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

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Abidjan Municipal Solid Waste-To-Energy Project
PDD Version 5
May 29th 2009

A.2. Description of the project activity:

The proposed project activity aims at developing a municipal solid waste treatment plant in the city of Bingerville, district of Abidjan, Ivory Coast.

The baseline scenario is the same as the scenario existing prior to the start of implementation of the project activity, i.e. waste is collected and dumped at Akouédo landfill located 15 km east side from downtown Abidjan.

Project activity summary

The project will manage 200,000 tons of municipal solid waste per year (80,000 tons the first year of operation). After sorting, waste will be treated through anaerobic fermentation. The treatment plant will be equipped with two digesters the first year. Three additional units will be installed the second year of operation.

The biogas derived from the waste will be used as fuel to produce annually 25 GWh of renewable electricity. A part will be used for covered on-site consumption and the 20.5 GWh of excess electricity generated annually will be sold at 20 EUROS[1] per MWh to the state-owned company Société d'Opération Ivoirienne d'Électricité (SOPIE) on the basis of a Power Purchase Agreement (PPA) that runs for the whole project lifetime.

After the anaerobic fermentation, residual waste will be transformed into compost through aerobic treatment. The compost will be sold to local farmers.

The technology will be provided by PROMECO Spa, an Italian based company specialized in engineering, planning & turnkey building of urban and industrial waste treatment plants.

Project developer

The project will be developed and operated by Société Ivoirienne de Traitement des Déchets (SITRADE), an Ivorian based company registered in Abidjan and incorporated as a Société Anonyme under the laws of the Republic of Ivory Coast.

Greenhouse gas emission reductions

The project contributes to reduce greenhouse gas (GHG) emissions as it produces electricity from a renewable source and thus displaces fossil fuel-based grid electricity generation. It also avoids methane emissions by diverting organic waste from Akouédo landfill, where biogas emissions are caused by anaerobic processes. The project is expected to avoid 502,318 tCO_2e over the first 7 years crediting period.

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[1] *20 EUROS is equivalent to 10,000 FCFA*

Sustainable development

In addition to emission reductions, the contribution to the host country's sustainable development is significant in terms of social, environmental and economical well being.

Social impact
The treatment plant is expected to create more than 210 jobs (140 the first year of operation) including high qualified positions such as engineers. The company plans to hire a significant part of graduates. In Ivory Coast unemployment rate is high, especially within young people. This situation has worsened during the last year due to the political crisis[2]. The project will contribute directly to poverty alleviation as there is no financial support from the government dedicated to people seeking for a job. According to the United Nation Development Program, the Human Development Index of Ivory Coast is 0.432, which gives the country a rank of 166th out of 177 countries[3].

Environmental impacts
As mentioned previously, the project will mitigate greenhouse gas emissions as it produces clean electricity and avoids methane emissions caused by landfilling. In addition, the project will reduce soil and water pollution in Akouédo's neighborhood by avoided landfilling. Indeed, the municipal waste is actually filled in wholes of the existing landfill of Akouédo without protection barrier against water and soil pollutions. It will also contribute to improve the living conditions of the local population by reducing health hazards (fires and potentially lethal explosions), odors, particles and noise, among other benefits. The project will provide compost to local farmers. This compost will replace the use of chemical fertilizers in the local agriculture.

Technology transfer
The technology selected for the project activity is the most advanced and innovative municipal waste management system to be implemented in West Africa so far. It will be the first of its kind within the whole region.
PROMECO Spa, the technology provider, will organize trainings in Italy and Ivory Coast. SITRADE staff will deeply benefit from the know-how transfer.

Conclusion

The proposed project activity is:
- the first CDM project in Ivory Coast;
- the first municipal solid waste to energy project in West Africa;
- the first municipal waste management system using the anaerobic fermentation process in the region;

The project is a model for the whole region and could be duplicated. The SITRADE expects to develop similar project activities throughout Africa.

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[2] *There is no official statistic in Ivory Coast regarding the unemployment rate. Nevertheless, several non-official sources indicate an unemployment rate ranging from 19% to 61%:*
« Le chômage pousse de jeunes diplômés vers la terre », Fulgence Zamblé, 2006,
http://ipsnews.net/fr/_note.asp?idnews=3009
« Avant-garde Magazine », n° 005 of April – June 2007
http://www.av-garde.com/extrait.php?extid=17&idmag=5&idsom=88
"Pauvreté, chômage », Zadi Kessy, July 24th 2007
http://www.ivoirenews.net/news/401.html
"Editorial: Tout le pouvoir à l'Etat », Ferro M. Bally, August 17th 2007,
http://www.acibe.org/fr/index.php?s=ch%C3%B4mage&submit=Recherche
[3] *Côte d'Ivoire: The Human Development Index - going beyond income, UNDP, 2007/2008 report*
http://hdrstats.undp.org/countries/country_fact_sheets/cty_fs_CIV.html

A.3. Project participants:

Name of Party involved (*) ((host) 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)
Ivory Coast	SITRADE	No
Swiss Confederation	Green Hercules Trading Limited-C/O Cargill PLC	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

The project will be developed and operated by the Société Ivoirienne de Traitement des Déchets (SITRADE) an Ivorian based company registered in Abidjan (CI-ABJ-2007-B-5762) and incorporated as a Société Anonyme under the laws of the Republic of Ivory Coast.
Chief Executive Officer: KOUADIO YAO LEONARD
Chairman: OUSMANE DIABATE

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Republic of Ivory Coast

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

District of Abidjan

A.4.1.3. City/Town/Community etc:

City of Bingerville – AKAKRO road – Industrial zone

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

Bingerville is located 15 km east of Abidjan. The town is situated on a plateau overlooking the Ébrié lagoon. The population is estimated at 56.357.

The treatment plant will be built in the city's industrial area. On-site activities will enlarge upon 5 hectares.

GPS coordinates: 5°20'18".07 N 3°51'58".97 W

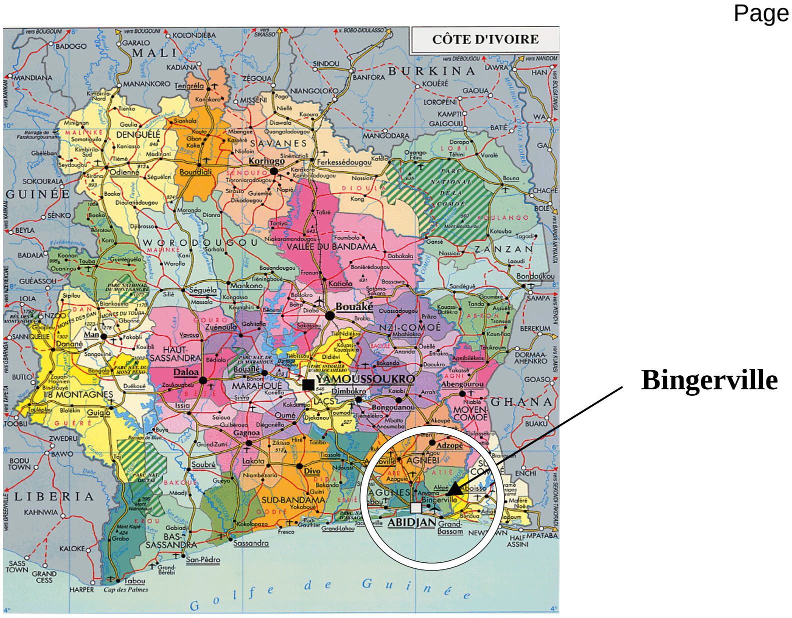

Figure 1: Map of Ivory Coast.[4]

Figure 2: City of Bingerville and project site location.

[4] *Division Géographique du Ministère des Affaires Étrangères.*

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

Sectoral scope 01 – Energy industries (renewable /non-renewable sources)
Sectoral scope 13 – Waste handling and disposal.

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

In baseline scenario, waste is collected and dumped at Akouédo landfill.

Technical description of the proposed project activity

Municipal solid waste will be delivered to the plant in the estimated amount of 200,000 tons/year (80,000 tons the first year of activity). As a reception hall, PROMECO Spa has planned a covered area of approx. 2,000 m².

The first product treatment phase, with a throughput rate of 31.7 t/h (12.7 t/h the first year of activity), consists of a dry-wet mechanical selection process, in which the material is coarsely divided into two differently characterized flows, by preparing this product for further treatments.

The material is then gathered from the initial storage area and sent, through a mechanical loader, to a slow grinder followed by a star screen device: on the conveyor belt which connects such phases a magnetic separation unit has been planned.

The material is then drawn through a material handling system and loaded into the primary cutting device to "open bags" and reduce the size of the material to be sent to further phases. Cut waste is gathered by a belt elevator which, brings it to the sorter, equipped with a screen with 80 mm meshes, to divide the material in relation to dimensions and, partially, to compound type .

At the end of this phase the raw material is separated into two distinct flows:

- The upper-riddle, mostly consisting of inorganic compounds such as plastics and textiles, is sent with a belt conveyor and recycled out of the site after the magnetic separation of its ferrous components.
- The lower-riddle, with its very heterogeneous composition, is sent to wet selection with a hydropulper treatment.

WET SELECTION THROUGH HYDROPULPER

After waste separation through dry-wet separation lines, the lower-riddle is gathered by a conveyor belts system located under the sorter. The latter, passing through a magnetic separator, sends the material, in the amount of 22.5 t/h (9 t/h the first year of activity), to the hydropulper loading system, where separation of different waste fractions takes place, by selecting a clean organic suspension to be delivered to anaerobic digestion.

ANAEROBIC DIGESTER

After being heated, the biomass is pumped into the digester, where the material ferments at anaerobic conditions. The organic substance is moved by agitator shaft attached on the roof of digester.

At a biochemical level, the reactor enables the transformation of part of the organic substances fed into biogas, basically consisting of methane (CH_4) at a 60 – 70% rate, carbon dioxyde (CO_2) at 30 – 40%, in addition to limited amounts of steam, hydrogen sulphide and other minor gases. The reactor works at mesophile conditions (36 –

37°C), 1/3 of thermal energy produced by electricity generation is used to ensure the optimal condition of temperature for digesters. The hydraulic biomass storage time needed to complete this process is 15 – 18 days.

The sludge extracted from the digester is sent to the centrifugation section, where humidity rate is reduced approx. up to 80% obtaining a certain consistency. Dewatered materials are then subjected to an aerobic treatment stage for the production of a quality stabilized organic fraction (compost).

Dewatered sludge waters are recirculated to the treatment section with hydropulper, provided a temporary storage in a process waters tank: a discharge is planned for a minimum liquid amount, which is removed and sent to control the humidity rate during the composting process and to irrigate lands.

BIOGAS ENERGY RECOVERY

The biogas produced during digestion process leaves the reactor and is gathered into the gasholder, which is dimensioned to fill in the gap between anaerobic reactor production and consumption of devices for biogas power recovery. Hydrogen sulphide removal is accomplished through a desulphurizator. From the second year of operation, the estimated biogas production is about 11 million m^3/year (4.5 million m^3/year the first year of activity). To increase gas utilization plants pressure, radial blowers have been installed. In case the gasholder is full or a gas utilization plants breakdown or malfunctioning occurred, a torch to burn exceeding gas has been planned.

Biodigesters

Biodigesters characteristics: - Made of concrete - Height: 19 m - Internal diameter: 18.5 m - External diameter: 19.3 m

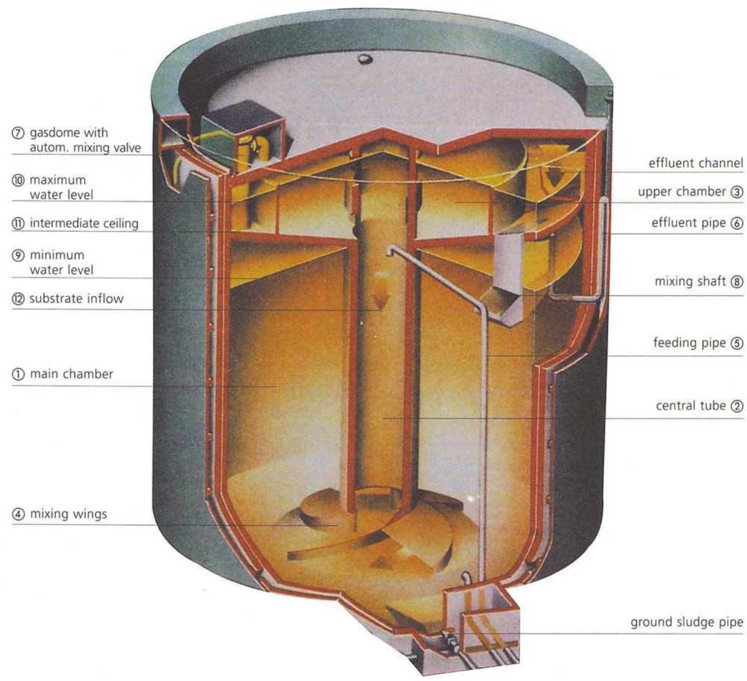

Figure 3: BIMA Digester System[5]

[5] *Promeco Spa*

Gasholder

MEMBRANES made of double-sided PVC coated polyester fiber fabric.

Volume:	2,600 m^3
External membrane:	Permeability to methane: $3.68x10^{-18}$ m²/Pa.s
	Velocity: $3.68x10^{-15}$ m/Pa.s
Internal membrane:	Permeability to methane: $6.04x10^{-18}$ m²/Pa.s
	Velocity: $7.45x10^{-15}$ m/Pa.s

Flare system (for regulation and emergency case)

Temperature burning:	600 – 700°C
Capacity max:	700 Nm^3/h – 60% CH_4
Capacity min:	200 Nm^3/h – 60% CH_4
Pressure:	200 mm H_20
Input voltage:	110 V – 50 Hz
Electrical power absorbed:	400 VA
Flare type:	Enclosed flare
Flare efficiency:	90% (default value proposed in the "*Tool to calculate emission from flaring*")
Flare manufacturer:	*PROGECO*

Biogas power utilization is accomplished through gas motors, which transform gas energy into electric power that can be used again in the process (autoconsumption) or put into the net, and into heat, necessary for biomass heating, which is fed to the reactors and possibly given for other utilizations.
Combustion smokes are removed by a chimney.

Gas Motors

Total installed capacity in phase 2:	3000 kW
Number of motors:	2 x 600 kW for the 1st year of operation,
	5 x 600 kW from the 2nd year of operation
Efficiency electric:	38.6-42.1 %
Efficiency thermic:	41.8-44.2 %
Emission Nox	< 450 mg/mc
Emission CO	< 500mg/mc

COMPOST PRODUCTION

After anaerobic fermentation process, the digested sludge is sent to the centrifugation section to reduce the humidity of the material to be sent to an in-house composting process.
After such a treatment we get an organic substance with a water content of 15-20%: actually an amount of process water of approx. 55t/h (22 t/h the first year of activity) is separated and, after being stored, is used again in wet process with hydropulper, while remaining dewatered substance, approx. 10 t/h is sent to a feeding bunker to be subjected to composting process.

The composting process lasts 6 weeks, this includes:
- 2 weeks for the intensive maturation at 63°C-65°C,
- 4 weeks for the post-maturation period.

The composting plant will be equipped with temperature, relative humidity and oxygen captors. The high temperature (65°C) at least during 3 days will ensure the hygienisation of compost.

MAINTENANCE
Maintenance will be assured by SITRADE following Promeco's instructions and manual. Set of spare parts will be available on site.
A dedicated team will be set up including at least: 1 engineer, 1 technician, 2 workers.
Promeco will be also available for on-site maintenance when required by SITRADE.

The expected lifetime of the waste treatment plant is 20 years.

The emissions sources and the greenhouse gases involved in the project activity are the following:

Baseline emissions
- CH_4 emissions produced in the landfill in the absence of the project activity.
- CO_2 emissions from generation of energy displaced by the project activity.

Project emissions:
- CO_2 emissions from electricity consumption on-site due to the project activity.
- CO_2 emissions on-site due to fuel consumption on-site.
- CH_4 and N_2O emissions during the composting process.
- CO_2 emissions from flaring.

Leakage emissions:
- CO_2 emissions from increased transport.

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

Year	Annual estimation of emission reductions in tonnes of CO_2e
2009 (starting date : April1st)	7,186
2010	39,001
2011	59,485
2012	72,316
2013	81,633
2014	88,488
2015	93,604
2016 (end of 1st crediting period: March 31st)	60,605
Total estimated reduction (tonnes CO_2e)	**502,318**
Total number of crediting years	7 years (renewable)
Annual average over the crediting period of estimated reductions (tonnes CO_2e)	**71,760**

Process flow diagram of the proposed project activity

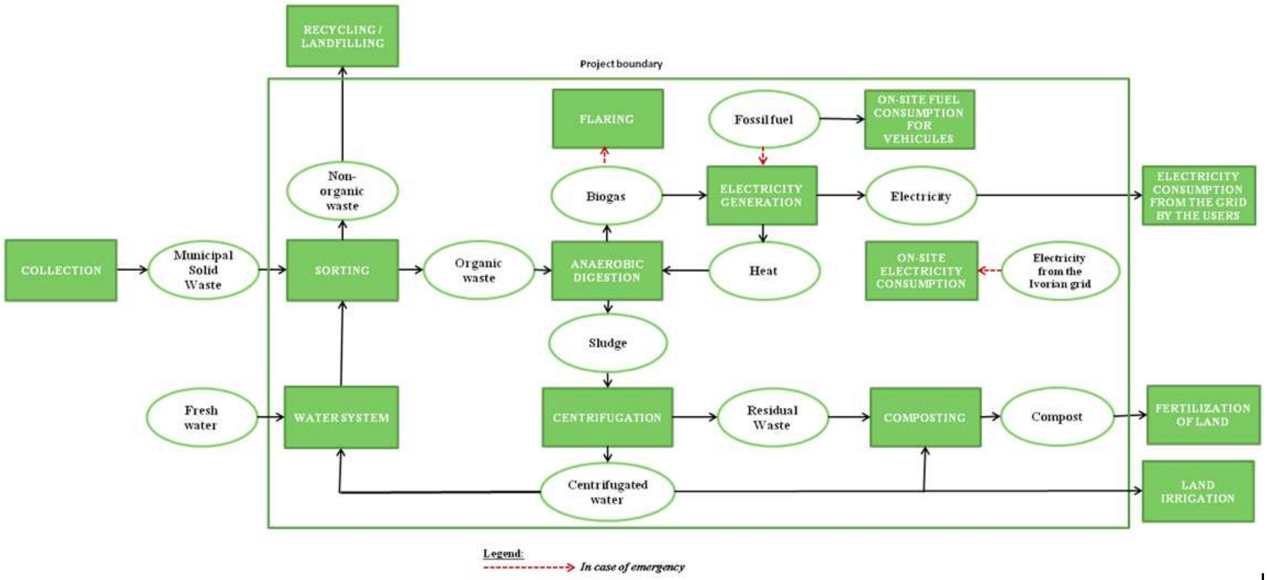

Figure 4: Process flow diagram of the Abidjan municipal solid waste-to-energy project.

