 2 years
Any comment:	The NCV will be obtained for each heavy fuel delivery, from which weighted average annual values should be calculated

Data / Parameter:	$NCV_{j,y}$
Data unit:	GJ/tonne
Description:	Weighted average net calorific value of the Jatropha during year y.

Source of data to be used:	Measurements by the SOCOCIM INDUSTRIES
Value of data applied for the purpose of calculating expected emission reductions in section B.5	20.934
Description of measurement methods and procedures to be applied:	Measurements are undertaken in line with international fuel standards.
QA/QC procedures to be applied:	According to ISO 9000 or similar quality systems Data Archived: Entire Crediting Period + 2 years
Any comment:	The NCV will be measured by SOCOCIM INDUSTRIES for each Jatropha delivery, from which weighted average annual values should be calculated

Data / Parameter:	$NCV_{rh,y}$
Data unit:	GJ/tonne
Description:	Weighted average net calorific value of the rice husk during year y.
Source of data to be used:	Measurements by SOCOCIM INDUSTRIES
Value of data applied for the purpose of calculating expected emission reductions in section B.5	12.5604
Description of measurement methods and procedures to be applied:	Measurements are undertaken in line with international fuel standards.
QA/QC procedures to be applied:	According to ISO 9000 or similar quality systems Data Archived: Entire Crediting Period + 2 years
Any comment:	The NCV will be measured by SOCOCIM INDUSTRIES for each rice husk delivery, from which weighted average annual values should be calculated

Data / Parameter:	$P_{clinker,y}$
Data unit:	tonne
Description:	Clinker production during year y.
Source of data to be used:	Manufacturing plant
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1234000
Description of	Instrument used: Weighing feeders

measurement methods and procedures to be applied:	Data Archived: 2 years after the end of crediting period Monitoring frequency: Recorded daily and reported monthly.
QA/QC procedures to be applied:	Instrument should be calibrated regularly according to manufacturer's guidelines.
Any comment:	For the purpose of cross-checking, clinker production is calculated based on the raw meal consumption and raw meal to clinker conversion factor. SOCOCIM INDUSTRIES has in house procedure for periodic verification of the factor and calibration of the weighing feeders.

Data / Parameter:	$FC_{hf,CPP,y}$
Data unit:	Tonnes
Description:	Quantity of heavy fuel used in the project CPP during year *y*
Source of data to be used:	Measurements in the manufacturing CPP
Value of data applied for the purpose of calculating expected emission reductions in section B.5	31738
Description of measurement methods and procedures to be applied:	A flow meter totalizer will be utilized. The consistency of metered heavy fuel consumption quantities will be crosschecked by an annual mass balance that is based on quantities provided to the cement plant and stock changes. The purchased heavy fuel invoices from the financial records will be used to cross-check the metered heavy fuel consumption quantities.
QA/QC procedures to be applied:	Instrument will be calibrated regularly according to manufacturer's guidelines.
Any comment:	

Data / Parameter:	$EG_{CPP,y}$
Data unit:	MWh
Description:	Electricity generated by the SOCOCIM INDUSTRIES CPP during year y
Source of data to be used:	Measurements in the manufacturing CPP
Value of data applied for the purpose of calculating expected emission reductions in section B.5	144000
Description of measurement methods and procedures to be applied:	Instrument used: Electricity meter Data Archived: 2 years after the end of crediting period Monitoring: Continuously and reported monthly.
QA/QC procedures to be applied:	Instrument will be calibrated regularly according to manufacturer's guidelines.
Any comment:	

Data / Parameter:	EG P,y
Data unit:	MWh
Description:	Electricity consumed due to the proposed project activity during year y
Source of data to be used:	Measurements in SOCOCIM INDUSTRIES
Value of data applied for the purpose of calculating expected emission reductions in section B.5	360
Description of measurement methods and procedures to be applied:	Instrument used: Electricity meter Data Archived: 2 years after the end of crediting period Monitoring: Continuously and reported monthly.
QA/QC procedures to be applied:	Instrument will be calibrated regularly according to manufacturer's guidelines.
Any comment:	