Please refer to Annex 4 for monitoring process flow diagram.

A.4.5. Public funding of the project activity:

The Project does not involve public funding from Annex I countries.

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:

METHODOLOGIES

AM0025 – Version 10.1: Avoided emissions from organic waste through alternative waste treatment processes

METHODOLOGICAL TOOLS

- Tool for the demonstration and assessment of additionality – Version 05
- Tool to calculate the emission factor for an electricity system – Version 01
- Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site –Version 04
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion – Version 02
- Tool to determine project emissions from flaring gases containing methane (EB 28).

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

AM0025: Avoided emissions from organic waste through alternative waste treatment processes.

The project activity involves anaerobic digestion and composting of waste that would have otherwise been disposed of in a landfill. The project activity fulfills the AM0025 Methodology requirements.

- The project activity involves :
  - Anaerobic digestion with biogas collection,
  - Composting process in aerobic conditions of residual waste from digestors,
  - Use of compost as soil fertilizer,
  - Electricity generation from collected biogas,
  - Use of generated electricity for on-site consumption,
  - Electricity surplus exported to the Ivorian grid.

- The proportions and characteristics of different types of organic waste can be determined in order to apply a multiphase landfill gas generation model to estimate the quantity of landfill gas that would have been generated in the absence of the project activity.

- The baseline scenario is the continuation of the current practice: waste landfilling.

- There is no specific regulation regarding biogas flaring in Ivory Coast.The Environment Code only provides some general principles and guidelines for toxic waste (Article 26 - Loi n° 96-766 du 3 octobre 1996 Portant Code de l'Environnement) The Code also states that non toxic waste treatment is subject to administrative approval (Article 27) and should comply with the Laws of the Country and be undertaken in a way to facilitate the valorization (Article 28).

- The compliance rate of the environmental regulations during (part of) the crediting period is below 50% just before the project starts, this parameter will be monitored each year (if monitored compliance with the MSW rules exceeds 50%, the project activity shall receive no further credit, since the assumption that the policy is not enforced is no longer tenable).

- The proposed project activity does not involve thermal treatment process of neither industrial nor hospital waste. SITRADE will control input material by spot check. Two workers will be in charge of this task.

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

	Source	Gas		Justification/Explanation
Baseline	Emissions from decomposition of waste at landfill site	CH_4	Included	The major source of emissions in the baseline.
		N_2O	Excluded	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
	Emissions from electricity consumption	CO_2	Included	Electricity may be consumed from the grid in the baseline scenario.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Emissions from thermal energy generation	CO_2	Included	Thermal energy generation is included in the project activity. This energy is used to heat digesters but no CERs are claimed for thermal energy generation.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Included	It includes vehicles used on-site and fuel consumption for boiler
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from onsite electricity use	CO_2	Included	Electricity is generated from collected biogas, these emissions are not accounted for. In case of emergency, if electricity has to be provided by the grid, the resulting emissions will be accounted for.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Direct emissions from the waste treatment processes	N_2O	Included	Composting activities can be an emission source. N_2O can be emitted from anaerobic digestion of waste.
		CO_2	Excluded	The project activity does not include incineration, gasification or combustion of fossil based waste. In addition, CO_2 emissions from the decomposition of organic waste are not accounted.[6]
		CH_4	Included	The composting process may not be complete and result in anaerobic decay. CH_4 leakage from the anaerobic digester and incomplete combustion in the flaring process are potential sources of project emissions.
	Emissions from waste water treatment	CO_2	Excluded	CO_2 emissions from the decomposition of waste water are accounted for.
		CH_4	Included	The wastewater treatment should not result in CH_4 emissions, such as in anaerobic treatment; otherwise accounting for these emissions should be done.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.

[6] *CO_2 emissions from the combustion or decomposition of biomass (see definition by EB in Annex 8 of the EB's 20th meeting report) are not accounted as GHG emissions. Where the combustion or decomposition of biomass under a CDM project activity results in a decrease of carbon pool, such changes should be considered in the calculation of emission reduction. This is not the case for waste treatment projects.*

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

As required by the methodology, the last version of the "*Tool for demonstration and assessment of additionality*" is used to identify baseline scenario.

Step 1: Identification of all alternatives to the project activity consistent with current laws and regulations

Project participants should use step 1 of the latest version of the "*Tool for the demonstration and assessment of additionality*", to identify all realistic and credible baseline alternatives. In doing so, relevant policies and regulations related to the management of landfill sites should be taken into account. Such policies or regulations may include mandatory landfill gas capture or destruction requirements because of safety issues or local environmental regulations.[7] Other policies could include local policies promoting productive use of landfill gas such as those for the production of renewable energy, or those that promote the processing of organic waste. In addition, the assessment of alternative scenarios should take into account local economic and technological circumstances.
National and/or sectoral policies and circumstances must be taken into account in the following ways:

• In Sub-step 1b of the "*Tool for the demonstration and assessment of additionality*", the project developer must show that the project activity is not the only alternative that is in compliance with all regulations (e.g. because it is required by law);

Via the adjustment factor AF in the baseline emissions, which is based on the approved consolidated baseline methodology ACM0001 "Consolidated baseline methodology for landfill gas project activities", project developers must take into account that some of the methane generated in the baseline may be captured and destroyed to comply with regulations or contractual requirements;

• The project developer must monitor all relevant policies and circumstances at the beginning of each crediting period and adjust the baseline accordingly.

Step 1a: identification of alternative scenarios.

Alternatives for the disposal/treatment of the fresh waste in the absence of the project activity, i.e. the scenario relevant for estimating baseline methane emissions, to be analysed should include, *inter alia*:

M1. The project activity (anaerobic digestion, composting, electricity and heat production) not implemented as a CDM project;
M2. Disposal of the waste at landfill where landfill gas is flared.
M3. Disposal of the waste on a landfill without the capture of landfill gas.

If energy is exported to a grid and/or to a nearby industry, or used on-site, realistic and credible alternatives should also be separately determined for:

• Power generation in the absence of the project activity;
• Heat generation in the absence of the project activity.

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[7] *The project developer must bear in mind the relevant clarifications on the treatment of national and/or sectoral policies and regulations in determining a baseline scenario as per Annex 3 to the Executive Board 22nd meeting and any other forthcoming guidance from the Board on this subject.*

For power generation, the realistic and credible alternative(s) may include, *inter alia*:

P1. Power generated from by-product of one of the options of waste treatment as listed in M1 above, not undertaken as a CDM project activity.
P2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant.
P3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant.
P4. Existing or Construction of a new on-site or off-site fossil fuel fired captive power plant.
P5. Existing or Construction of a new on-site or off-site renewable based captive power plant.
P6. Existing and/or new grid-connected power plants.

For heat generation, the realistic and credible alternative(s) may include, *inter alia*:

H1. Heat generated from by-product of one of the options of waste treatment as listed in M1 above, not undertaken as a CDM project activity;
H2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant;2
H3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant;3
H4. Existing or new construction of on-site or off-site fossil fuel based boilers;
H5. Existing or new construction of on-site or off-site renewable energy based boilers;
H6. Any other source such as district heat;
H7. Other heat generation technologies (e.g. heat pumps or solar energy).

Heat generation is not considered as part of the CDM proposed project activity.

Assessment of the potential waste management alternatives

M1. The project activity (anaerobic digestion, composting, electricity and heat production) not implemented as a CDM project;

As described in section B.5 below, M1 is not a realistic scenario because the high investment required and the technical complexity of the whole project – a first of its kind in Ivory Coast.
To date no similar investment has been done for waste treatment in the country. The situation worsened in the last years due to the political crisis. The conflict has severely affected the country risk profile. Access to finance became merely impossible in international markets and local banks are missing liquidity and expertise to assess such projects. The assessment capacity is key as the technology is completely new in the country. The risk is thus reinforced and the fund raising process even harder.
⇨ *M1 is not a realistic scenario.*

M2. Disposal of the waste at landfill where landfill gas is flared.

Landfill gas capture and destruction facilities are not existent in Ivory Coast (for a confirmation please see the statement from the Ivorian National Agency for Environment - ANDE). This could be explained by several reasons: (i) there is no regulation to enforce landfill gas capture and flaring even for safety and odor concerns (ii) the lack of financial resources and expertise to purchase, install and operate such installation (iii) there are some technical constraints due to the landfills configuration (they were not planned to implement methane recovery projects and the situation is today quite chaotic to install such equipment) (IV) several LFG technology provider or project developer won't accept to sell or work in Ivory Coast as they favour much more stable and profitable markets (India, Mexico, China,…).
⇨ *M2 is not a realistic scenario.*

M3. Disposal of the waste on a landfill without the capture of landfill gas.

Currently, waste is dumped in the landfill, where organic matter is broken down through uncontrolled anaerobic processes, releasing all produced methane into the atmosphere.

This practice has been implemented since 1965 (opening date of Akouédo landfill). Akouédo is the sole landfill for the whole district of Abidjan that comprises more than five million people. It covers an area of 153 ha, 2 Km long, 20 meters deep. It is the biggest in the country.
Since the 60's, no municipal waste management system has been implemented there. Waste is only dumped in deep holes excavated by onsite workers. This practice creates environmental concerns for the neighbourhood such as the pollution of nearby streams and under-ground aquifers.

The Ivorian authorities stated that Akouédo will continue to operate in the future. No date has been fixed for a potential closure. Thus the remaining capacity is unknown. To date the landfill stores around 25 million tons of solid waste. New landfills should be opened close to Abidjan. None of these projects plans a methane capture / gas flaring system. [8]

This practice has been implemented mainly because it is the cheapest and easiest way to dispose waste. The most likely scenario for the waste is M3: the continued disposal of Municipal Solid Waste at Akouédo Landfill site.
⇨ *M3 is the most realistic scenario.*

Figure 5: Views on Akouédo landfill[9]

Analysis of scenario for electricity generation

P1. Power generated from by-product of one of the options of waste treatment as listed in M1 above, not undertaken as a CDM project activity.

In the case of P1, according to ANDE[10], all landfills in Ivory Coast vent LFG directly into the atmosphere. This alternative cannot be implemented without the carbon credit incentive as the purchase price for electricity is not financially attractive. To date, no similar project has been developed in the country.
⇨ *P1 is not a realistic scenario.*

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[8] Please refer to "Letter of ANDE regarding waste landfilling in Ivory Coast".
[9] *On site visit in December 2007.*
[10] *Please refer to "Letter of ANDE regarding landfilling in Ivory Coast", August 11th 2008", provided by Pr. Joseph Seka Seka, Director of ANDE .*

P2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant.

P3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant.

The Alternatives P2 and P3 do not generate the same output as the proposed project activity.
Meanwhile electricity and heat would be the output in both alternatives, heat is not considered as part of the proposed project activity and therefore they are unrealistic alternatives.

⇨ *P2 and P3 are not a realistic scenario.*

P4. Existing or Construction of a new on-site or off-site fossil fuel fired captive power plant.

P5. Existing or Construction of a new on-site or off-site renewable based captive power plant.

P4 and P5 do not apply to this project as the anaerobic digestion plant is seeking to generate electricity primarily for sale to the local grid, rather than to meet existing energy requirements.

⇨ *P4 and P5 are not a realistic scenario.*

P6. Existing and/or new grid-connected power plants.

In the absence of the project activity; therefore, P6 is the most likely scenario for the supply of electricity to the Ivory Coast Power Grid: existing and new grid-connected power plants would supply electricity.
Various interviews with authorities from the ministry of energy indicate that future capacity will be added to the grid thanks to thermal power plants[11].

⇨ *P6 is the most realistic scenario.*

Conclusion

In the absence of the Project activity, the most likely scenario is, as described above, as follows:

- M3 Disposal of the waste on a landfill without the capture of landfill gas.
- P6 Existing and/or new grid-connected power plants.

NOTE: Steps 3 and 4 (described in section B.5. below) shall be applied for each component of the baseline, i.e. baseline for waste treatment, electricity generation and heat generation.

Step 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable.

Demonstrate that the identified baseline fuel is available in abundance in the host country and there is no supply constraint. In case of partial supply constraints (seasonal supply), the project participants may consider an alternative fuel that result in lowest baseline emissions during the period of partial supply.
Detailed justification shall be provided for the selected baseline fuel. As a conservative approach, the lowest carbon intensive fuel such as natural gas throughout the period may be used.

The baseline for the energy source is the Ivorian Grid. Fuel mix for the year 2006 is presented in the pie chart below:

[11] *On-site interview with N'Guessan Pacôme N'CHO in charge of Energy Efficiency and Renewable Energy Department at the Ministry of Energy, Thursday 28th of February, Abidjan, Hotel Tiama. This interview took place with the representatives of the DOE.*

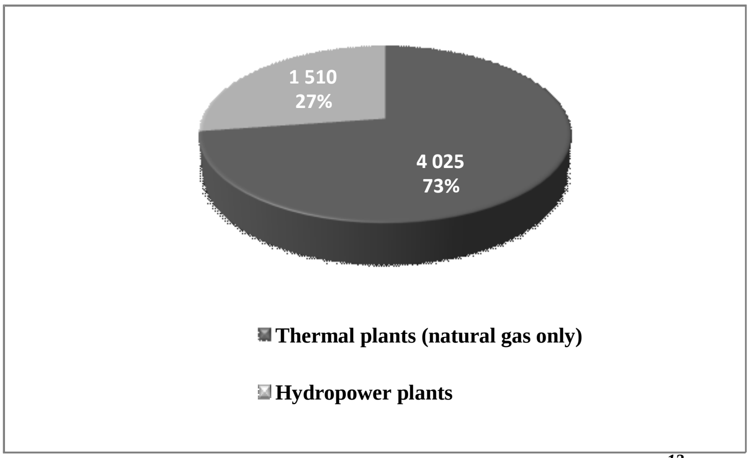

Figure 6: Energy mix in Ivory Coast for the year 2006.[12]

Therefore, there will not be any supply constraint for the identified baseline scenario source of fuel.

A 4th thermal power plant is planned in Abidjan to address the current shortage. This will be done through a Build Operate Transfer (BOT) scheme. The plant combined cycle will have a total installed capacity of approximately four hundred and fifty megawatts (450 MW).

The Compagnie ivoirienne de production d'électricité (Ciprel) owned by the French conglomerate Bouygues and the Ivory Coast State announced the completion of a 18 M. EUR loan from Banque ouest-africaine de développement (BOAD) to increase its installed capacity from 210 MW to 321 MW in 2010. A new thermal power plant will be built in Vridi, District of Abidjan. [13]

Another company - Energie électrique ivoirienne (EEI) – backed by the State Of Ivory Coast and Libya announced in August 2008 the construction of a new combined cycle thermal power plant of 104 MW under a Build Own Operate Transfer (BOOT) scheme. The Lybian African Investment Corporation (L.A.I.C.O.) will invest 72 M. EUR in the project.[14]

Baseline			Description situation
Waste	Electricity	Heat	
M3	P6	-	The disposal of the waste in a landfill site without capturing landfill gas. The electricity is obtained from the grid. None carbon credits are claimed for heat generation.

Step 1b: Consistency with mandatory laws and regulations.

All the alternatives mentioned above comply with the laws and regulatory requirements of Ivory Coast.

[12] *Energy Ministry*
[13] *Article « Côte d'Ivoire : la BOAD finance la CIPREL », http://www.lesafriques.com/cote-d-rsquo-ivoire/cote-d-ivoire-la-boad-finance-la-ciprel.html?Itemid=50, May 2nd 2008*
[14] *Article : « Production d`énergie électrique en Côte d`Ivoire - La Libye va investir 47.543 milliards de FCFA », http://news.abidjan.net/article/?n=299789, August 5th 2008*

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 Project activity faces prohibitive barriers. These barriers are clearly identified using the Tool for the demonstration and assessment of additionality- Version 5. The following steps from the additionality tool are completed below:

STEP 1 – Identification of alternatives to the project activity consistent with current laws and regulations
STEP 2 – Investment analysis
STEP 3 – Barrier analysis
STEP 4 – Common practice analysis

As it is specified in the Tool: "*Proceed to Step 2 (Investment analysis) or Step 3 (Barrier analysis). (Project participants may also select to complete both Step 2 and 3.)*".
SITRADE has selected the step that seems the most relevant for it i.e. Step 3.

As the project activity is the first-of-its-kind, STEP 4 – Common practice analysis is not used.[15]

Step 1 - Identification of alternatives to the project activity consistent with current laws and regulations.

Sub-step 1a. Define alternatives to the project activity

Following the *Tool for the Demonstration and Assessment of Additionality*, the identified realistic and credible alternatives available to the Project Developer or others that provide outputs or services comparable (Solid Waste Management) to the proposed CDM project activity are:

Alternative 1.
Implementing the project activity without CDM assistance, i.e. the Project Developer would invest in anaerobic digesters, composting plant and motors in order to sell compost and to supply electricity to the grid.

Alternative 2.
Building a fossil fuel-fired electricity generation plant, likely to be a natural gas-fired turbine.

Alternative 3.
Continuing the business-as-usual, i.e. using a passive simple venting system and not implementing the project activity or any other alternative activities.

Sub-step 1b. Enforcement of applicable laws and regulations

The alternatives comply with all applicable laws and regulations.

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[15] *According to EB39 (§26), "the common practice test shall not be used in cases where the proposed CDM project activity is the first of its kind".*

Alternative 1.
Implementing the project activity without CDM assistance, i.e. the Project Developer would invest in anaerobic digesters, composting plant and motors in order to sell compost and to supply electricity to the grid.

1) *Anaerobic digestion and composting comply with the current laws:*

This process complies with the current code of Environment and all applicable Laws. The project has received the backing and the approval from the dedicated authorities.

2) *Biogas to electricity complies to the current laws:*

To date, the Republic of Ivory Coast does not have a specific law for the renewable energy sector.
The electricity production from renewable sources has the same treatment than the thermal production. There is no incentive or scheme that favors renewables. The same provisions apply for the whole energy sector. All power producers operate under the Law No. 85-583 enacted the 29th of July 1985. This text aims at "organizing the electricity production, transport and distribution in Ivory Coast".
In addition, the letter received by SITRADE from Ministry of Energy (28th April 2008) clearly confirms that the implementation of biogas to energy project is considered in compliance with the law.

Alternative 2.
Building a fossil fuel-fired electricity generation plant, likely to be a natural gas-fired turbine.

As explained for alternative 1, all power producers including fossil fuel fired generation plants operate under the Law No. 85-583 enacted the 29th of July 1985.
In addition, the new combined cycle power plant project illustrates that this alternative comply with the law.

Alternative 3.
Continuing the business-as-usual, i.e. using a passive simple venting system and not implementing the project activity or any other alternative activities.

This option complies with the current Laws of Ivory Coast as no provisions mandate the methane capture from landfills in the country in the Environment Code.

Conclusion of sub-step 1b: all alternatives identified comply with the current laws and regulations of Ivory Coast.

Step 3. Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of the proposed CDM project activity:

The following categories of barriers: (a) Investment Barriers, (b) Technological Barriers and (c) Prevailing Practice were used in the analyses as explained below:

The proposed project activity consists of anaerobic digestion, composting of residual waste from anaerobic digestion, electricity and heat generation. This first municipal solid waste-to-energy project in Ivory Coast and West Africa faces a number of barriers described hereunder.

Investment barriers

The political context is one of the main issues for investors in Ivory Coast.
A civil war erupted in 2002 after a failed coup. A tenuous peace was reached in 2003, but the country remained divided, with the former rebels controlling the north and the government controlling the south. A United Nations peacekeeping force has helped to monitor the peace since 2004. Under the Ouagadougou Accord, reached in March 2007, the country has been reunified, and new elections are to be held in 2008. However the business climate and investments in Ivory Coast were severely curtailed by the events of November 2004. [16]
Since the beginning of the crisis, the country risk profile has severely increased as stated in several reports issued by rating agencies, multilateral institutions and researchers.[17] This situation prevented a number of foreign investors to finance project in Ivory Coast. The country risk is highly priced by most of the market players and thus access to finance becomes prohibitive. In addition, investors require strong bank credentials and guarantees that could be hardly reached by local developers.

To overcome this issue a number of Ivorian developers turn to local banks and investors to fund their projects. As mentioned in various reports, access to local financing is a difficult task. Loans granted by local banks decreased and credit risk increased significantly during the last years.[18] According to the World Bank, the financial sector does not provide sufficient effort to support businesses.[19] This is mainly due to the bank sector crisis: 8 banks over a total of 18 do not meet the minimum capital requirements, 5 banks reported losses for 2006, 6 banks are monitored by the Ivorian national bank watchdog agency. The leading banks favor large corporations in their investment policy and decrease their exposure on small/medium businesses and start-ups.[20]

Project developers face several other investment barriers such as: starting a business, dealing with licenses, employing workers, registering property, paying taxes, enforcing contracts, closing a business. Ivory Coast is ranked 155th out of 178 economies in one of the latest World Bank publication[21]. As an example, getting licenses to build a warehouse in Ivory Coast requires 21 procedures, takes 628 days, and costs 247.74% GNI per capita.[22]

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[16] *IMF Report n°07/312, September 2007, Côte d'Ivoire — Rapport des services du FMI pour les consultations de 2007 au titre de l'article IV et demande présentée au titre de l'aide d'urgence aux pays sortant d'un conflit; note d'information du public (NIP); Déclaration du représentant des services du FMI; Communiqué de presse; et déclaration de l'administrateur pour la Côte d'Ivoire, page 7.*

[17] *IZF, 2007 (CEMAC and UEMOA), http://www.izf.net/affiche_oscar.php?num_page=4783*

- *Doing business, 2008, http://www.doingbusiness.org/ExploreEconomies/?economyid=51*
- *Index of economic freedom (The Wall Street Journal and The Heritage Foundation), 2008 : http://www.heritage.org/research/features/index/countryFiles/pdfs/IvoryCoast.pdf*
- *Ducroire, September 2007: http://www.ducroire.fr/WebdFR/WebSite.nsf/AllWeb/C%F4te+d'Ivoire?OpenDocument&Disp=1*

[18] *IMF Report n°07/312, September 2007, page 8 and page 9*

[19] *World Bank Memo, September 2007*

[20] *IMF Report n°07/312, September 2007, page 15*

[21] *Ease of Doing Business in Côte d'Ivoire, 2008 http://www.doingbusiness.org/Documents/CountryProfiles/CIV.pdf*

[22] *Ease of Doing Business in Côte d'Ivoire, 2008, Page 6*

Technological barriers

The risk of technological failure is important as methanization is a very complex biological process. Indeed, the overall digestors efficiency depends on several parameters:
- Quality of waste sorting. Improper preparation of solid waste can break down the system (blockages, accumulation of inert particles such as sand and rocks).
- Regulation of pH. The optimal growth of methanogenic bacteria occurs only if a specific range of pH is reached.
- Regulation of temperature. Fluctuations can disturb bacteria metabolism and thus the biogas production level.
- Other risks can influence the process (bad management of loading rate, retention time, dilution ratio, etc.).

The particular technology used in the proposed project activity is not available in the region. Apart from civil engineering, all components will be imported.

In addition to this technology transfer, know-how will be shared thanks to dedicated capacity building seminars. SITRADE engineers will follow special trainees organized by the technology provider– PROMECO Spa. These trainees will take place in Italy and Ivory Coast. The project will require a special assistance the first months of operations.

Barriers due to prevailing practice

The project activity is the "first of its kind" in Ivory Coast. This is clear from on-site visits and confirmed by the Ministry of Energy.[23]

Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

Alternative 1: Due to the significant investment, technological and financial barriers described in 3a, Ivory Coast has not implemented in its whole history a municipal waste management system other than landfilling which is the cheapest and easiest form of municipal waste treatment.

The proposed project activity is one of the most complex and advanced process for urban solid waste treatment. The capital costs involved are extremely high considering the project risks (the technology is new in the country). In addition the political conflict severely damaged the opportunity to raise fund in the international market at a reasonable costs and local banks are more stringent in their selection because they lack liquidity and thus they need to prioritarize their investment.

The absence of carbon credits will make the proposed project activity impossible as it cancels an essential source of revenues and increases the project risks (carbon credits diversify the company revenues). Climate change has also been the central argument to convince all stakeholders involved. This can be clearly understood from the letter of the main potential sponsor bank[24].The project validation is essential for the project funding as it drives the loan acceptance. In addition the developer asked for carbon credits prepayment to facilitate the funding.[25] Carbon credits are vital for the project.

The Municipal Solid Waste-to-Energy Project could not be undertaken without CDM assistance. The PDD has been the first investment made by the project developer. SITRADE has been a pioneer to explain the CDM and carbon credits concept in the country.

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[23] *Letter of N'Guessan Pacôme N'CHO in charge of Energy Efficiency and Renewable Energy Department at the Ministry of Energy: "Statement of Ministry of Energy – First-of-its-kind project.pdf"*

[24] *Letter of "Banque Atlantique.pdf", May 5th 2008*

[25] *Letter "Cargill GHT Pre Payment letter.pdf"*

Alternative 2: The identified barriers would not prevent the implementation of a fossil-fuel plant based on natural gas turbine. Energy generation based on natural gas as fuel is currently a policy encouraged by the Ivorian Government.[26] As mentioned in B.4 Step 2 several projects are being currently developed. They are all based on thermal power plants. [27], [28].

This alternative would not be prevented by the barriers described, but it also would not be implemented by the Project Developer as the main company focus is the waste treatment (SITRADE is the acronym for Société Ivoirienne de Traitement des Déchets – Ivorian Waste Treatment Company).

Alternative 3: The identified barriers would not prevent the implementation of the business-as-usual scenario: “Disposal of the waste on a landfill without the capture of landfill gas” since:

- The cost of this option is by far the most attractive: landfilling requires only the purchase of the land and operational costs are low.
- This option does not involve any particular technical skills.
- No current or planned regulation prevents this practice. No current or planned regulation requires municipal solid waste treatment.
- Akouédo landfill opened in 1965. Since the start of operation, landfilling has been the current practice to manage Abidjan municipal solid waste.

This situation is likely to continue in the future as it is the less costly and less complex solution to carry on in the absence of any new regulation. Landfilling represents the worst scenario regarding greenhouse gas emissions.

SITRADE business model aims at diversifying revenues using the most advanced municipal waste treatment technology to date to produce several inputs such as compost, electricity and carbon credits which is not possible with alternative 3 (the price of electricity is low and the market for natural compost is to be developed and thus risky). SITRADE corporate policy and strategic objectives also include the fight against climate change in West Africa. The goal of SITRADE founders also aims at demonstrating the capacity and ability of West African people to develop challenging projects with the best available technology.

Project timeline

Project milestones	Date	Installed capacity of the biogas combustion engines
Site preparation	February 2008	0
Building construction	October 2008	
Equipment delivery and on-site installation	January 2009	
Start of operation (2 digesters) – running process	April 2009	1.2 MW
Full operation (2 digesters – 80,000 T/year)	June 2009	
Site extension	January 2010	
Start of operation for the additional digesters Full operation (5 digesters – 200,000 T/year)	April 2010	3 MW

Table 1: Project timeline.

[26] *Côte d'Ivoire: Energie électrique - la centrale thermique d'Azito va connaitre une extension, 5 Avril 2008 http://fr.allafrica.com/stories/200804060011.html,*

[27] *Article « Côte d’Ivoire : la BOAD finance la CIPREL », http://www.lesafriques.com/cote-d-rsquo-ivoire/cote-d-ivoire-la-boad-finance-la-ciprel.html?Itemid=50, May 2 th 2008*

[28] *Article : « Production d`énergie électrique en Côte d`Ivoire - La Libye va investir 47,543 milliards de FCFA », http://news.abidjan.net/article/?n=299789, August 5th 2008*

Timeline of events and actions which have been taken to achieve CDM registration

Events and action	Date	Evidence provided to the DOE
First CDM consideration	April 11th 2007	1st Project Idea Note
First contact with a PDD consultant	May 31st 2007	Carbon potential assessment by ecosur
	June 4th 2007	CDM services proposal (ecosur)
	August 31st 2007	Carbon potential assessment by ecosur
	October 9th 2007	Letter ecosur-SITRADE
First contact with carbon credits buyer	November 6th 2007	Letter of intent - Belgian JI/CDM tender
SITRADE introduced the project and carbon credits revenues in the press.	December 11st 2007	Article from L'INTER "Traitement des ordures ménagères à Abidjan", G. DE GNAMIEN
Start of PDD completion	December 14th 2007	CDM questionnaire sent by ecosur to SITRADE
Contact with a DOE	January 9th 2008	Financial proposition of TUV SUD
Term-Sheet with the carbon credits buyer	January 28th 2008	Indicative contract between a buyer and Société Ivoirienne de Traitement des Déchets (SITRADE)
Proposal for ERPA review by a Law Firm	January 29th 2008	Gide Loyrette Nouel
Start of CDM validation	February 20th 2008 - March 20th 2008	Period for comments
Ivorian DNA approbation	February 25th 2008	Letter of Approval from DNA of Ivory Coast
Agreement between the equipment supplier and the project participant	February 25th 2008	Agreement between PROMECO and SITRADE
Loan Bank approval phase 1	As soon as the final validation report will be available	Letter "Banque Atlantique.pdf", May 5th 2008
Carbon Credit buyer prepayment offer	Upon first demand bank guarantee	Letter "Cargill GHT Pre Payment letter.pdf" May 15th 2008
Loan Bank approval phase 2	Under consideration by BIDC	On-site visit by three BIDC experts in August 2008
Purchase order	Upon bank approval and loan agreement	-

Table 2: Timeline of events and actions which have been taken to achieve CDM registration.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The following equations are used to calculate emission reductions, baseline emissions, project emissions and leakage:

Emission Reductions

To calculate the emission reductions, the project participant shall apply the following equation:

$$ER_y = BE_y - PE_y - L_y \quad \textbf{(1)}$$

Where:

ER_y is the emissions reductions in year y (tCO_2e)
BE_y is the emissions in the baseline scenario in year y (tCO_2e)
PE_y is the emissions in the project scenario in year y (tCO_2e)
Ly is the leakage in year y (tCO_2e)

If the sum of PE_y and L_y is smaller than 1% of BE_y in the first full operation year of a crediting period, the project participants may assume a fixed percentage of 1% for PE_y and L_y combined for the remaining years of the crediting period.

Baseline emissions

To calculate the baseline emissions, project participants shall use the following equation:

$$BE_y = (MB_y - MD_{reg,y}) + BE_{EN,y} \quad \textbf{(2)}$$

Where:

BE_y is the baseline emissions in year y (tCO_2e)
MB_y is the methane produced in the landfill in the absence of the project activity in year y (tCO_2e)
$MD_{reg,y}$ is methane that would be destroyed in the absence of the project activity in year y (tCO_2e)
$BE_{EN,y}$ Baseline emissions from generation of energy displaced by the project activity in year y (tCO_2e).

Adjustment Factor (AF)

In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$, an Adjustment Factor (AF) shall be used and justified, taking into account the project context. In doing so, the project participant should take into account that some of the methane generated by the landfill may be captured and destroyed to comply with other relevant regulations or contractual requirements, or to address safety and odor concerns.

$$MD_{reg,y} = MB_y * AF \quad \textbf{(3)}$$

Where:

AF is Adjustment Factor for MBy (%)

The parameter AF shall be estimated as follows:

• In cases where a specific system for collection and destruction of methane is mandated by regulatory or contractual requirements, the ratio between the destruction efficiency of that system and the destruction efficiency of the system used in the project activity shall be used;
• In cases where a specific percentage of the "generated" amount of methane to be collected and destroyed is specified in the contract or mandated by the regulation, this percentage divided by an assumed efficiency for the collection and destruction system used in the project activity shall be used.

The 'Adjustment Factor' shall be revised at the start of each new crediting period taking into account the amount of GHG flaring that occurs as part of common industry practice and/or regulation at that point in the future.
In Ivory Coast, there is no regulation to collect and flare landfill gas. Therefore, $MD_{reg,y} = MB_y$ x AF

Rate of compliance

In cases where there are regulations that mandate the use of one of the project activity treatment options and which is not being enforced, the baseline scenario is identified as a gradual improvement of waste management practices to the acceptable technical options expected over a period of time to comply with the MSW Management Rules. The adjusted baseline emissions ($BE_{y,a}$) are calculated as follows:

$$BE_{y,a} = BE_y * (1 - RATE_{Compliance,y}) \quad \textbf{(4)}$$

Where:

BE_y is the CO_2-equivalent emissions as determined from equation (2).
$RATE^{Compliance}_y$ is the state-level compliance rate of the MSW Management Rules in that year *y*.

The compliance rate shall be lower than 50%; if it exceeds 50% the project activity shall receive no further credit. In such cases $BE_{y,a}$ should replace BE_y in equation (4) to estimate emission reductions.

The compliance ratio $RATE_{Compliance,y}$ shall be monitored *ex post* based on the official reports for instance annual reports provided by municipal bodies.

In Ivory Coast, there is no specific regulation:
- to collect and flare landfill gas,
- to sort waste,
- to treat organic waste by anaerobic fermentation,
- to compost organic waste,
- to use biogas for heat and electricity generation.

The Environment Code only provides some general principles and guidelines for toxic waste (Article 26 - Loi n° 96-766 du 3 octobre 1996 Portant Code de l'Environnement). The Code also states that non toxic waste treatment is subject to administrative approval (Article 27) and should comply with the Laws of the Country and be undertaken in a way to facilitate the valorization (Article 28)."

Therefore, $BE_{y,a} = BE_y$.

Methane generation from the landfill in the absence of the project activity (MB_y)

The amount of methane that is generated each year (MB_y) is calculated as per the latest version of the approved "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site – Version 4*", considering the following additional equation:

$$MB_y = BE_{CH4,SWDS,y} \quad \textbf{(5)}$$

Where:

$BE_{CH4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity at year y, calculated as per the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site – Version 4*". The tool estimates methane generation adjusted for, using adjustment factor (AF) any landfill gas in the baseline that would have been captured and destroyed to comply with relevant regulations or contractual requirements, or to address safety and odor concerns. As this is already accounted for in equation 2, "AF" in the tool shall be assigned a value 0.

Note: Where for a particular year it cannot be demonstrated that the waste would have been disposed of in the landfill, the waste quantities prevented from disposal (*Wj,x*) in the tool should be assigned a value 0 (zero).