Data / Parameter:	N_y
Data unit:	
Description:	Number of truck trips during the year *y*
Source of data to be used:	Transportation data logs
Value of data applied for the purpose of calculating expected emission reductions in section B.5	6368
Description of measurement methods and procedures to be applied:	Continuously monitored
QA/QC procedures to be applied:	Check of the consistency of the number of truck trips with the quantity of biomass combusted, e.g. by the relation with previous years
Any comment:	

Data / Parameter:	AVD_y
Data unit:	km
Description:	Average round trip distance from the Jatropha plantations to the SOCOCIM INDUSTRIES cement plant during the year *y*
Source of data to be used:	Transportation data logs
Value of data applied for the purpose of calculating expected	150

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Continuously monitored
QA/QC procedures to be applied:	Check consistency of distance records provided by the truckers by comparing recorded distances with other sources (e.g. maps).
Any comment:	

Data / Parameter:	$EF_{km,CO2,y}$
Data unit:	tCO_2/km
Description:	Average CO_2 emission factor for the trucks measured during the year *y*
Source of data to be used:	Conduct sample measurements of the fuel type, fuel consumption and distance traveled for all truck types. Calculate CO_2 emissions from fuel consumption by multiplying with appropriate net calorific values and CO_2 emission factors. For net calorific values and CO_2 emission factors, use reliable national default values or, if not available, (country-specific) IPCC default values. Alternatively, choose emission factors applicable for the truck types used from the literature in a conservative manner (i.e. the higher end within a plausible range).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0012
Description of measurement methods and procedures to be applied:	This measurement will be done at least annually following a well described procedure
QA/QC procedures to be applied:	Cross-check measurement results with emission factors referred to in the literature.
Any comment:	

Data / Parameter:	$FC_{diesel,plant,y}$
Data unit:	tonnes
Description:	Quantity of diesel used in the project plantations during year *y*
Source of data to be used:	Measurements in the project plantations
Value of data applied for the purpose of calculating expected emission reductions in section B.5	615
Description of measurement methods and procedures to be	A flow meter totalizer will be utilized. The consistency of metered diesel consumption quantities will be crosschecked by an annual mass balance that is based on quantities provided to the plantations and stock

applied:	changes. The purchased diesel invoices from the financial records will be used to cross-check the metered diesel consumption quantities.
QA/QC procedures to be applied:	Instrument will be calibrated regularly according to manufacturer's guidelines.
Any comment:	

Data / Parameter:	$NCV_{diesel,y}$
Data unit:	GJ/tonne
Description:	Weighted average net calorific value of diesel during year y.
Source of data to be used:	Values provided by the fuel supplier in invoices
Value of data applied for the purpose of calculating expected emission reductions in section B.5	43.33
Description of measurement methods and procedures to be applied:	Measurements are undertaken in line with international fuel standards.
QA/QC procedures to be applied:	According to ISO 9000 or similar quality systems Data Archived: Entire Crediting Period + 2 years
Any comment:	The NCV will be obtained for each diesel delivery, from which weighted average annual values should be calculated

Data / Parameter:	$EF_{CO2,diesel,y}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor for diesel during year *y*
Source of data to be used:	Measurements by the project participants or use of the IPCC default values at the upper/lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0741
Description of measurement methods and procedures to be applied:	In case during year y SOCOCIM INDUSTRIES can undertake the measurement locally in line with international fuel standards, the measurement will be the option otherwise the IPCC guidelines will be used.
QA/QC procedures to be applied:	According to ISO 9000 or similar quality systems Data Archived: Entire Crediting Period + 2 years
Any comment:	If measurements are made, the CO_2 emission factor will be determined for each diesel delivery, from which weighted average annual values should be calculated. If the IPCCC values are used then any future revision of the IPCC Guidelines will be

	taken into account.