Aj,x is the amount of organic waste type j prevented from disposal in the landfill in the year x (tonnes/year), this is the value to be used for variable $W_{j,x}$ in the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site – Version 4*".

$$BE_{CH4,SWDS,y} = \varphi*(1-f)*GWP_{CH4}*(1-OX)*\frac{16}{12}*F*DOC_f*MCF*\sum_{x=1}^{y}\sum_j W_{j,x}*DOCj*\ e^{-k_j(y-x)}*(1-e^{-k_j}) \quad \textbf{(6)}$$

Where:

BECH4,SWDS,y is the methane emissions avoided during the year *y* from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO_2e)

φ is the model correction factor to account for model uncertainties (0.9)

f is fraction of methane captured at the SWDS and flared, combusted or used in another manner

GWPCH4 is the Global Warming Potential (GWP) of methane, valid for the relevant commitment period

OX is the oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)

F is the fraction of methane in the SWDS gas (volume fraction) (0.5)

DOCf is the fraction of degradable organic carbon (DOC) that can decompose

MCF is the methane correction factor

Wj,x is the amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons)

DOCj is the fraction of degradable organic carbon (by weight) in the waste type *j*

kj is the decay rate for the waste type *j*

j is the waste type category (index)

x is the year during the crediting period: x runs from the first year of the first crediting period (x = 1) to the year y for which avoided emissions are calculated (*x* = *y*)

y is the year for which methane emissions are calculated

Waste composition of Abidjan waste entering into digestors is provided below:

Waste type *j*	**Proportion**
Pulp, paper and cardboard	1.26%
Textiles	0.59%
Wood and wood products	0.00%
Garden, yard and park waste	24.40%
Food, food, waste	58.57%
Glass, plastic, metal, other inert waste	15.18%
TOTAL	100.00%

Table 3: Waste composition of Abidjan municipal solid waste.[29]

Baseline emissions from generation of energy displaced by the project activity.

$$BE_{EN,y} = BE_{elec,y} \quad \textbf{(7)}$$

Where:

$BE_{elec,y}$ is the baseline emissions from electricity generated utilizing the biogas in the project activity and exported to the grid or displacing onsite/offsite fossil fuel captive power plant (tCO_2e)

Carbon credits will not be claimed for thermal energy production. 1/3 of thermal energy produced by electricity generation is used to ensure the optimal condition of temperature for digesters.

$$BE_{elec,y} = EG_{d,y} * CEF_{elec,y\ d,y\ d} \quad \textbf{(8)}$$

Where:

$EG_{d,y}$ is the amount of electricity generated utilizing the biogas in the project activity and exported to the grid or displacing onsite/offsite fossil fuel captive power plant during the year y (MWh)

CEF_d is the carbon emissions factor for the displaced electricity source in the project scenario (tCO_2/MWh)

Determination of CEF_d

In case the generated electricity from the biogas displaces electricity that would have been generated by other power plants in the grid in the baseline, CEF_d should be calculated according to the "*Tool to calculate the emission factor for an electricity system*".

[29] *These proportions are based on several studies «Stratégie Nationale de Gestion Durable des Déchets » (Ministry of Environment, BNETD, 2000), « Une ville face à ses déchets : une problématique géographique de la pollution à Abidjan (Côte d'Ivoire) » (SANÉ, Y. thèse de doctorat, Université Laval, Québec, 290 pages, 1999) and are based on Promeco process sorting efficiency.*

Project participants shall apply the following six steps:
STEP 1. Identify the relevant electric power system.
STEP 2. Select an operating margin (OM) method.
STEP 3. Calculate the operating margin emission factor according to the selected method.
STEP 4. Identify the cohort of power units to be included in the build margin (BM).
STEP 5. Calculate the build margin emission factor.
STEP 6. Calculate the combined margin (CM) emissions factor

Step 1. Identify the relevant electric power system

The following map shows that the Ivorian electrical grid is interconnected: power plants are physically connected through transmission and distribution lines to the project activity. Therefore, the relevant electric power system is the national grid.

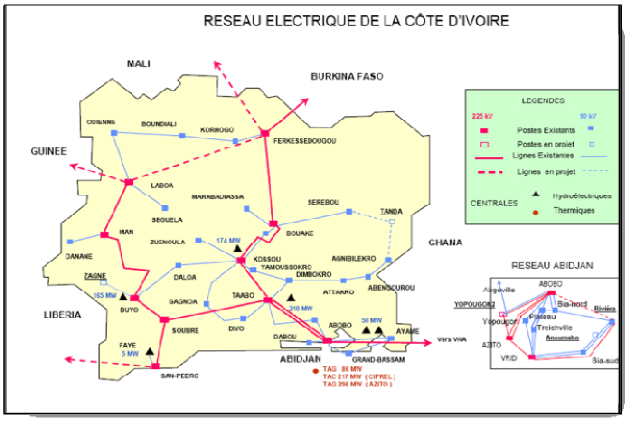

Figure 7: Map of the Ivorian electrical grid.[30]

Step 2. Select an operating margin (OM) method.

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch data analysis OM, or
(d) Average OM.

The method (c) requires the detailed operation and hourly dispatch data of power plants in the grid. To date, there is no publicly available dispatch data for the Ivorian grid. Method (c) is therefore not applicable.

The method (b), simple adjusted OM, needs the annual load duration curve of the grid. Based on the same reason stated above, the data required is difficult to obtain. Method (b) is therefore not applicable.

The method (d), average OM, is used when low-cost/must run resources constitute more than 50% of the total amount of power generation on the grid. According to SOPIE, the total electric power generation of the Ivorian Grid in 2006 is 5,538 GWh, in which gas power generation is 4,025 GWh, accounting for 72.7% and hydro power

[30] *SOPIE, http://www.sopie.ci/reseau_electrique.htm*

generation is 1,510 GWh accounting for 27.3%. Therefore, the Ivorian grid generation system is dominated by gas power, and this trend will not be easy to curb in the mid-long term. Method (d) is therefore not applicable.

The Simple OM method (a) can be used when low-cost/must run resources constitute less than 50% of the total amount of the power generation on the grid, in average of the five most recent years. As mentioned before, in 2006 the Ivorian grid generation system is dominated by gas power. As the table below shows, hydropower represents all of the low-cost/must run resources with a share of 25.8% in 2005 and 27.3% in 2006. Therefore, method (a) is the most appropriate method to calculate the OM emission factor.

	2002	2003	2004	2005	2006
Gross production [GWh]	5,294	5,086	5,396	5,561	5,535
Hydro [GWh]	1,729	1,832	1,748	1,433	1,510
Share of hydro [%]	**32.7%**	**36.0%**	**32.4%**	**25.8%**	**27.3%**

Table 4: Share of hydroelectric production in Ivory Coast, 2003-2006.

The Simple OM can be calculated using either of the two following data vintages for years(s) *y*:
- (ex-ante) the full generation-weighted average for the most recent 3 years for which data are available at the time of PDD submission, if or,
- the year in which project generation occurs, if $EF_{OM,y}$ is updated based on ex-post monitoring.

As explained in STEP 6 below, ex-ante vintage is chosen, and EF_{OM} is fixed during the crediting period.

STEP 3. Calculate the operating margin emission factor according to the selected method.

According to the tool, the Simple OM emission factor ($EF_{OM,\ simple,y}$) is calculated as the generation- weighted average emissions per electricity unit (tCO_2/MWh) of all generating sources that serve the system, excluding low-operating cost and must-run power plants.

The formula of $EF_{OM,simple,y}$ calculation is:

$$EF_{grid,OMsimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \times NCV_{i,j} \times EF_{CO2,i,y}}{\sum_j EG_{m,y}} \quad \textbf{(9)}$$

Where:

$EF_{grid,OM,simple,y}$	Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,m,y}$	Amount of fossil fuel type *i* consumed by power plant / unit m in year *y* (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ / mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$	Net electricity generated and delivered to the grid by power plant / unit m in year *y* (MWh)
m	All power plants / units serving the grid in year *y* except low-cost / must-run power plants / units
i	All fossil fuel types combusted in power plant / unit m in year *y*
y	Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option)

For the calculation of the OM emission factor, the consumption data for gas (the only fossil-fuel used to produce electricity on the national grid) are taken from the SOPIE database[31]. SOPIE holds data on annual fuel consumption, electricity generation by sources and electricity exports.

Data for the year 2007 are not yet available; therefore the calculation of the OM is based on the years 2004, 2005 and 2006.

If available, local values of NCV_i and $EF_{CO2,i}$ shall be used. If not, country-specific values are preferable to IPCC default values. In this PDD, NCV_i and $EF_{CO2,i}$ gas come from IPCC default values which are provided in section B.6.3.

The overall emissions from electricity production are calculated as shown in the table provided in section B.6.3.

Based on 2004, 2005 and 2006, the calculated Operating Margin is: **0.8642 tCO_2/MWh.**

STEP 4. Identify the cohort of power units to be included in the build margin (BM).

According to the "*Tool to calculate emissions factor for an electricity system*", project participants should use the set of power units that comprises the larger annual generation.

The build margin consists of either:

(a) The set of five power units that have been built most recently, or
The set of five power units that have been built most recently (5 gas plants) represents a gross electricity production (in year 2006) of **4,025 GWh.**

(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.
20% of gross electricity production (in year 2006) represent **1,112 GWh.**

Project participants should use the set of power units that comprises the larger annual generation.

As a general guidance, a power unit is considered to have been built at the date when it started to supply electricity to the grid.

Power plants registered as CDM project activities should be excluded from the sample group *m*. However, if the group of power units, not registered as CDM project activity, identified for estimating the build margin emission factor includes power unit(s) that is(are) built more than 10 years ago then:

(i) exclude power unit(s) that is (are) built more than 10 years ago from the group; and
(ii) include grid connected power projects registered as CDM project activities, which are dispatched by dispatching authority to the electricity system.

If after the exclusion of power units built more than 10 years ago and inclusion of registered CDM project activities, the sample group of power units m does not meet either condition (a) or (b) above, the sample group m shall also include power units built more than 10 years ago, starting with the ones built most recently, until either condition (a) or (b) above is met. If there are no power units registered as CDM project activities in the relevant electric power system, and if after the exclusion of power units built more than 10 years ago the sample group of power units m

[31] A letter from the Ministry of Soil Resources and Energy certifying the data related to the power plants in Ivory Coast is submitted to the DOE.

does not meet either condition (a) or (b) above, power units built more than 10 years ago shall be included in the sample group *m*, starting with the ones built most recently, until either condition (a) or (b) above is met.

Name of the plant	Starting date of operation	Type	Generation [MWh]	Cumulated share of gross generation [%]
Azito - TAG 2	2000	Gas - combined cycle[32]	1, 062,396	**19.19%**
Azito - TAG 1	1999	Gas - combined cycle[33]	1, 111,230	**39.27%**
Vridi II - TAG 8	1997	Gas - open cycle	788,918	-
Vridi II - TAG 5/6/7	1985	Gas - open cycle	686,119	-
Vridi I - TAG 1/2/3/4	1984	Gas -steam turbine	376,472	-
		TOTAL	**4, 025,135**	-

TOTAL GENERATION IN 2006	**5, 535,000**
20% of TOTAL GENERATION IN 2006	**1, 107,000**

The set of five power units that have been built most recently (5 gas plants) represents a gross electricity production (in year 2006) of **4,025 GWh.**

Even if the option (a) represents a larger annual generation, the option (b) is chosen because in the set of five power units that have been built most recently, two power plants are built more than 10 years ago.

STEP 5. Calculate the build margin emission factor.

The build margin emissions factor is the generation weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_m \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{(10)}$$

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	Power unit included in the build margin
y	Most recent historical year for which power generation data is available

Choice of electrical efficiency rate

The Annex I of the "*Tool to calculate the emission factor for an electricity system*" provides default efficiency factors for power plants. These values depend on the type of power plant and on their starting date of operation.

[32] *According to SOPIE, the combined cycle of AZITO 2 is not yet operating. The default value provided in the tool for the electrical efficiency of a new natural gas -open cycle power plant is chosen, this is a conservative assumption as regards the date of operation of the plant.*

[33] *According to SOPIE, the combined cycle of AZITO 1 is not yet operating. Therefore, the default value provided in the tool for the electrical efficiency of an old natural gas -open cycle power plant is chosen.*

Name of the plant	Installed capacity	Type	Starting date of operation	Electrical efficiency
Azito - TAG 2	150	Gas - combined cycle[34]	**2000**	39.5%
Azito - TAG 1	150	Gas - combined cycle[35]	**1999**	30.0%

Table 5: List of the fossil-fuel based power plant in operation in 2008 in Ivory Coast.

Carbon EF [kgCO_2/TJ]	Carbon EF [tCO_2/MWh]
56,100	0.2019

Table 6: Natural gas carbon emission factor[36].

Name of the plant	Generation of the set of power units [MWh]	BM emission factor [tCO_2/MWh]	Emission [tCO_2]
Azito - TAG 1	1, 111,230	0.6731	748,020
Azito - TAG 2	1, 062,396	0.5113	543 150
	2, 173,626		1, 291,170

Table 7: Emission of the set of power units.

Based on the period 1999 to 2000, the calculated Build Margin is: **0.5940 tCO_2/MWh**.

STEP 6. Calculate the combined margin (CM) emissions factor.

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,\ OM,y} \text{ x } W_{OM} + EF_{grid,\ BM,y} \text{ x } W_{BM} \quad \textbf{(11)}$$

$EF_{grid,\ BM,y}$	Build margin CO_2 Mission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$	Operating margin CO_2 Mission factor in year y (tCO_2/MWh)
W_{OM}	Weighting of operating margin emission factor (%)
W_{BM}	Weighting of operating margin emission factor (%)

For projects (other than wind and solar power generation): w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting periods.

Based on 2004, 2005 and 2006, the combined margin emission factor is **0.7291 tCO_2/MWh.**

[34] *According to SOPIE, the combined cycle of AZITO 2 is not yet operating. The default value provided in the tool for the electrical efficiency of a new natural gas -open cycle power plant is chosen, this is a conservative assumption as regards the date of operation of the plant.*

[35]*According to SOPIE, the combined cycle of AZITO 1 is not yet operating. Therefore, the default value provided in the tool for the electrical efficiency of an old natural gas -open cycle power plant is chosen.*

[36] *IPCC 2006 Volume 2 - Chapter 1 – Table 1.3 – Default value of carbon content.*

In terms of data vintage, SITRADE can choose between one of the following two options:

Option 1. For the first crediting period, calculate the build margin emission factor ex-ante based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2. For the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex-ante, as described in option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

SITRADE has chosen the option 1. According to the Ministry of Energy[37], it seems that the additional future power plant units will be mainly fossil fuel based plants. Therefore, the approach selected by SITRADE is the most conservative.

Project emissions

The project emissions in year *y* are:

$$PE_y = PE_{elec,y} + PE_{FC,j,y} + PE_{c,y} + PE_{a,y} + PE_{w,y} \quad \textbf{(12)}$$

Where:

PE_y	is the project emissions during the year *y* (tCO_2e)
$PE_{elec,y}$	is the emissions from electricity consumption on-site due to the project activity in year *y* (tCO_2e)
$PE_{FC,y}$	is the emissions on-site due to fuel consumption on-site in year *y* (tCO_2e)
$PE_{c,y}$	is the emissions during the composting process in year *y* (tCO_2e)
$PE_{a,y}$	is the emissions from the anaerobic digestion process in year *y* (tCO_2e)
$PE_{w,y}$	is the emissions from waste water released (tCO_2e)

(i) Emissions from electricity use ($PE_{elec,y}$)

Where the project activity involves electricity consumption, CO_2 emissions are calculated as follows:

$$PE_{elec,y} = EG_{PJ,FF,y} * CEF_{elec} \quad \textbf{(13)}$$

[37] *On-site interview with N'Guessan Pacôme N'CHO in charge of Energy Efficiency and Renewable Energy Department at the Ministry of Energy, Thursday 28th of February, Abidjan, Hotel Tiama. This interview took place with the representatives of the DOE.*

Where:

$EG_{PJ,FF,y}$	is the amount of electricity generated in an on-site fossil fuel fired power plant or consumed from the grid as a result of the project activity, measured using an electricity meter (MWh)
CEF_{elec}	is the carbon emissions factor for electricity generation in the project activity (tCO_2/MWh)

When electricity is purchased from the grid, the emission factor CEF_{elec} should be calculated according to the "*Tool to calculate the emission factor for an electricity system*".

During the first days of operation (running phase), electricity will be consumed from the national grid.

The emissions associated are estimated ex-ante in the PDD and will be reviewed ex-post.

After the running phase, project emissions from electricity consumption are not accounted as this electricity is generated on-site by the project activity from biogas.

(ii) Emissions from fuel used on-site ($PE_{FCj,y}$)

Project participants shall account for CO_2 emissions from any on-site fuel combustion.

The "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (version 01) (EB 32, annex 09)*" is applied.

CO_2 emissions from fossil fuel combustion in process *j* are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \quad \textbf{(14)}$$

Where:

$PE_{FC,j,y}$	are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2 / year);
$FC_{i,j,y}$	is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit / yr);
$COEF_{i,y}$	is the CO_2 emission coefficient of fuel type i in year *y* (tCO_2 / mass or volume unit);
i	are the fuel types combusted in process *j* during the year *y*.

The CO_2 emission coefficient $COEF_{i,y}$ can be calculated following two procedures, depending on the available data on the fossil fuel type *i*, as follows:

Option A: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type *i*, using the following approach:

If $FC_{i,j,y}$ is measured in a mass unit: $COEF_{i,y} = w_{C,i,y} \times 44/12$

If $FC_{i,j,y}$ is measured in a volume unit: $COEF_{i,y} = w_{C,i,y} \times \rho_{i,y} \times 44/12$

Where:

$COEF_{i,y}$	is the CO_2 emission coefficient of fuel type *i* (tCO_2 / mass or volume unit);
$w_{C,i,y}$	is the weighted average mass fraction of carbon in fuel type *i* in year *y* (tC / mass unit of the fuel);

i,y is the weighted average density of fuel type *i* in year *y* (mass unit / volume unit of the *fuel);*
i are the fuel types combusted in process *j* during the year *y*.

Option B: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type *i*, as follows:

$$COEF = NCV \times EF \quad \textbf{(15)}$$

Where:

$COEF_{i,y}$ is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2 / mass or volume unit);
$NCV_{i,y}$ is the weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit);
$EF_{CO2,i,y}$ is the weighted average CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ);
i are the fuel types combusted in process *j* during the year *y*.

Option A should be the preferred approach, if the necessary data is available.

Regarding diesel consumption during the project activity, option B is chosen because local values are not available[38]. SITRADE use IPCC default values for the net calorific values (IPCC 2006 - Vol. 2 - Table 1.2 - 43 MJ/kg equivalent to 10,272 Kcal/kg) and CO_2 emission factors (IPCC 2006 - Vol. 2 Table 1.4 – 74.1 TCO_2/TJ).

In the project activity, $FC_{i,j,y}$ will be measured in volume unit. According to Société Ivoirienne de Raffinage, gas-oil density is comprised between 0.820 and 0.880 kg/m^3 in Ivory Coast. To be conservative, SITRADE chose a value of 0.880 kg/m^3.

In the project activity, fuel will be used on-site:
a) For vehicles consumption used on-site
b) For boiler: in the particular case of the running phase, where electricity would not be produced by biogas engines, where cogeneration would not be possible, fuel use allows boiler to maintain optimal temperature for the growth of bacteria in digesters.