Data / Parameter:	$EF_{CO2,BL,y}$
Data unit:	tCO_2/GJ
Description:	Carbon dioxide emissions factor for the coal displaced by the use of Jatropha in the SOCOCIM INDUSTRIES cement plant
Source of data to be used:	Calculated as follows as the lowest of the following CO_2 emission factors: - The weighted average annual CO_2 emission factor for the fossil fuel(s) consumed and monitored ex ante during the most recent three years before the start of the project activity; - The weighted average annual CO_2 emission factor of the fossil fuel(s) consumed in the project plant in year *y* that are not less carbon intensive fossil fuels.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0937
Description of measurement methods and procedures to be applied:	Continuously, aggregated at least annually
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	FertC,y
Data unit:	tonnes
Description:	Quantity of fertilizer used during year y
Source of data to be used:	Measurements in the project plantations
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1594
Description of measurement methods and procedures to be applied:	Measured continuously and aggregated at least annually with a weight meter
QA/QC procedures to be applied:	The weight meter will be calibrated regularly according to manufacturer's guidelines.
Any comment:	

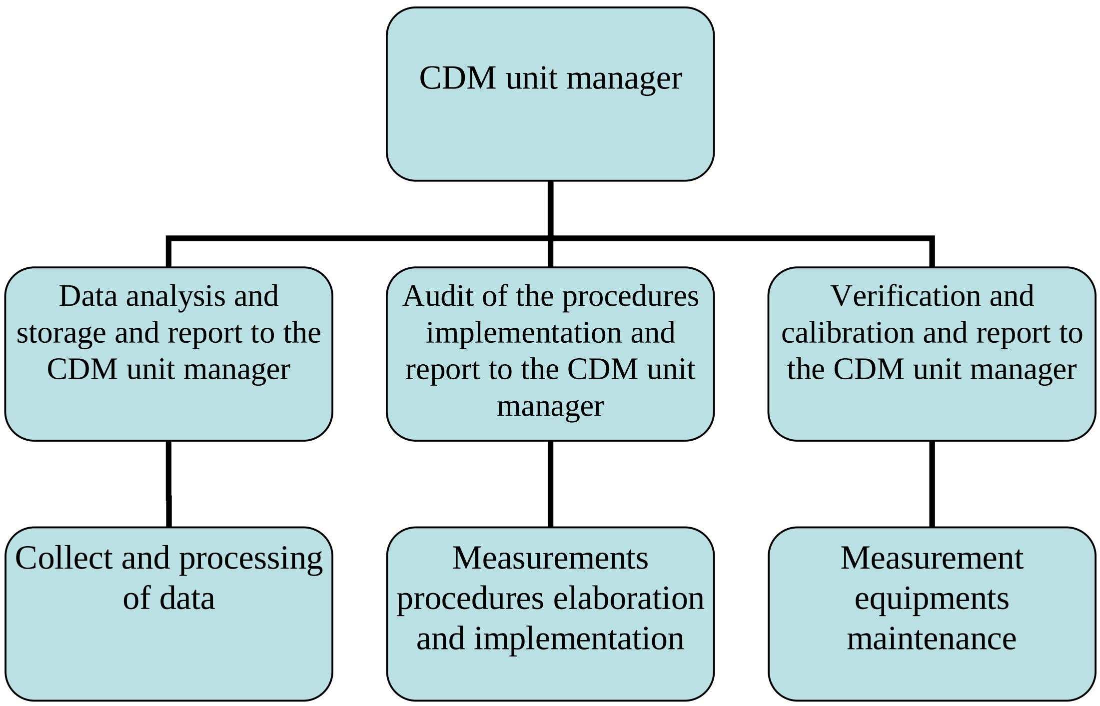
Data / Parameter:	
Data unit:	Tonnes
Description:	Quantity of biomass residues of type *k* that are utilized (e.g. for energy generation or as feedstock) in the defined geographical region

Source of data to be used:	Surveys or statistics
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Annually monitored
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	
Data unit:	Tonnes
Description:	Availability of a surplus of biomass residue type *k* (which cannot be sold or utilized) at the ultimate supplier to the project and a representative sample of other suppliers in the defined geographical region.
Source of data to be used:	Surveys or statistics
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Annually monitored
QA/QC procedures to be applied:	
Any comment:	

B.7.2 Description of the monitoring plan:

Emission monitoring and calculation procedure will follow the following organizational structure:



Monitoring and calculation activities	Procedure and responsibility
Data source and collection	Data is taken from the purchase, materials and accounting system. Most of the data is available in ISO 9001 quality management system.
Frequency	Monitoring frequency will be done as per ACM0003.
Review	All received data is reviewed by the department in charge of the monitoring of the cement plant parameters.
Data compilation	All the data is compiled and stored in CDM unit.
Emission calculation	Emission reduction calculations will be done annual based on the data collected. Engineers of production/ R & D department will do the calculations.
Review	The manager of the CDM unit will review the calculation and elaborate the monitoring report.
Emission data review	Final draft of the monitoring report is reviewed and approved by the cement plant manager.
Record keeping	All calculation and data record will be kept within the CDM unit for all the crediting period and two years after the crediting period.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Baseline study and monitoring methodology completion date: 28/05/2008

Responsible person: Moctar DIAW (see Annex 1)

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/01/2009
SOCOCIM INDUSTRIES has already carried out small scale Jatropha plantation tests in year 2007 (150 ha) and 2008 (150 ha).
Large surfaces of Jatropha (thousands of hectares) should be planted in year 2009; therefore starting date of the project activity has been fixed to 01/01/2009.

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

Lifespan of Jatropha plantations: approximately 50 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

01/06/2009

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable.

C.2.2.2. Length:

Not applicable.

SECTION D. Environmental impacts

SOCOCIM INDUSTRIES as a cement manufacturer has to meet all environmental laws and regulations which are applicable in Senegal for the exploitation of its quarries and the operation of its cement plant. Since the takeover of SOCOCIM INDUSTRIES in 1999 by the French cement group VICAT, major investment programs have been carried out to reduce its environmental impact on the air (NOx, sulfur and dusts), the soils, and the water resources. SOCOCIM INDUSTRIES management has also made special efforts to reduce impacts of cement plant on the inhabitants of Rufisque (dust, noise, security, vegetation regeneration, creation of artificial lakes, etc.) through a continuous dialogue with local authorities and trade unions.

An action program for environment is under implementation. This program has been validated end 2007 by the Senegalese government and the Prefect of Rufisque, as representative of the government, is ensuring quarterly field visits to check its progress and report it to the Ministry. The action program is covering in particular the following components: reduction of cement dusts on the soil through concrete flooring, green spaces and plantations, watering of transport lanes, purchase of a special vacuum cleaning truck for dust collection, improvement of truck parking, new access road to reduce traffic in Rufisque town, creation of 3 artificial lakes, dust control investment in cement workshops, installation of electro filters and bag filters on furnace chimneys, installation of new production lines with higher energy efficiency and reduced air pollution and noise.

The project activity will generate important additional benefits on the environment at local level through the regeneration of about 11,000 ha of eroded marginal soils and its associated benefits. The additional incomes generated in the rural areas by this Jatropha culture will limit the over exploitation of existing soils used for food and cash crops and cattle grazing. Indeed, the “green belts” made from dedicated Jatropha plantations will contribute to restore local environment in areas severely touched by climate change.

At cement plant level, the project activity will result in a major reduction of greenhouse gas (about 2.9 million tonnes over 21 years) issued from coal combustion taking into account the fact that its consumption will be reduced by about 40 %.

More generally this project activity is playing a pioneer role in the new Senegalese government environment and energy policy to demonstrate that it is possible to use widely local renewable resources while reducing dependence on energy imports. The project activity, with the CDM incentive, will contribute to convince other industries that such conversions are feasible and interesting for the country as well as for the developers.

The following table summarizes the different impacts of the project activity. As it appears, the negative impacts are limited and can be alleviated by relevant initiatives.

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

Jatropha plantations

	Negative impact	**No significative impact**	**Positive impact**
Biodiversity			Jatropha plantation will be carried out on poor land, with little or no fauna and flora.
GHG emissions			Very positive thanks to carbon storage (Jatropha trees and fruit)
Rainwater retention			Better assimilation and retention of rainwater in the ground water
Soil quality			The soil quality will be improved with Jatropha plantations
Toxicity		Jatropha leaves and latex are toxic for humans and animals if eaten. But no impact on the environment.	
Visual impact			Poor land will be revegetalised on a sustainable basis
Water consumption		No existing irrigation system deviation	
Water pollution		No chemicals used for the culture (only organic fertilizers, pesticides…)	

In accordance with the Senegalese legislation (Law n°2001-01 dated January15, 2001 related to the Environment Code – Section I : Classified installations for environment protection), an environmental impact study will be carried out for over 1,000 hectares plantations, and an environmental analysis will be carried out for smaller plantations.