Details of emissions calculation are provided in section B.6.3.

a) Estimation of on-site vehicles consumption

Emissions due to vehicles used on-site are estimated ex-ante and reviewed annually ex-post.

Type of vehicles	Number	Power	Distance (km/day)	Consumption of diesel (Liters/100 km)	Consumption (Liters/day/ vehicles)	Days of operation/week (52 weeks/year)	Total Consumption (Liters/year)
Car	1	13 CV	150	12	18	6	**5,616**
Car	5	11 CV	100	10	10	6	**15,600**
Pick-up 4x4	1	12 CV	200	11	22	6	**6,864**
Car	2	08 CV	300	9	27	6	**16,848**
Bus	1	-	300	13	39	6	**12,168**
Other vehicle	1	-	200	14	28	6	**8,736**
TOTAL	**11**						**65,832**

[38] *Société Ivoirienne de Raffinage, April 2008.*

b) Estimation of boiler consumption

70 liters/hours x 21 hours/day x 60 days = 88,200 liters of gas-oil.

Emissions due to boiler fuel consumption are estimated ex-ante but these emissions will be monitored and reviewed annually ex-post.

(iii) Emissions from composting of residual waste ($PE_{c,y}$)

$$PE_{c,y} = PE_{c,N2O,y} + PE_{c,CH4,y} \quad \textbf{(16)}$$

Where:

$PE_{c,N2O,y}$ is the N_2O emissions during the composting process in year y (tCO_2e)

$PE_{c,CH4,y}$ is the emissions during the composting process due to methane production through anaerobic conditions in year y (tCO_2e)

N_2O emissions

During the storage of waste in collection containers, as part of the composting process itself, and during the application of compost, N_2O emissions might be released. Based upon Schenk[39] and others, a total loss of 42 mg N_2O-N per kg composted dry matter can be expected (from which 26.9 mg N_2O during the composting process). The dry matter content of compost is around 50% up to 65%.

Based on these values, project participants should use a default emission factor of 0.043 kg N_2O per tonne of compost for $EF_{c,N2O}$ and calculate emissions as follows:

$$PE_{c,N2O,y} = M_{compost,y} * EF_{c,N2O} * GWP_{N2O} \quad \textbf{(17)}$$

Where:

$PE_{c,N2O,y}$ is the N_2O emissions from composting in year *y* (tCO_2e)

$M_{compost,y}$ is the total quantity of compost produced in year *y* (t/a)

$EF_{c,N2O}$ is the emission factor for N_2O emissions from the composting process (tN_2O/t compost)

GWP_{N2O} is the Global Warming Potential of nitrous oxide, (tCO_2/tN_2O)

CH_4 emissions

During the composting process, aerobic conditions are neither completely reached in all areas nor at all times. Pockets of anaerobic conditions – isolated areas in the composting heap where oxygen concentrations are so low that the biodegradation process turns anaerobic – may occur.

The emission behaviour of such pockets is comparable to the anaerobic situation in a landfill. This is a potential emission source for methane similar to anaerobic conditions which occur in unmanaged landfills.

The duration of the composting process is less than the duration of the crediting period. This is because of the fact that the compost may be subject to anaerobic conditions during its end use, which is not foreseen that it could be monitored. Assuming a residence time for the compost in anaerobic conditions equal to the crediting period is

[39] *Manfred K. Schenk, Stefan Appel, Diemo Daum, « N_2O emissions during composting of organic waste », Institute of Plant Nutrition University of Hannover, 1997.*

conservative. Through pre-determined sampling procedures the percentage of waste that degrades under anaerobic conditions can be determined. Using this percentage, project methane emissions from composting are calculated as follows:

$$PE_{c,CH4,y} = MB_{compost,y} * GWP_{CH4} * S_{a,y} \quad \textbf{(18)}$$

Where:

$PE_{c,CH4,y}$	is the project methane emissions due to anaerobic conditions in the composting process in year *y* (tCO_2e)
$S_{a,y}$	is the share of the waste that degrades under anaerobic conditions in the composting plant during year *y* (%)
$MB_{compost,y}$	is the quantity of methane that would be produced in the landfill in the absence of the composting activity in year *y* (tCH_4). $MB_{compost,y}$ is estimated by multiplying MB_y estimated from equation 18 by the fraction of waste diverted, from the landfill, to the composting activity (f_c) relative to the total waste diverted from the landfill to all project activities (anaerobic digestion, composting)
GWP_{CH4}	is the Global Warming Potential of methane (tCO_2e/tCH_4)

Calculation of $S_{a,y}$

$S_{a,y}$ is determined by a combination of measurements and calculations. Bokhorst et al[40] and Richard et al[41] show that if oxygen content is below 5% - 7.5%, aerobic composting processes are replaced by anaerobic processes. To determine the oxygen content during the process, project participants shall measure the oxygen content according to a predetermined sampling scheme and frequency.

These measurements should be undertaken for each year of the crediting period and recorded each year. The percentage of the measurements that show an oxygen content below 10% is presumed to be equal to the share of waste that degrades under anaerobic conditions (i.e. that degrades as if it were landfilled), hence the emissions caused by this share are calculated as project emissions ex-post on an annual basis:

$$S_{a,y} = S_{OD,y} / S_{total,y} \quad \textbf{(19)}$$

Where:

$S_{OD,y}$	is the number of samples per year with an oxygen deficiency (i.e. oxygen content below 10%)
$S_{total,y}$	is the total number of samples taken per year, where $S_{total,y}$ should be chosen in a manner that ensures the estimation of $S_{a,y}$ with 20% uncertainty at a 95% confidence level.

$S_{a,y}$ is estimated to 2% for ex-ante calculation. This parameter will be monitored during the project activity.

The produced compost can either be used as soil conditioner or disposed of in landfills. In case it is disposed of in landfills, emissions are estimated as per the leakage section. In case it is used as soil conditioner, its fate should be monitored as per the provisions of the monitoring methodology to ensure that it is not eventually disposed of in landfills. Otherwise, it should be conservatively assumed that the compost is disposed of in landfills and accordingly emissions should be estimated as per the leakage section.

[40] *Jan Bokhorst.Coen ter Berg – Mest & Compost Behandelen beoordelen & Toepassen (Eng : Manure & Compost treatment, judgment and use), Louis Bolk Instituut, Handbook under number LD8, Oktober 2001.*

[41] *Tom Richard, Peter B. Woodbury, Cornell composting, operating fact sheet 4 of 10, Boyce Thompson Institute for Plant Research at ornell University.*

In the project activity, compost produced will be sold to local farmers. In accordance with the monitoring plan, all sales invoices and analysis of SB will be provided to the DOE. Therefore, off-site emissions from end-use of the stabilized biomass are assumed to be zero ex-ante. If necessary, they will be reviewed ex-post.

***(iv) Emissions from anaerobic digestion** ($PE_{a,y}$)*

$$PE_{a,y} = PE_{a,l,y} + PE_{a,s,y} \quad \textbf{(20)}$$

Where:

$PE_{a,l,y}$	is the CH_4 leakage emissions from the anaerobic digesters in year *y* (tCO_2e)
$PE_{a,s,y}$	is the total emissions of N_2O and CH_4 from stacks of the anaerobic digestion process in year *y* (tCO_2e)

(i) *CH_4 Emissions from leakage ($PE_{a,l,y}$)*

A potential source of project emissions is the physical leakage of CH_4 from the anaerobic digesters and from gas holders.

Three options are provided for quantifying these emissions, in the following preferential order:

Option 1: Monitoring the actual quantity of the gas leakage;

Option 2: Applying an appropriate IPCC physical leakage default factor, justifying the selection:

$$PE_{a,l,y} = P_l * M_{a,y} + P_2 * M_{a,y} \quad \textbf{(21)}$$

Where:

$PE_{a,l,y}$	is the leakage of methane emissions from the anaerobic digester in year *y* (tCO_2e)
P_l	is the physical leakage factor from a digester (fraction)
P_2	is the physical leakage factor from a gasholder (fraction)
$M_{a,y}$	is the total quantity of methane produced by the digester in year *y* (tCO_2e)

Option 3: Applying a physical leakage factor of zero where advanced technology used by the project activity prevents any physical leakage.

For digesters, option 3 is chosen as the technology implemented for the project activity is an advanced technology. The project proponent will provide the DOE with the details of the technology to prove that a zero leakage factor is justified and applicable.

For gasholders, a zero leakage factor is also justified and applicable considering the following demonstration [42]

Membrane permeability of internal membrane	= 6.04×10^{-18} m^2 / Pa x s
Membrane diameter	= 21.50 m
Membrane surface	= 1,089 m^2
Membrane thickness	= 1 mm
Relative pressure of biogas	= 0.02 atm

[42] *See Section A.4.3 and technical documentation provided to the DOE by Promeco Spa.*

Methane content in biogas	= 60%
Density of Methane (1.013 bar and 15 °C (59 °F)) kg/m^3	= 0.7168 (IPCC default value)
Total PERMEABILITY	= 6.04 x 8.726 x1,089 x 0.02 = 1,148 cm^3/d = 1.15 l/d
1.15 liter of biogas/day	= 420 liters of biogas/year
420 x 0.6 = 252 liters of methane	= 0.252 m^3
0.252 x 0.7168	= 0.1806 kg CH_4
0.1806 t x 21	= 3.8 tonnes eq. CO_2/an

These emissions are not significant for gasholder. Moreover, this calculation only considers the impermeability of the internal membrane. There are not CH_4 emissions from leakage ($PE_{a,l,y}$) that need to be calculated, therefore $PE_{a.l.y} = 0$.

(ii) *Emissions from anaerobic digestion stacks ($PE_{a,s,y}$)*

Biogas produced from the anaerobic digestion process may be either flared or used for energy generation.

The final stack emissions (either from flaring or energy generation process) are monitored from the final stack and estimated as follows:

$$PE_{a,s,y} = SG_{a,y} * MC_{N2O,a,y} * GWP_{N2O} + SG_{a,y} * MC_{CH4,a,y} * GWP_{CH4} \quad (22)$$

Where:

$PE_{a,s,y}$	is the total emissions of N_2O and CH_4 from stacks of the anaerobic digestion process in year *y* (tCO_2e)
$SG_{a,y}$	is the total volume of stack gas from the anaerobic digestion in year y (m^3/yr)
$MC_{N2O,a,y}$	is the monitored content of nitrous oxide in the stack gas from anaerobic digestion in year *y* (tN_2O/m^3)
GWP_{N2O}	is the Global Warming Potential of nitrous oxide (tCO_2e /tN_2O)
$MC_{CH4,a,y}$	is the monitored content of methane in the stack gas from anaerobic digestion in year y (tCH_4/m^3)
GWP_{CH4}	is the Global Warming Potential of methane (tCO_2e /tCH_4)

Since the project is a Greenfield project values of $MC_{N2O,a,y}$ and $MC_{CH4,a,y}$ are not yet available. In the project activity the equivalent CO_2 emission from CH_4 and N_2O will be determined based on ex-post monitored $MC_{N2O,a,y}$ and $MC_{CH4,a,y}$ from a single point, since there is only one stack in the project activity.

For ex-ante estimation, the most conservative methane emission factor and nitrous oxide emission factor of IPCC guidelines[43] is applied. As these emission factors are expressed in kg of greenhouse gases per TJ, the use of the default NCV value provided by IPCC[44] is the most relevant.

The annual average emissions from anaerobic digestion stacks ($PE_{a,s,y}$) are estimated to 45 tCO_2. Detailed calculation is provided in section B.6.3.

[43] *IPCC Guidelines for National Greenhouse Gas Inventories 2006, Volume 2 Energy - Chapter 2: Stationary Combustion, TABLE 2.5 – Default emission factors for stationary combustion in residential and agridulture / forestry / fishing / fishing farms categories. , **default values** for the category "Other Biogas" (i.e. 5 kg CH_4/TJ and 0.1 kg N_2O/TJ)*

[44] *IPCC Guidelines for National Greenhouse Gas Inventories 2006, Volume 2 Energy - Chapter 1: Introduction - TABLE 1.2 Default net calorific values (NCVs) and lower and upper limits of 95% confidence intervals, **default value** for the category "Other Biogas" page 1.18 (i.e. 50.4 TJ/Gg)*

(v) Emissions from wastewater treatment ($PE_{w,y}$)

If the project activity includes waste water release, methane emissions shall be estimated. If the wastewater is treated using aerobic treatment process, the CH_4 emissions from wastewater treatment are assumed to be zero. If wastewater is treated anaerobically or released untreated, CH_4 emissions are estimated as follows:

$$PE_{CH4,w,y} = Q_{COD,y} \times P_{COD,y} \times B_0 \times MCF_p \quad \textbf{(23)}$$

Where:

$PE_{CH4,w,y}$	are the methane emissions from the wastewater treatment in year y (t_{CH4}/y)
$Q_{COD,y}$	is the amount of wastewaster treated anaerobically or released untreated from the project activity in year *y* (m^3/yr), which shall be measured monthly and aggregately annually.
$P_{COD,y}$	Chemical Oxygen Demand (COD) of wastewaster (tCOD/m^3), which will be measured monthly and averaged annually.
B_0	Maximum methane producing capacity (t_{CH4}/t COD)
MCF_p	Methane conversion factor (fraction), preferably local specific value should be used.

In absence of local values, MCF_p default values can be obtained from table 6.3, chapter 6, and volume 4 from IPCC 2006 guidelines.

IPCC 2006 guidelines specifies the value for B_0 as 0.25 kg CH_4/kg COD. Taking into account the uncertainty of this estimate, project participants should use a value of 0.265 kg CH_4/kg COD as a conservative assumption for B_0.

One of the objectives of the SITRADE project is to avoid natural resources wasting. To achieve this goal, sludge from anaerobic digestion will be centrigated and water will be used:

1. To sort waste in hydropulpers (water recycling),
2. To control the humidity rate of compost during composting process (water recycling),
3. To irrigate lands.

Before being used, centrifugated water will stay in a tank no more than 1 or 2 days:

Tank capacity: 20 m x 10 m x 2.5 m = 500 m^3
74,000 m^3 of centrifugated water /300 days per year = 247 m^3/day

Maximum retention time: 500 m^3 / 247 m^3 = 2.03 days

As a conclusion, 3 key elements demonstrate that no emission could occur in this part of the process:

- Water utilization: internal recycling in the process and irrigation,
- Nature of water: centrifugated water after anaerobic digestion (very low quantity of organic matter and stabilized matter thanks to digestion).
- Very low retention time: 2 days maximum.

Regarding possible wastewater from composting process, it is important to precise that:

a. composting process will be operated indoor :
- To better control the humidity rate of the compost and to avoid the impact of rains.
- To give more acceptable working environment.

  Therefore, the amount of wastewater will be limited.

b. as it is mentioned in the environmental impact study, SITRADE will take care to avoid soil contamination by putting in place a impermeable membrane. Leachate collected thanks to this membrane will be transport to the tank mentioned previously

There is not project emission from wastewater that needs to be calculated. Therefore, $PE_{w,y}$= 0.

Leakage

The sources of leakage considered in the methodology are CO_2 emissions from off-site transportation of waste materials in addition to CH_4 and N_2O emissions from the residual waste from the anaerobic digestion. Positive leakages that may occur through the replacement of fossil-fuel based fertilizers with organic composts are not accounted for.

Leakage emissions should be estimated from the following equation:

$$L_y = L_{t,y} + L_{r,y} + L_{s,y} \quad \textbf{(24)}$$

Where:

$L_{t,y}$	is the leakage emissions from increased transport in year *y* (tCO_2e)
$L_{r,y}$	is the leakage emissions from the residual waste from the anaerobic digesters or compost in case it is disposed of in landfills in year *y* (tCO_2e)
$L_{s,y}$	is the leakage emissions from end use of stabilized biomass

Emissions from transportation ($L_{t,y}$)

The project may result in a change in transport emissions. This would occur when the waste is transported from waste collecting points, in the collection area, to the treatment facility, instead of to existing landfills.

When it is likely that the transport emissions will increase significantly, such emissions should be incorporated as leakage. In this case, project participants shall document the following data in the CDM PDD: an overview of collection points from where the waste will be collected, their approximate distance (in km) to the treatment facility, existing landfills and their approximate distance (in km) to the nearest end-user.

For calculations of the emissions, IPCC default values for fuel consumption and emission factors may be used. The CO_2 emissions are calculated from the quantity of fuel used and the specific CO_2-emission factor of the fuel for vehicles *i* to *n*, as follows:

$$L_{t,y} = \Sigma NO_{vehicles,i,y} \times DT_{i,y} \times VF_{cons,i} \times NCV_{fuel} \times D_{fuel} \times EF_{fuel} \quad \textbf{(25)}$$

Where:

$NO_{vehicles,i,y}$	is the number of vehicles for transport with similar loading capacity
$DT_{i,y}$	is the average additional distance traveled by vehicle type *i* compared to baseline in year *y* (km)
VF_{cons}	is the vehicle fuel consumption in liters per kilometer for vehicle type *i* (l/km)
NCV_{fuel}	is the Net Calorific Value of the fuel (MJ/Kg or other unit)
D_{fuel}	is the fuel density (kg/l), if necessary
EF_{fuel}	is the Emission Factor of the fuel (tCO_2/MJ)

In the current situation, municipal solid wastes are disposed of in Akouédo Landfill. As mentioned in section A.4.1., the project activity is located in Bingerville, 5 km away from Akouédo.

Type of vehicles	Liter /100 km	Number of vehicles	Daily additional distance (km/day)	Daily additional consumption (liter/day)	Days of operation per week	Annual additional consumption (liter/year)
Iveco ML90E18	16.3	10	100	16.3	6	5,086
Iveco ML120E21	16.8	10	100	16.8	6	5,242
Iveco AD380T38H	34.5	10	100	34.5	6	10,764
Iveco AD720T38H	36.7	2	20	7.34	6	2,290
TOTAL	**-**	**32**	**-**	**-**	**-**	**23,381**

Table 8: Increase of collecting vehicles consumption compared to the baseline.

Calculation details associated to the increase of transport is provided in section B.6.3.

Emissions from the residual waste from the anaerobic digesters or compost in case it is disposed of in landfills ($L_{r,y}$)

In the project activity, the residual waste from the anaerobic digesters will be transformed in compost through an aerobic process. The compost produced will not be disposed of in landfill; it will be used as fertilizer by local famers. Therefore, $L_{r,y} = 0$.