Jatropha storage

	Negative impact	No significative impact	Positive impact
Fire	The risk is real. No storage of big quantities; fruits will be isolated and widely spread out.		
GHG emissions		No GHG emissions since the storage will avoid fermentation	
Odor		The Jatropha fruit doesn't smell if not fermented	
Toxicity		Jatropha fruit are toxic for humans and animals if eaten. But no impact on the environment.	
Visual impact		Existing storage centers (used for groundnuts for example) will be used in priority.	
Water pollution		Little leakage since the storage areas will be covered during rainy season. Anyway, leakage is non toxic.	

Transport scheme

	Negative impact	No significative impact	Positive impact
GHG emissions	GHG emissions due to heavy load trucks		
Noise	Additional noise along the roads due to heavy load trucks		
Traffic	Increase of traffic, especially close to the cement plant, due to Jatropha deliveries.	Return trips of cement deliveries will be used to transport Jatropha fruit to the cement plant, reducing significantly the impact of transport.	

In order to reduce transport, Jatropha plantation sites will be chosen preferentially in the proximity of the cement plant.
The above table doesn't take into account the impacts related to the transport of coal to the cement plant: extraction of coal (South Africa), train or heavy load truck transportation to harbor, ship to Dakar, heavy load truck to Rufisque cement plant.

Cement plant

	Negative impact	No significative impact	Positive impact
CO_2 emissions			Very positive thanks to substitution to fossil fuels
VOC emissions			Jatropha fruit contain less volatile matter than charcoal
Electric energy consumption			Less charcoal grinding thanks to the use of Jatropha fruit
Fire		The Jatropha storage in the cement plant is not more likely to burn than the coal storage. The cement plant will apply to the Jatropha storage the existing self ignition prevention procedures.	
Noise		No additional noise in the cement plant	
Odor		The Jatropha fruit doesn't smell if not fermented	
SO_2 emissions			Reduction of SO_2 emissions
Visual impact		Not significant (storage and feeding systems will be integrated in existing buildings)	
Water pollution		The leakages of the Jatropha storage will be treated the same way as the more pollutant leakages of the coal storage	

D.2. If environmental 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 undertaken in accordance with the procedures as required by the host Party:

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SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

SOCOCIM INDUSTRIES, right from the beginning of the activity, has conducted an in-depth dialogue with local stakeholders through meetings, presentations, field visits, interviews, etc. at all levels of the Senegalese society. In particular the following local stakeholders were associated:

- Local rural communities within the perimeter of the project,
- Mayors and representatives of related towns (Rufisque, Bargny…), regions, communities and villages
- Traditional and religious authorities of the region,
- Senior officers from relevant Ministries (environment, industry, energy, biofuels, local communities, interior),
- Experts from national agriculture and forestry research institutes (ISRA, IRD, PROGEDE…),
- NGO organizations (ENDA, CONGAD…),
- International cooperation organizations involved in rural development (AFD, GTZ, USAID…).

In addition, the project was visited on 14th December 2007 by the President of Senegal, his Excellence Maître Abdoulaye Wade, who strongly supports with his government the development of local bioenergy and considers SOCOCIM's Jatropha project as an example of its new sustainable energy policy.

To facilitate the dialogue with local stakeholders, SOCOCIM INDUSTRIES has developed different tools to present the project activity to the local stakeholders: PowerPoint presentations, video, theatre play, presentation of samples of Jatropha fruit, visits of the 300 ha Jatropha nursery, articles in the local papers.