Off-site emissions from end-use of the stabilized biomass ($L_{s,y}$)

This section is not applicable to the project activity as the project will not generate stabilized biomass.

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

Data and parameters not monitored:

- **Baseline emissions parameters:**

(i) **Parameters to determine methane emissions avoided from dumping waste at a solid waste disposal site.**

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e / tCH_4
Description:	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
Source of data applied:	IPCC
Value of data applied:	21

Data / Parameter:	φ
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Value of data applied:	0.9
Any comment:	Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results.

Data / Parameter:	OX
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data:	Site visit at Akouédo landfill (December 2007) in order to assess the type of cover of the solid waste disposal site: there is no cover material.
Value of data applied:	Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost. Use 0 for other types of solid waste disposal. A value of zero is chosen.

Data / Parameter:	f
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value of data applied:	0.5 (IPCC default value)
Any comment:	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Data / Parameter:	DOC_f
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value of data applied	0.5 (default value)

Data / Parameter:	MCF
Data unit:	-
Description:	Methane correction factor
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value of data applied	The following value for MCF is used: • 0.8 for **unmanaged solid waste disposal sites – deep and/or with high water table**. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste. Akouédo landfill is 10 to 25 meters deep.[45]
Any comment:	The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.

Data / Parameter:	DOCj
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value of data applied	The following values for the different waste types *j* are applied:

	DOCj (% of wet waste)	DOCj (% of dry waste)
Wood and wood product	**43**	50
Pulp, paper and cardboard (other than sludge)	**40**	44
Food, food waste, beverages and tobacco	**15**	38
Textiles	**24**	30
Garden, yard and park waste	**20**	49
Glass, plastic, metal, other than inert waste	**0**	0

Any comment:	As recommended in the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site – Version 4*", long-term statistical data averages are used to determine Abidjan climate. Abidjan climate : Tropical wet Annual average rainfall : 1947 mm Annual average temperature : 26°C Source : Abidjan data derived from GHCN1 : 702 months between 1929 and 1990 Weather station ABIDJAN is at about 5.25°N 3,90°W. Height about 7m/22 feet above sea level. http://www.worldclimate.com

[45] *La politique de l'environnement dans les capitales africaines, de Guétondé Touré - 2003*

<table>
<tr><th>Data / Parameter:</th><th>kj</th></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value of data applied</td><td>The following default values for the different waste types j are used :
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th colspan="2">Boreal and Temperate (MAT>20°C)</th><th colspan="2">Tropical (MAT>20°C)</th></tr>
<tr><th>Dry (MAP/PET <1)</th><th>Wet (MAP/PET >1)</th><th>Dry (MAP <1000mm)</th><th>Wet (MAP<1000 mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper and carboard (other than sludge), textiles</td><td>0.04</td><td>0.06</td><td>0.045</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td><td>0.025</td><td>0.035</td></tr>
<tr><td rowspan="2">Rapidlydegrading</td><td>Other (no-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.10</td><td>0.065</td><td>0.17</td></tr>
<tr><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.06</td><td>0.185</td><td>0.085</td><td>0.40</td></tr>
</table>
</td></tr>
<tr><td>Any comment:</td><td>As recommended in the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site – Version 4”, long-term statistical data averages are used to determine Abidjan climate.

<u>Abidjan climate</u> : Tropical wet
Annual average rainfall : 1947 mm
Annual average temperature : 26°C
Source : Abidjan data derived from GHCN1 : 702 months between 1929 and 1990
Weather station ABIDJAN is at about 5.25°N 3,90°W.
Height about 7m/22 feet above sea level.
http://www.worldclimate.com</td></tr>
</table>

Project emissions and leakage emissions parameters:

(ii) Parameters to determine emissions from fuel use:

Data / Parameter:	**$NCV_{i,y}$**
Data unit:	TJ/t
Description:	Weighted average net calorific value of fuel type *i* in year *y*
Source of data:	IPCC Guideline 2006 – Volume 2 - Table 1.2 : “DEFAULT NET CALORIFIC VALUES (NCVs) AND LOWER AND UPPER LIMITS OF THE 95% CONFIDENCE INTERVALS”
Value of data applied	0.043 TJ/t for gas-oil
Monitoring frequency:	Any future revision of the IPCC Guidelines should be taken into account
Any comment:	IPCC value has been chosen for conservative estimation.

Data / Parameter:	**$EF_{CO2,i,y}$**
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor of fuel type *i* in year *y*
Source of data:	IPCC Guideline 2006 Vol 2 table 1.4 : “DEFAULT CO_2 EMISSION FACTORS FOR COMBUSTION”
Value of data applied:	74.1 tCO_2/GJ for gas-oil
Monitoring frequency:	Any future revision of the IPCC Guidelines should be taken into account
Any comment:	IPCC value has been chosen for conservative estimation.

<table>
<tr><td>Data / Parameter:</td><td>$\rho_{i,y}$ (=D_{fuel} for leakage emissions due to increase of transportation)</td></tr>
<tr><td>Data unit:</td><td>Mass unit / volume unit</td></tr>
<tr><td>Description:</td><td>Weighted average density of fuel type i in year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><td>Data source</td><td>Conditions for using the data source</td></tr>
<tr><td>a)Values provided by the fuel supplier in invoices</td><td>This is the preferred source.</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available
These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>d) IPCC default values at the upper 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</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Source of data used :</td><td>Option c is chosen : Société Ivoirienne de Raffinage.</td></tr>
<tr><td>Value of data applied:</td><td>0.880</td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international fuel standards.</td></tr>
<tr><td>Monitoring frequency:</td><td>For a) and b): The CO_2 emission factor should be obtained for each fuel delivery, from</td></tr>
</table>

	which weighted average annual values should be calculated For c): Review appropriateness of the values annually For d): Any future revision of the IPCC Guidelines should be taken into account.
QA/QC procedures:	
Any comment:	Applicable where option B is used. For a): If the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options b), c) or d) should be used.

(iii) **Parameters to determine emissions from composting:**

Data / Parameter:	**$EF_{C,N2O}$**
Data unit:	kg N_2O/tons of compost
Description:	Emission factor for N_2O from the composting process
Source of data to be used:	Research literature
Value of data applied:	0.043

(iv) **Parameters to determine emissions from anaerobic digestion:**

- ***CH_4 Emissions from leakage ($PE_{a,l,y}$)***

Data / Parameter:	**P_1**
Data unit:	Fraction
Description:	Leakage of methane emissions from anaerobic digester
Source of data to be used:	Technology provider (PROMECO Spa)
Value of data applied:	0
Description of measurement methods and procedures to be applied:	**Option 3** is chosen. Option 1: Monitoring the actual quantity of the gas leakage; Option 2: Applying an appropriate IPCC physical leakage default factor, justifying the selection; Option 3: Applying a physical leakage factor of zero where advanced technology used by the project activity prevents any physical leakage. In such cases, the project proponent must provide the DOE with details of the technology to prove that zero leakage factor is justified.

Data / Parameter:	**P_2**
Data unit:	Fraction
Description:	Leakage of methane emissions from gas holders
Source of data to be used:	Technology provider (PROMECO Spa)
Value of data applied:	0
Description of measurement methods and procedures to be applied:	**Option 3** is chosen. Option 1: Monitoring the actual quantity of the gas leakage; Option 2: Applying an appropriate IPCC physical leakage default factor, justifying the selection; Option 3: Applying a physical leakage factor of zero where advanced technology used by the project activity prevents any physical leakage. In such cases, the project

	proponent must provide the DOE with details of the technology to prove that a zero leakage factor is justified.

- ***Emissions from anaerobic digestion stacks ($PE_{a,s,y}$)***

Data / Parameter:	**NCV_{biogas}**
Data unit:	TJ/Gg of biogas
Description:	Net Calorific Value of biogas
Source of data to be used:	IPCC Guidelines for National Greenhouse Gas Inventories 2006, Volume 2 Energy - Chapter 1: Introduction - TABLE 1.2 Default net calorific values (NCVs) and lower and upper limits of the 95% confidence intervals, **default value** for the category "Other Biogas" page 1.18
Value of data applied:	50.4
Comment	Value use to estimate ex-ante $PE_{a,s,y}$. As emission factors are expressed in kg of greenhouse gases per TJ, the use of the default NCV value provided by IPCC is the most relevant.

Data / Parameter:	**$EF_{CH4, biogas}$**
Data unit:	kg CH4/TJ
Description:	Methane emission factor for biogas
Source of data to be used:	IPCC Guidelines for National Greenhouse Gas Inventories 2006, Volume 2 Energy - Chapter 2: Stationary Combustion, TABLE 2.5 – Default emission factors for stationary combustion in the residential and agricultural, forestry, fishing; fishing farms categories, **default values** for the category "Other Biogas".
Value of data applied:	5
Comment	Value use to estimate ex-ante $PE_{a,s,y}$. As emission factors are expressed in kg of greenhouse gases per TJ, the use of the default NCV value provided by IPCC is the most relevant.

Data / Parameter:	**$EF_{N2O, biogas}$**
Data unit:	kg N_2O/TJ
Description:	Nitrous oxyde emission factor for biogas
Source of data to be used:	IPCC Guidelines for National Greenhouse Gas Inventories 2006, Volume 2 Energy - Chapter 2: Stationary Combustion, TABLE 2.5 – Default emission factors for stationary combustion in the residential and agricultural, forestry, fishing; fishing farms categories, **default values** for the category "Other Biogas"
Value of data applied:	0.1
Comment	Value use to estimate ex-ante $PE_{a,s,y}$. As emission factors are expressed in kg of greenhouse gases per TJ, the use of the default NCV value provided by IPCC is the most relevant.

B.6.3 Ex-ante calculation of emission reductions:

- Baseline emissions

(i) Baseline emissions from methane emissions avoided from dumping waste at a solid waste disposal site.

Waste type j	Proportion	k_j %	DOC_j (% wet waste)
Pulp, paper and cardboard	1.26%	0.07	40%
Textiles	0.59%	0.07	24%
Wood and wood products	0.00%	0.035	43%
Garden, yard and park waste	24.40%	0.17	20%
Food, food waste	58.57%	0.4	15%
Glass, plastic, metal, other inert waste	15.18%	0	0%
Total	**100.00%**		

Table 9: Waste composition[46], kj, DOCj.

Year	Quantity of waste before sorting	Quantity of waste after sorting
	tons	tons
2009 (from April 1st)	58,800	41,200
2010	174,300	122,000
2011	200,000	140,000
2012	200,000	140,000
2013	200,000	140,000
2014	200,000	140,000
2015	200,000	140,000
2016 (to March 31st)	50,000	35,000
Total	**1, 283,100**	**898,200**

For emissions reduction calculation, the quantity of waste after sorting is taken into account.

φ	90%
AF	0%
GWP_{CH4}	21
OX	0%
F	50%
DOC_f	50%
MCF	80%

Year	Baseline emission from methane emissions avoided from dumping waste at a solid waste disposal site Mb_y
	tCO_2e
2009 (from April 1st)	7,689
2010	28,221
2011	46,183
2012	59,067
2013	68,422
2014	75,306
2015	80,443
2016 (to March 31st)	57,508
Total	**422,840**

46 *«Stratégie Nationale de Gestion Durable des Déchets », Ministry of Environment, BNETD, 2000*

(ii) Baseline emissions from generation of energy displaced by the project activity.

CM EF	0,7291 tCO_2/MWh

Please refer to Annex 3 for grid emission factor calculation.

Year	$EG_{d,y}$	Baseline emissions from generation of energy displaced by the project activity $BE_{EN,y}$
	MWh	tCO_2e
2009 (from April 1st)	3,012	2,196
2010	16,915	12,333
2011	20,544	14,979
2012	20,544	14,979
2013	20,544	14,979
2014	20,544	14,979
2015	20,544	14,979
2016 (to March 31st)	5,136	3,745
Total	**127,783**	**93,167**

- Project emissions

(i) Emissions from electricity consumption used on-site ($PE_{elec,y}$)

Year	$PE_{elec,y} = EG_{PJ,FF,y} * CEF_{elec}$ (2)		
	$PE_{elec,y}$	$EG_{PJ,FF,y}$	CEF_{elec}
	tCO_2	MWh	tCO_2/MWh
2009 (from April 1st)	729	1,000	0.7291
2010	0	0	
2011	0	0	
2012	0	0	
2013	0	0	
2014	0	0	
2015	0	0	
2016 (to March 31st)	0	0	
Total	**729**	**1,000**	-

(ii) Emissions from fuel use on-site ($PE_{fuel, on-site,y}$)

$PE_{fuel,on-site,y} = F_{cons,y}$ x NCV_{fuel} x EF_{fuel}					
Year	$PE_{fuel, on-site,y}$	Fuel Cons.	Fuel Dens.	NCV_{fuel}	EF_{fuel}
	tCO_2/year	liters/year	t/L	TJ/t	tCO_2/TJ
2009 (from April 1st)	1,615	137,574	0.00088	0.043	74.1
2010	773	65,832	0.00088	0.043	74.1
2011	773	65,832	0.00088	0.043	74.1
2012	773	65,832	0.00088	0.043	74.1
2013	773	65,832	0.00088	0.043	74.1
2014	773	65,832	0.00088	0.043	74.1
2015	773	65,832	0.00088	0.043	74.1
2016 (to March 31st)	193	16,458	0.00088	0.043	74.1

Total	**6,444**	-	-	-	-

(iii) Emissions from composting ($PE_{c,y}$)

$PE_{c,y} = PE_{c,N2O} + PE_{c,CH4,y}$							
Year	$PE_{N2O,y}=M_{compost,y}*EF_{c,N2O}*GWP_{N2O}$				$PE_{c,CH4,y}=MB_{compost,y}*GPW_{CH4}*S_{a,y}$		
	$PE_{c,y}$	$PE_{c,N2O,y}$	$M_{compost,y}$	$EF_{c,N2O}$	$PE_{c,CH4,y}$	$MB_{compost,y}$	$S_{a,y}$
	tCO_2e	tCO_2e	tonnes/a	t N_2O/t compost	tCO_2e	tCH_4	%
2009 (from April 1st)	123	96	7,227	4.30E-05	27	64	2%
2010	472	354	26,531	4.30E-05	118	281	2%
2011	578	386	28,935	4.30E-05	192	457	2%
2012	631	386	28,935	4.30E-05	245	583	2%
2013	669	386	28,935	4.30E-05	283	675	2%
2014	697	386	28,935	4.30E-05	312	742	2%
2015	718	386	28,935	4,30E-05	333	792	2%
2016 (to March 31st)	334	96	7,233	4.30E-05	238	566	2%
Total	**4,223**	**2,475**	**185,666**	**-**	**1,748**	**4,161**	**-**

(iv) Emissions from anaerobic digestion ($PE_{c,y}$)

Emissions associated to gasholders are assumed to be zero.

Emissions associated to stack gas are estimated ex-ante and monitored during the crediting period.

Methane density at STP (273.15 °K and 1013 bar).	0.0007168	tCH_4/m^3CH_4.
NCV biogas	50.4	TJ/Gg of biogas [47]
EF_{CH4}	5	kg CH_4/TJ[48]
EF_{N2O}	0.1	kg N_2O/TJ[49]
GWP_{CH4}	21	
GWP_{N2O}	310	

	$PE_{a,s,y} = SG_{a,y} * MC_{N2O,a,y} * GWP_{N2O} + SG_{a,y} * MC_{CH4,a,y} * GWP_{CH4}$					
	$PE_{a,s,y}$	CH_4 emissions	N_2O emissions	Energy	Biogas	
	teq CO_2	tCH_4	tN_2O	TJ	m^3	Tonnes
2009 (9 months)	26	1.030	0.021	205.9	5,700,000	4,086
2 010	35	1.373	0.027	274.6	7,600,000	5,448
2 011	52	2.059	0.041	411.8	11,400,000	8,172
2 012	52	2.059	0.041	411.8	11,400,000	8,172
2 013	52	2.059	0.041	411.8	11,400,000	8,172
2 014	52	2.059	0.041	411.8	11,400,000	8,172
2 015	52	2.059	0.041	411.8	11,400,000	8,172
2016 (3 months)	13	0.515	0.010	103.0	2,850,000	2,043
Total	**333**					

[47] *IPCC Guidelines for National Greenhouse Gas Inventories 2006, Volume 2 Energy - Chapter 1: Introduction - TABLE 1.2 Default net calorific values (NCVs) and lower and upper limits of 95% confidence intervals,* ***default value*** *for the category "Other Biogas" page 1.18 (i.e. 50.4 TJ/Gg)*

[48] *IPCC Guidelines for National Greenhouse Gas Inventories 2006, Volume 2 Energy - Chapter 2: Stationary Combustion, TABLE 2.5 – Default emission factors for stationary combustion in residential and agridulture / forestry / fishing / fishing farms categories.* ***default values*** *for the category "Other Biogas"*

[49] *IPCC Guidelines for National Greenhouse Gas Inventories 2006, Volume 2 Energy - Chapter 2: Stationary Combustion, TABLE 2.5 – Default emission factors for stationary combustion in residential and agridulture / forestry / fishing / fishing farms categories.* ***default values*** *for the category "Other Biogas"*

(v) Emissions from wastewater treatment ($PE_{w,y}$)

There is not project emission from wastewater that needs to be calculated. Therefore, $PE_{w,y}$= 0.

Summary of project emissions.

Year	$PE_{elec,y}$	$PE_{fuel, on-site,y}$	$PE_{c,y}$	$PE_{a,s,y}$	Total PE_y
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2009 (from April 1st)	729	1,615	123	26	2,493
2010	0	773	472	35	1,279
2011	0	773	578	52	1,402
2012	0	773	631	52	1,455
2013	0	773	669	52	1,494
2014	0	773	697	52	1,522
2015	0	773	718	52	1,543
2016 (to March 31st)	0	193	334	13	540
Total	**729**	**6,444**	**4,223**	**333**	**11,729**

- Leakage emissions

(i) Leakage emissions from increased transport

$L_{t,y}=F_{cons,y}*NCV_{fuel}*EF_{fuel}$					
Year	$L_{t,y}$	**Fuel Cons.**	**Fuel Dens.**	NCV_{fuel}	EF_{fuel}
	t CO_2/year	L/year	t/L	MJ/kg	t CO_2/TJ
2009 (from April 1st)	206	17,536	0.00088	0.043	74.1
2010	274	23,381	0.00088	0.043	74.1
2011	274	23,381	0.00088	0.043	74.1
2012	274	23,381	0.00088	0.043	74.1
2013	274	23,381	0.00088	0.043	74.1
2014	274	23,381	0.00088	0.043	74.1
2015	274	23,381	0.00088	0.043	74.1
2016 (to March 31st)	69	5,845	0.00088	0.043	74.1
Total	**1,921**	-	-	-	-

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

Year	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2 e)
2009 (from April 1st)	2,493	9,885	206	7,186
2010	1,279	40,554	274	39,001
2011	1,402	61,161	274	59,485
2012	1,455	74,046	274	72,316
2013	1,494	83,401	274	81,633
2014	1,522	90,285	274	88,488
2015	1,543	95,422	274	93,604
2016 (to March 31st)	540	61,253	69	60,605
Total (tonnes of CO_2e)	**11,729**	**516,006**	**1,921**	**502,318**

Total number of crediting years	**7 years**
Annual average of estimated reductions over the crediting period (tCO_2e)	**71,760**

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

B.7.1 Data and parameters monitored:

The monitoring methodology AM0025 “Avoided methane emissions from organic waste through alternative waste treatment process” is applied. All data will be archived for 2 years following the end of the crediting period by means of electronic and paper backup.

Baseline emission parameters monitored:

i. ***Parameters to determine methane emissions avoided from dumping waste at a solid waste disposal site.***

Data / Parameter:	$Rate_y^{compliance}$
Data unit:	Number
Description:	Rate of compliance
Source of data to be used:	On site visits at Akouédo landfill. Written statement from the technical director of Akouédo landfill.
Description of measurement methods and procedures to be applied:	The compliance rate is based on the annual reporting of the municipal bodies issuing these reports. The state-level aggregation involves all landfill sites in the country. If the rate exceeds 50%, no CERs can be claimed.
Value of data applied	0
Monitoring frequency:	Annual

Data / Parameter:	AF
Data unit:	%
Description:	Methane destroyed due to regulatory or other requirements.

Source of data:	Ministère de la Ville et de la Salubrité Publique de Côte d'Ivoire
Monitoring frequency:	At renewal of crediting period
QA/QC procedures:	Data are derived from or based upon local or national guidelines, so QA/QC procedures for these data are not applicable. A specialized law Ivorian law firm will issue a specific statement based on the national regulation.
Any comment:	Changes in regulatory requirements, relating to the baseline landfill(s) need to be monitored in order to update the adjustment factor (AF), or directly MDreg.. This is done at the beginning of each crediting period.

Data / Parameter:	**Wx**
Data unit:	tons
Description:	Total amount of organic waste prevented from disposal in year *x* (tons)
Source of data:	Measurements by SITRADE
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	
Any comment:	

Data / Parameter:	$\mathbf{p_{n,j,x}}$
Data unit:	-
Description:	Weight fraction of the waste type *j* in the sample *n* collected during the year *x*
Source of data:	Sample measurements by SITRADE.
Monitoring frequency:	The size and frequency of sampling should be statistically significant with a maximum uncertainty range of 20% at a 95% confidence level. As a minimum, sampling should be undertaken four times per year.
Measurement procedures:	Sample the waste prevented from disposal, using the waste categories *j*, as provided in the table for *DOCj* and *kj*, and weigh each waste fraction.
Any comment:	This parameter needs to be monitored because of the waste prevented from disposal includes several waste categories *j*, as categorized in the tables for *DOCj* and *kj*.
Data / Parameter:	**z**
Data unit:	-
Description:	Number of samples collected during the year *x*
Source of data:	SITRADE
Monitoring frequency:	Continuously, aggregated annually
Measurement procedures:	
Any comment:	This parameter needs to be monitored because of the waste prevented from disposal includes several waste categories *j*, as categorized in the tables for *DOCj* and *kj*.

ii. Parameters to determine emissions displaced through electricity generation

Data / Parameter:	$\mathbf{EG_{d,y}}$
Data unit:	MWh
Description:	Amount of electricity generated utilizing the biogas in the project activity displacing electricity in the baseline during the year '*y*' (electricity delivered to the grid).
Source of data:	Electricity meter
Measurement procedures (if any):	The readings of electricity meter will be measured continually and monthly recorded.

Monitoring frequency:	Continuous
QA/QC procedures:	The electricity output from engines will be monitored and recorded at the on-site control centre using a computer system. SITRADE is responsible for recording this set of data. Electricity sales receipts will be double checked with the financial/audit department.
Any comment:	

Data / Parameter:	**CEF_d**
Data unit:	tCO_2 e/MWh
Description:	Electricity emission factor for displaced electricity generation
Source of data to be used:	The grid emission factor used in the project is 0,5370 (see emission factor calculation in section B.6.3). The "*Tool to calculate the emission factor for an electricity system*" is applied.
Value of data applied	0.7399
Description of measurement methods and procedures to be applied:	SITRADE has chosen the option 1 of the **"Tool to calculate the emission factor for an electricity system"**. According to the Ministry of Energy[50], it seems that the additional future forecasted power plant units will be mainly fossil fuel based. Therefore, SITRADE has chosen the more conservative approach. This value will be updated at the beginning of each new crediting period.

- **Project emissions parameters monitored:**

(i) <u>Parameters to determine emissions from electricity consumed from the grid :</u>

Data / Parameter:	**$EG_{PJ,FF,y}$**
Data unit:	MWh
Description:	Amount of electricity consumed from the grid as a result of the project activity
Source of data:	Electricity meter
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	Electricity meter will be subject to regular maintenance and testing to ensure accuracy (in accordance with instructions from the meter supplier) The readings will be double checked by the electricity distribution company (SOPIE).
Any comment:	

(ii) <u>Parameters to determine emissions from fuel use on-site:</u>

Data / Parameter:	**$FC_{i,j,y}$**
Data unit:	Mass or volume unit per year (e.g. ton/yr or m^3/yr)
Description:	Quantity of fuel type *i* combusted in process *j* during the year *y*
Source of data:	On-site measurements, Purchase invoices.
Measurement procedures (if any):	• Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the

[50] *On-site interview with N'Guessan Pacôme N'CHO in charge of Energy Efficiency and Renewable Energy Department at the Ministry of Energy, thursday 28th of February, Abidjan, Hotel Tiama. This interview took place with the representatives of the DOE.*

	following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift); • Accessories such as transducers, sonar and piezoelectronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance; • In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions.
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered fuel consumption quantities should be crosschecked by an annual energy balance based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be crosschecked with available purchase invoices from the financial records.
Any comment:	

(iii) ***<u>Parameters to determine emissions from composting:</u>***

Data / Parameter:	$\mathbf{M_{compost,y}}$
Data unit:	tons
Description:	Total quantity of compost produced in year '*y*'.
Source of data:	Plant records.
Measurement procedures (if any):	Data will be archived for 2 years following the end of the crediting period by means of electronic and paper backup.
Value of data applied	
Monitoring frequency:	Annual
QA/QC procedures:	Weighed on calibrated scale; also double check with sales of compost.
Any comment:	The compost produced will be trucked off from site. All trucks leaving the site will be weighed. Possible temporary storage of compost will be weighed for calculations carbon credits purposes.

Data / Parameter:	$\mathbf{S_{a,y}}$
Data unit:	%
Description:	Share of the waste that degrades under anaerobic conditions in the composting plant during year '*y*'.
Source of data:	$\mathbf{S_{OD,y} / S_{total,y}}$
Measurement procedures (if any):	See $S_{total,y}$
Monitoring frequency:	Weekly
QA/QC procedures:	See $S_{total,y}$
Any comment:	Used to determine percentage of compost material that behaves anaerobically.

Data / Parameter:	$\mathbf{S_{OD,y}}$
Data unit:	Number
Description:	Number of samples with oxygen deficiency (i.e. oxygen content below 10%).
Source of data:	Measurement by SITRADE using an Oxygen measurement device
Measurement procedures (if any):	See $S_{total,y}$

Monitoring frequency:	Weekly
QA/QC procedures:	See $S_{total,y}$
Any comment:	Samples with oxygen content <10%. Weekly measurements throughout the year but accumulated once per year only.

Data / Parameter:	$\mathbf{S_{total,y}}$
Data unit:	Number
Description:	Number of samples
Source of data:	Measurement by SITRADE using an oxygen measurement device
Measurement procedures (if any):	Statistically significant
Monitoring frequency:	Weekly
QA/QC procedures:	O_2-measurement-instrument will be subject to periodic calibration (in accordance with instruction of instrument-supplier). Measurement itself to be done by using a standardised mobile gas detection instrument. A statistically significant sampling procedure will be set up that consists of multiple measurements throughout the different stages of the composting process according to a predetermined pattern (depths and scatter) on a weekly basis.
Any comment:	Total number of samples taken per year, where $S_{total,y}$ should be chosen in a manner that ensures estimation of $S_{a,y}$ with 20% uncertainty at 95% confidence level. To determine the oxygen content during the process, project participants shall measure the oxygen content according to a predetermined sampling scheme and frequency. These measurements should be undertaken for each year of the crediting period and recorded each year.

(iv) Parameters to determine emissions from anaerobic digestion stacks ($PE_{a,s,y}$)

Data / Parameter:	$SG_{a,y}$
Data unit:	m^3/yr
Description:	Stack gas volume flow rate
Source of data:	Project participants
Measurement procedures (if any):	
Monitoring frequency:	Continuous or periodic (at least quarterly)
QA/QC procedures:	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected.
Any comment:	The stack gas flow rate is either directly measured or calculated from other variables where direct monitoring is not feasible. Where there are multiple stacks of the same type, it is sufficient to monitor one stack of each type. The stack gas volume flow rate may be estimated by summing the inlet biogas and air flow rates and adjusting for stack temperature. Air inlet flow rate should be estimated by direct measurement using a flow meter.

Data / Parameter:	$MC_{N2O,a,y}$
Data unit:	tN_2O/m^3
Description:	Concentration of N_2O in stack gas
Source of data:	Project Participants

Measurement procedures (if any):	
Monitoring frequency:	At least quarterly
QA/QC procedures:	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected.
Any comment:	More frequent sampling is encouraged

Data / Parameter:	$MC_{CH4,a,y}$
Data unit:	tCH_4/m^3
Description:	Concentration of CH_4 in stack gas
Source of data:	Project Participants
Measurement procedures (if any):	
Monitoring frequency:	At least quarterly
QA/QC procedures:	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected.
Any comment:	More frequent sampling is encouraged

- **Leakage emissions parameters monitored:**

(i) ***<u>Parameters to determine emissions from transportation:</u>***

Data / Parameter:	$\mathbf{NO_{vehicles,i,y}}$
Data unit:	Number
Description:	Vehicles per carrying capacity per year
Source of data:	Project developer
Measurement procedures (if any):	Counter should accumulate the number of trucks per carrying capacity
Monitoring frequency:	Annual
QA/QC procedures:	Number of vehicles shall be consistent with total amount of sold compost. The ratio will be checked by DOE.
Any comment:	

Data / Parameter:	**DTi,y**
Data unit:	km
Description:	Average additional distance travelled by vehicle type '*i*' compared to the baseline in year '*y*'.
Source of data:	Project developer
Measurement procedures (if any):	The average additional distance is equal to the distance between Akouédo landfill and the project site.
Monitoring frequency:	Annual
QA/QC procedures:	Assumption to be approved by DOE.
Any comment:	

Data / Parameter:	$\mathbf{F_{cons,y}}$
Data unit:	Liter
Description:	Fuel consumption on-site in a year *y*
Source of data:	Purchase invoices.
Measurement procedures	The data of each year will be summed up and recorded.
Monitoring frequency:	Annual
QA/QC procedures:	The amount of fuel will be derived from the paid fuel invoices (administrative obligation).
Any comment:	

Data / Parameter:	$\mathbf{VF_{cons}}$
Data unit:	L/km
Description:	Vehicle fuel consumption in liters per kilometer for vehicle type *i*
Source of data:	Technology provider (Promeco Spa) for ex-ante estimation and fuel consumption record during the project activity.
Measurement procedures	
Monitoring frequency:	Annual
QA/QC procedures:	
Any comment:	

- **Other parameters:**

Data / Parameter:	**Amount of compost produced**
Data unit:	tons
Description:	Project Proponents shall monitor the amount of the compost produced from the composting treatment process.
Source of data:	Project Site
Measurement procedures (if any):	Sales invoices of the compost should be kept at the project site. They should contain customer contact details, physical location of delivery, type, amount (in tons) and the use of compost. A list of customers and delivered compost amount should be kept at the project site.
Monitoring frequency:	Weekly
QA/QC procedures:	Data will be archived for 2 years following the end of the crediting period by means of electronic and paper backup.
Any comment:	

B.7.2 Description of the monitoring plan:

The project is operated and managed by SITRADE who is the project proponent. SITRADE ensures the overall site operation safety in accordance with Ivorian Laws and technology providers' guidelines.

A specific monitoring plan has been established for Abidjan Municipal Solid Waste-to-Energy Project. The following paragraphs are an extract of this document.

The following list presents different tasks envisaged by various units/departments of SITRADE:

1. **Technical/Engineering/Maintenance Department**; SITRADE may already practice equipment monitoring and maintenance as part of the Standard Operation/Maintenance Procedure.
2. **Accounting/Sales/Purchasing Departments**; Several CDM data are needed to be crosschecked, reconciled or consolidated with multiple sources whenever possible. For example, the project exports electricity to grid, the data obtained from the electricity meters can be crosschecked against the sales receipts issued by SOPIE. This kind of reconciliation activity will be recorded properly as DOE may request for such information during the verification.
3. **Finance Department**; CERs are either cash flow or equity related. The finance department may find it necessary to monitor the amount of emission reduction to estimate the financial risks/potential revenue. In such a case, the finance department may feel the need to monitor CER production closely.

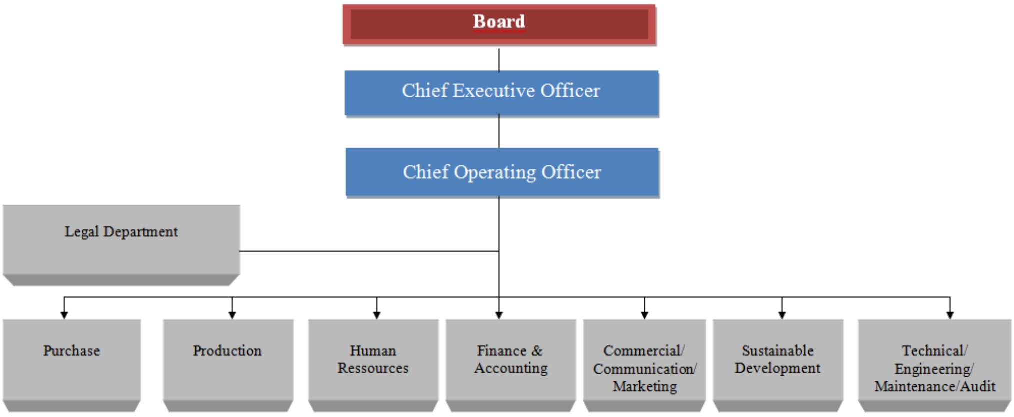

Figure 8: SITRADE organisation chart.

Mr. Kouadio Yao Léonard, Chief Executive Officer of SITRADE (refer to figure 8), will establish a CDM team dedicated to the project activity monitoring. The Board of SITRADE will appoint a CDM coordinator.

The responsibility of the CDM coordinator covers supervision for:

1. Monitoring equipment compliance check, ensuring that instrumentations and devices are available and properly suited to perform its function for emission reduction monitoring;
2. Development, execution, analysis and improvement of the Standard (CDM) Monitoring/Reporting Procedures;
3. Deployment of the procedures through trainings, ensuring that these procedures are fully complied with;
4. Communication and coordination between and among multiple departments in a company to disseminate CDM related information;
5. Calculation and reporting of the emission reductions and;
6. Liaison with a DOE during the verification.

The CDM coordinator will be a senior and experienced engineer.

In addition to the check of data sources and resources, a monitoring plan strategy will be implemented by SITRADE. This strategy will cover the following:

A. **Distribution of Data Collection Tasks**. SITRADE will assign member of its staff for every data that has to be recorded. Step-by-step instructions on how the data will be measured, logged, consolidated and archived will be provided to this monitoring team.

B. **Distribution of Equipment Calibration Tasks**. For every instrument or device that is used for CDM monitoring, its associated calibration means, standard, and requirement will be identified and a procedure will be established to ensure its compliance to the monitoring plan.

C. **Mechanism for Data Reconciliation**. SITRADE will identify which data is required to be reconciled from other sources and will integrate this step as part of the standard procedure for monitoring.

D. **Archiving Data and Reports**. Data will be maintained for a minimum of 2 years after the crediting period. In order to meet this obligation, SITRADE will establish the means of data keeping and maintenance that ensure the survival of data for the required period.

E. **Emission Reduction Calculation & Reporting**. A calculation and reporting format report has been established. This template will be used throughout the crediting period. This document will significantly reduce the volume of data consolidation and facilitate reporting prior to the verification process. Moreover, a project logbook will be established in which all events relevant for the projects performance (breakdowns, errors, all deviations from normal procedure) are noted down. This logbook will help to recall and explain certain deviations during the verification audits.

F. **Personnel Trainings and Procedure Compliance.** SITRADE will delegate tasks and will ensure that human resources are properly trained to perform the tasks in the appropriate manner. SITRADE will identify trainings that might be required to ensure that the tasks can be carried out smoothly. For example, the person in charge to perform gas sampling should have a good understanding on how the sample should be taken and handled to minimize contamination. They should also have a good understanding of statistical knowledge to perform the tasks within the confidence required by the monitoring plan.

SITRADE has drafted an equipment naming and labeling system. This plan will allow equipment and instruments to be easily referred to onsite and accurately labeled for documentation purposes. The naming and labeling of the equipment and instrument will be unique and clear, preferably using materials that will not be damaged by heat or moisture.