On 11th July 2008 from 9am to 14 pm, a large stakeholder consultation meeting was jointly organized by the "Comité National sur les Changements Climatiques" upon request of the DNA of Senegal and SOCOCIM INDUSTRIES. The aim of this meeting was to provide detailed information on the proposed CDM activity and to obtain questions, comments and recommendations on the implementation of this project activity. The meeting was attended by 84 participants including two regional governors (Kaolack and Fatick) and two senior representatives of the governors of Saint Louis and Dakar, four prefects (Fatick, Bambey, Diourbel, Nioro du Rip) and four representatives of prefects (Kaffrine, Mbour, Mbacké and Thiès), nine Presidents of Rural Communities (Diender, Réfane, Pire Goureye, Taïba Niassene, Nbiebel, Mont Rolland, Gawane, Ngaye Khome, and Niakhene), farm owners, representatives of agricultural and development research institutes, NGO representatives active in rural development, representatives of local and national financial institutions, senior officers of ministries, representatives of embassies and journalists from the press, radio and TV.

The stakeholder consultation meeting was introduced by Mr Aly LO, President of the "Association Nationale des Conseils Ruraux du Sénégal", Mrs Codou MAR DIOP from Ministry of Environment, Mr Marc LIESING Managing Director of SOCOCIM INDUSTRIES and Mr Moctar DIAW Director of Environment at SOCOCIM INDUSTRIES. Following these introductory speeches, various contributions were submitted to the organizers by the participants through comments, recommendations and questions. The comments by participants have been laid down on special sheets and collected by organizers to provide later, if necessary, clarifications on some of the points raised during the presentations. A detailed report of the meeting with all presentations, questions and answers and the written comments of participants has been established complemented by a CD recording of the stakeholder consultation. All these documents (see list in Annex 5) are available for the designated operational entity experts.

E.2. Summary of the comments received:

Globally, the comments of the participants were the following:

- The participants welcome the SOCOCIM INDUSTRIES initiative as the first private company in Senegal to enter into the CDM process,
- The participants recognize the opportunity and pertinence of this Jatropha project in a world environment facing a critical energy crisis particularly severe for developing countries like Senegal where rising oil imports are weakening the economy,
- The participants, and in particular, the representatives of rural populations (governors, prefects and presidents of rural communities) have stressed the positive impact of the project on local development through the cultivation of new surfaces uncultivated so far due to their degradation,
- The participants expect that this project will play a catalyst role for other private developers in the rural sector,
- Several participants have stressed the importance of a rapid project implementation to improve rural incomes in related regions.

Regarding the questions and preoccupations raised by participants, they were mainly related to:

- The relation between the SOCOCIM Jatropha project and the national biofuel program,
- The mode and organization of the partnership between SOCOCIM INDUSTRIES and Jatropha producers as well as the role of local communities in the institutional framework which will be set up,
- The need to raise awareness amid local populations through sessions of the « Conseils Départementaux de Développement » (CDD) and of the « Conseils Régionaux de Développement” (CRD),
- The motivation of producers to start this new culture taking into account its anticipated price,
- The arbitration mode between soil allocation for food crops and bioenergy,
- The limitation to a 150 km radius for Jatropha cultivation for SOCOCIM,
- The eligibility criteria of Jatropha producers according to the “Agricultural Charter” prepared by SOCOCIM,
- The need to closely associate the agricultural research center ISRA in the selection of Jatropha seeds and to avoid contamination by other crops,
- The reason why forestry was not taken into account in the PDD,
- The status of financing of the whole project and the possibility to use local banking,
- The impact of the project on cement prices.

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

Detailed answers to the above questions were given by Mr Mbaye DIAGNE of the “Comité National sur les Changements Climatiques” and Mr Marc LIESING and Moctar DIAW of SOCOCIM INDUSTRIES. The main answers were the following:

- SOCOCIM INDUSTRIES has already established contacts with the ministry in charge of local communities, the ministry of agriculture and the ministry of renewable energy and biofuels. Drafts partnership agreements are under preparation with these entities as well as with the "Programme National Biocarburants", in order to ensure that this Jatropha project is in synergy with the national Jatropha development policy,
- SOCOCIM INDUSTRIES prepares the implementation of a relevant structure which will play as an interface with all entities involved in Jatropha: producers, donors, institutional and socio-economic partners. The framework of this structure is illustrated in the project presentation. The rural communities being the legal entities in charge of soil allocations, SOCOCIM INDUSTRIES will establish close relations with them for the selection of allocated surfaces, the organization of populations and socio-professional entities and all other actors involved in agriculture,
- Other meetings with local stakeholders are planned at regional levels in the prefectures and rural communities preselected for Jatropha cultivation in association with the "Conseils Régionaux et Départementaux de Développement",
- SOCOCIM INDUSTRIES confirmed that the Jatropha cultivation must provide additional incomes to rural populations. This additional income by hectare is presently estimated in average at 60% of the income provided by groundnut cultivation. The comparison is about the same for tomato growers in the Senegal valley,
- The culture charter applicable to Jatropha producers selling to SOCOCIM industries ("Charte applicable aux producteurs de jatropha approvisionnant en exclusivité la cimenterie de Rufisque") is necessary to ensure CDM additionality and avoid diversion from food cultivation and deforestation,
- The 150 km maximum radius for Jatropha dedicated cultivation is defined to limit transport costs and CO_2 emissions,
- The forestry project component will need another CDM methodology. The project activity follows the ACM 0003 approved methodology,
- Project financing is open to donors and local financing institutions. Project financial closure has not yet been reached,
- Cement price of SOCOCIM is the lowest of the sub-region. The CDM activity, through the sale of CER, will contribute to its stabilization and reduce energy imports.

Following a question from a participant regarding the Jatropha production during the first years, SOCOCIM INDUSTRIES agreed to revise downward its estimates on the Jatropha substitution to reflect this transitional period.

SOCOCIM INDUSTRIES confirmed at the end of the meeting that, by using the dedicated forms filled by participants during the meeting (available on request), it will remain in contact with them and will reply by mail to their questions and interrogations.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the project activity.

Annex 3

BASELINE INFORMATION

No additional information.

Annex 4

MONITORING INFORMATION

The monitoring plan is based on two tools developed by the French cement industry:

CITEPA (Interprofessional Center for Atmospheric Pollution Study), version dated January 25, 2008
Methodological Guide of MEDD (Ministry of Ecology and Sustainable Development) section cement industry: calculation of CO_2 emissions of installations for cement and clinker production.

The objective of this document is to define guidelines for declaration of CO_2 emissions in accordance with the European Directive 2003/87/CE for cement and clinker installations using rotating furnaces with a production capacity of over 500 tonnes per day.

ATILH (Technical Association of Hydraulic Bindings Industry), 2005
Quantification of CO_2 emissions of the cement sector:
- Principles of the European Directive 2003/87/CE for exchanges of quotas;
- Principles for monitoring and declaration of emissions.

All these documents, in French, are available upon request from SOCOCIM INDUSTRIES.

Annex 5

LIST OF THE DOCUMENTS RELATED TO THE STAKEHOLDER CONSULTATION

LIST OF THE DOCUMENTS RELATED TO THE STAKEHOLDER CONSULTATION HELD ON JULY 11, 2008 IN DAKAR

Report on the consultation of the stakeholders of the project « Partial Substitution of Coal by Jatropha Fruits and Biomass Residues in the Production of Portland Cement » held on July 11, 2008 in Dakar by the "Comité National Sur Les Changements Climatiques (COMNAC)" and SOCOCIM INDUSTRIES

Annex 5.A:	Participant attendance sheet
Annex 5.B:	Speech of the representative of the Minister of Environment
Annex 5.C:	Presentation of COMNAC and the Designated National Authority by the President of "Comité National sur les Changements Climatiques"
Annex 5.D:	Speech of the Managing Director of SOCOCIM INDUSTRIES
Annexes 5.E et E.F:	Presentation of the Jatropha project of SOCOCIM INDUSTRIES by the Director of Environment of SOCOCIM INDUSTRIES
Annex 5.G:	Charter applicable to Jatropha producers supplying in exclusivity the Rufisque cement plant of SOCOCIM INDUSTRIES
Annex 5.H:	Minutes of questions and comments by participants
Annex 5.I:	Form used for questions and comments
Annex 5.J:	Press book = DVD video reporting + photos + articles « quotidien le Soleil » and economic newsletter «sustainable development and private sector in Senegal »

All these documents, in French, are available upon request from SOCOCIM INDUSTRIES.