The naming and labeling system will be accompanied with a map that indicates:

a) Major equipment with a unique name;
b) Major pipe network to which the instrumentations are attached indicating the material flow;
c) Location of instrumentations relative to the major equipment with a unique name;
d) Location of any sampling points relative to the major equipment with a unique name.

Figure 9 (please refer to Annex 4) illustrates the simple Process Flow Diagram (PFD) of the Abidjan Municipal Waste-to-Energy Project: biogas extraction system for electricity/heat generation and compost production from urban solid waste stream. The biogas from waste stream is extracted from an anaerobic digester, AD-101, before being fed to an electricity generation system, EG-101, and a heat generation system, HS-101. Excess gas is flared in unit FL-101. After anaerobic fermentation step, digestate is transformed in compost, CP-101. The position of all

instrumentations, indicators, sampling points relative to major equipment, and directions of material flow are indicated in the diagram.

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)

Date of completion: April 25th 2008

Name of entity determining the baseline:

ecosur
2 rue Greuze
75116 Paris
France
Tel. +33 1 47 55 06 78
Fax +33 1 45 05 27 02

Name of the contact person in charge of baseline calculation:

Aurélie Lepage
a.lepage@ecosur.fr
Tel. +33 1 47 55 06 78

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:

February 25th 2008, date of the agreement between the equipment supplier (PROMECO) and the project participant (SITRADE).

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

At least 25 years (300 months)

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:

The crediting period will start on April 1st 2009, or on the date of registration of the CDM project, whichever is later.

C.2.1.2. Length of the first crediting period:

7 years (84 months)

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

N/A

C.2.2.2. Length:

N/A

SECTION D. Environmental impacts

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

SITRADE has undertaken an Environmental Impact Assessment (EIA) from December 2007 to January 2008. The EIA has been carried out in compliance with the laws of Ivory Coast:

- **Environmental Code** (Law n°96-766 October 3rd 1996, Title IV ; Chapter I ; Articles 39 and 40)
- **Decree related to EIA procedures** (Decree n°96-894 November 8th 1996)

The final EIA report has been made publicly available for the purpose of this project; it will be transmitted to the DOE.

Technical data provided by engines manufacturer indicate that NO and CO emissions are low:

- NOx < 450 mg/m^3
- CO < 650 mg/m^3

"The main results of the environmental impact study regarding the proposed construction of the municipal waste treatment plant are listed below:

The physical environment outside the lagoon area should not suffer of significant adverse impact if the mitigation measures are followed, particularly those relating to the choice, the exploitation and the rehabilitation of borrowing and quarries areas;

• the lagoon area should not be affected by significant changes. The project implementation won't be in itself a source of pollution. However it is possible that the plant affect the hydrodynamics of the area.
• the biological environment will not be significantly affected if the recommendations are taken into account;
• Consequences of the project for the farming area will be minor. The only agricultural land that will be affected (destruction) are the ones included in the immediate borrowing zone. All damages will be fully compensated.
• The local population will be the first to benefit from the project.

The plant will respected the CEE rules regarding the decibel levels.

The explosion risks on digestate deposit are extremely low considering the storage time of 2 hours.

A mitigation plan has been established to overcome the negative impact identified (please see section E.3.)

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:

The EIA concludes that there will be no significant impact related to the project construction and operation.

SECTION E. Stakeholders' comments

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

Stakeholders have been invited to submit their comments according to the procedures established by the decree n°96-894 of November 8th 1996.

The stakeholder's consultation is composed of two distinct phases:

1. Meetings with local authorities:

The project has been introduced to the local authorities for an open discussion during two meetings organized by YOGA Félicien, an external consultant (BNTED) mandated by SITRADE.
The first meeting took place in Bingerville city hall the 18th of January 2008 from 9 am to 2 pm. Participants included:

- M. TOURE PEGNOUGO: 3rd Deputy Mayor of Bingerville
- M. KOFFI CELESTIN: 4th Deputy Mayor of Bingerville
- M. KABY GNAHOUA: SITRADE representative – in charge of external relations
- M. YOGA FELICIEN: Independent third party (BNETD)

The whole project documentation has been submitted to the city mayor chief of staff before the meeting and was available for all members of the city council. During the meeting Mr. KABY, the SITRADE representative introduced briefly the project. Then a conversation started with the participants. The comments received are summarized in section E.2.

Figure 9: Meeting with deputy mayors of Bingerville

The second meeting took place in the house of the village chief of Adjamé-Bingerville the 18th of January 2008 from 4.30 pm to 6.30 pm. Participants included:

- M. ACRADJI GUSTAVE : Chief of the Adjamé-Bingervillevillage
- M. DJOMAN Aba Sévérin : Notable
- M. N'KREDJI Nicolas: Notable
- M. MOBIO Grégoire: Member of supervisory committee
- M. YAPI Marcel: President of supervisory committee
- M. GBALOUE Grégoire: Landowner
- M. AYAKE Germain: Citizen of Bingerville and observer
- M. KABY GNAHOUA: SITRADE representative – in charge of external relations
- M. YOGA FELICIEN: Independent third party (BNETD)

As in the first meeting, Mr. KABY introduced the project and then started to discuss with the participants. The comments received are summarized in section E.2.

2. Public consultation:

The public consultation has been organized during two days between the 11th and 12thof January 2008 from 9 am to 11 am and from 3pm to 6 pm.

The public consultation has been undertaken following a survey methodology. M. YOGA Félicien – an independent expert (BNETD) - has been mandated by SITRADE to organize the survey and to receive the comments.

The population of Bingerville is around 56.357 people. Mr. YOGA Félicien selected 80 people using a sampling method based on the following criteria:

- 25 women between 15 to 35 years,
- 25 women over 35 years,
- 25 men between 15 to 35 years,
- 25 men over 35 years.

The complete list with the full name of each interviewed person has been submitted to the DOE and is publicly available.

E.2. Summary of the comments received:

All the comments received have been reported in a document made publicly available and submitted to the DOE for the purpose of this PDD.

1. Meetings with local authorities:

Local authorities expressed a strong support for the project. The city concil of Bingerville voted and agreed to support officially SITRADE. They underlined the fact that SITRADE is the first company to choose the new industrial zone of Bingerville to develop an activity. They hope that the project will foster local employment and will also provide indirect benefits. Thanks to the project, they are glad to increase the budget of the city; Bingerville has a number of public services to restore. Local authorities emphasized that SITRADE should be involved to Bingerville commuity projects (financing, expertise, education,…). Three of them are top priorities: restoration of the local hospital, restoration of the city college and reconstruction of the orphanage. The project has been described as a chance for the city of Bingerville. The main concern is linked to the use of local workers and

road safety measures. SITRADE had also to explain again clearly that the project is not a landfilling activity like in Akouédo.

2. Public consultation:

The comments show a strong support for the project as the population hope that the project will boost local employment and will foster development of new activities in the industrial area (to date neither companies nor industries are installed in this area).
Nevertheless part of the interviewed population expressed their concerns regarding odors, noise and road safety related issues.

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

All these comments have been taken into consideration by SITRADE management team and are addressed in a specific mitigation plan. All mitigation measures can be found in the Environmental Impact Studies (page 85, 86, 87 and pages 89, 90) approved by the DNA, submitted to the DOE and publicly available.

The full application of mitigation measures proposed by SITRADE will be controlled by the city council Bingerville. SITRADE will have to report directly to the City Mayor Chief of staff. In case of failure, a conciliation procedure will be conducted by a mediator. If no agreement is reached, the city will use its normal police authority.

1. Regarding road safety measures one of the most sensitive issues, SITRADE offered to implement the following actions:
- Provide identification access cards to the staff in order to allow only duly authorized workers and vehicles during the construction phase,
- Clearly identify and materialize the site boundaries and close the most sensitive areas,
- Add the proper traffic signals around the site,
- Hire dedicated local staff to protect and facilitate the traffic at the entrance / exit of the site,
- Bring together in the same place all construction vehicles when they are parked,
- Provide appropriate lightening to the car park during the night,
- Add the proper traffic signals around Adjamé-Village,
- Generate awareness in the local population with regards to construction work traffic,
- Add the proper speed limitation traffic signals around Bingerville's schools, health centers, markets for the operational phase,
- Organize and finance a free road safety training day for the local population each year.

2. Regarding local employment:

SITRADE committed to hire a significant part of local workers during project construction and operation. SITRADE already indicated that local people will be hired to ensure the security of the site. Other jobs will be available (mainly waste collection jobs and average technicians). SITRADE expects to hire 20% of its staff within the population of Bingerville (56,357 inhabitants over 5 million for the whole district of Abidjan).

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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State/Region:	District D’Abidjan
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URL:	
Represented by:	KOUADIO Yao Léonard
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Salutation:	
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Department:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This section is not relevant, as no public funds are involved in the Project.

Annex 3:

BASELINE INFORMATION

	2002	2003	2004	2005	2006
Gross production [GWh]	5,294	5,086	5,396	5,561	5,535
Hydro [GWh]	1,729	1,832	1,748	1,433	1,510
Share of hydro [%]	**32.7%**	**36.0%**	**32.4%**	**25.8%**	**27.3%**

Low-cost must-run<50%
► (a) simple OM

	2003	2004	2005	2006
Losses [GWh]	**30**	**34**	**36**	**32**
TOTAL net electricity [GWh]	**5,056**	**5,362**	**5,525**	**5,503**

	2003	2004	2005	2006
Natural gas [GWh]	3,255	3,648	4,128	4,025
Gross electricity production from fossil fuels [GWh]	**3,255**	**3,648**	**4,128**	**4,025**
Net electricity production from fossil fuels [GWh]	**3,225**	**3,614**	**4,092**	**3,993**

	2003	2004	2005	2006
Net electricity from fossil fuels [GWh]	**3,225**	**3,614**	**4,092**	**3,993**
Electricity import[GWh]	0	0	0	0
Electricity supplied to grid by relevant sources [GWh]	**3,225**	**3,614**	**4,092**	**3,993**

	2003	2004	2005	2006
OM emission factor [tCO_2/MWh]	**1.1720**	**0.8646**	**0.8604**	**0.8676**

Total electricity supplied by relevant sources [GWh] (2004 + 2005 + 2006)	11,699		
Share of total electricity supplied by relevant sources	31%	35%	34%

0.8642

	2003	2004	2005	2006
Natural gas	1, 403,530	1, 160,340	1, 307,410	1, 286,600
TOTAL	**1, 403,530**	**1, 160,340**	**1, 307,410**	**1, 286,600**

Table 10: Fuel consumption [1000m^3].

	Emission factor [$kgCO_2$/TJ]	NCV [TJ/kt]
Natural gas	56,100	48.00

Table 11: IPCC default value.

	2003	2004	2005	2006
Natural gas	3,779,426	3,124,564	3,520,594	3,464,556
TOTAL	**3,779,426**	**3,124,564**	**3,520,594**	**3,464,556**

Table 12: CO_2 emissions [tonnes].

The build margin consists of either:

(c) The set of five power units that have been built most recently, or
The set of five power units that have been built most recently (5 gas plants) represents a gross electricity production (year 2006) of **4,025,135 MWh.**

(d) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.
20% of gross electricity production (year 2006) represents **1,112,152 MWh**

The set of five power units that have been built most recently (5 gas plants) represents a gross electricity production (in year 2006) of **4,025 GWh.**

Even if the option (a) represents a larger annual generation, the option (b) is chosen because in the set of five power units that have been built most recently, two power plants are built more than 10 years ago.

Name of power plants (interconnected grid)	Capacity addition	Fuel Type	Date of operation
Ayamé 1	20	Hydro	1959
Ayamé 2	30	Hydro	1965
Kossou	174	Hydro	1972
Taabo	210	Hydro	1979
Buyo	165	Hydro	1980
Faye	5	Hydro	1983
Vridi I - TAG 1/2/3/4	88	Gas -steam turbine	1984
Vridi II - TAG 5/6/7	99	Gas - open cycle	1985
Vridi II - TAG 8	111	Gas - open cycle	1997
Azito - TAG 1	**150**	**Gas - combined cycle**[51]	**1999**
Azito - TAG 2	**150**	**Gas - combined cycle**[52]	**2000**

Table 13: Power units of Ivory Coast.

[51] According to information provided by SOPIE, the combined cycle is not yet operating.
[52] According to information provided by SOPIE, the combined cycle is not yet operating.

HYDROPOWER PLANT GENERATION

AYAME 1 => Date of operation : 1959		G1	G2	-	TOTAL
GENERATION (MWh)	2003	43,295	24,747		**68,042**
	2004	31,133	43,086		**74,219**
	2005	45,740	43,684		**89,424**
	2006	39,292	33,012		**72,304**

AYAME 2 => Date of operation : 1969		G1	G2	-	TOTAL
GENERATION (MWh)	2003	68,396	52,974		**121,370**
	2004	37,176	77,588		**114,764**
	2005	54,138	87,391		**141,528**
	2006	78,128	61,001		**139,129**

KOSSOU => Date of operation : 1972		G1	G2	G3	TOTAL
GENERATION (MWh)	2003	80,939	40,992	42,113	**164,044**
	2004	83,199	68,136	55,418	**206,753**
	2005	50,212	19,475	19,787	**89,474**
	2006	36,445	24,820	18,117	**79,382**

TAABO => Date of operation : 1979		G1	G2	G3	TOTAL
GENERATION (MWh)	2003	289,563	182,451	241,401	**713,415**
	2004	173,439	196,131	207,525	**577,095**
	2005	166,256	130,528	97,209	**393,993**
	2006	124,340	176,774	148,196	**449,310**

BUYO => Date of operation : 1980		G1	G2	G3	TOTAL
GENERATION (MWh)	2003	0	395,612	362,817	**758,429**
	2004	0	419,197	348,520	**767,717**
	2005	0	367,569	339,527	**707,096**
	2006	0	434,261	325,803	**760,064**

FAYE => Date of operation : 1983		G1	G2	-	TOTAL
GENERATION (MWh)	2003	4,436	1,802		**6,238**
	2004	7,535	51		**7,586**
	2005	6,193	5,228		**11,421**
	2006	1,431	8,648		**10,078**

		TOTAL Hydro plants
GENERATION (MWh)	2003	**1, 831,537**
	2004	**1, 748,134**
	2005	**1, 432,935**
	2006	**1, 510,268**

THERMAL PLANT GENERATION

VRIDI I (GAS) => Date of operation : 1984		G1	G2	G3	G4	TOTAL
GENERATION (MWh)	2003	19,170	61,986	54,606	35,049	**170,811**
	2004	0	87,997	75,233	39,682	**202,912**
	2005	22,821	119,207	88,615	88,557	**319,199**
	2006	157,961	75,420	0	143,091	**376,472**

VRIDI II => Date of operation : 1985		G5	G6	G7		TOTAL
GENERATION (MWh)	2003	266,782	170,072	265,917		**702,771**
	2004	271,103	270,349	271,854		**813,306**
	2005	245,191	267,143	268,187		**780,521**
	2006	240,981	217,408	227,730		**686,119**

VRIDI II => Date of operation : 1997		G8		TOTAL
GENERATION (MWh)	2003	696,928		**696,928**
	2004	672,024		**672,024**
	2005	838,160		**838,160**
	2006	788,918		**788,918**

AZITO I => Date of operation : 1999		G1		TOTAL
GENERATION (MWh)	2003	869,678		**869,678**
	2004	963,700		**963,700**
	2005	1, 165,916		**1, 165,916**
	2006	1, 111,230		**1, 111,230**

AZITO II => Date of operation : 2000		G2		TOTAL
GENERATION (MWh)	2003	814,690		**814,690**
	2004	995,823		**995,823**
	2005	1, 024,028		**1, 024,028**
	2006	1, 062,396		**1, 062,396**

		TOTAL Thermal Plants
GENERATION (MWh)	2003	**3, 254,878**
	2004	**3, 647,765**
	2005	**4, 127,824**
	2006	**4, 025,135**

Energy type	Generation of the set of power units	Carbon EF	Conversion factor from TJ to MWh	Carbon EF	Electrical efficiency	BM emission factor	Emission
	MWh	$kgCO_2/TJ$		tCO_2/MWh	%	tCO_2/MWh	tCO_2
Azito - TAG 1	1, 111,230	56,100	277.8	0.2019	30,0%	0.6731	748,020
Azito - TAG 2	1, 062,396	56,100	277.8	0.2019	39,5%	0.5113	543,150
	2, 173,626						**1, 291,170**

OM EF	**0.8642**	**tCO_2/MWh**

BM EF	**0.5940**	**tCO_2/MWh**

CM EF	**0.7291**	**tCO_2/MWh**

Annex 4:

MONITORING PLAN

A simple process flow diagram is introduced at page 78 (figure 9). Legend of this diagram is mentioned below.

Code	**Description**
AD-101	Anaerobic Digestion
CP-101	Composting Process
CS-101	Centrifugation System
D - 101	Average additional distance traveled by vehicle type '*i*' compared to the baseline in year '*y*'.
E -101	Electric-meter for energy produced and sold
E-102	Electric-meter for public energy net
EC-101	On-site electricity consumption
EG-101	Electricity generation system
F-101	Flow-meter input mud to digester
F-102	Flow-meter input mud into centrifugeuse
F-103	Flow-meter input biogas into gasholder
F-104	Flow-meter input biogas into motor
F-105	Flow-meter input biogas flaring
F-106	Flow-meter stack gas ($SG_{a,y}$)
F-107	Meter gasoil (gasoil for boiler)
F-108	Meter gasoil (gasoil for on-site vehicles fuel consumption)
F-109	Meter gasoil (collecting vehicle fuel consumption in liters per kilometer for vehicle type *i*)
FL-101	Flaring system
G-101	Gas analyser to determine methane content in biogas
GH-101	Gas holder
HS-101	Heat system
I - 101	Invoices of tipping fee to cross-check the quantity of waste input
I - 102	Fuel invoices to cross-check the quantity of fuel used for boiler (F-107)
I - 103	Fuel invoices to cross-check the quantity of fuel used by on-site vehicles fuel (F-18)
I - 104	Fuel invoices to cross-check the quantity of fuel used by collecting vehicles (F-109)
I - 104	Compost invoices to cross-check the amount of compost produced (W-104)
I - 105	Electricity output invoices to cross-check electric-meter for energy produced and sold (E-101)
I - 106	Electricity input invoices to cross-check electric-meter for public energy net (E-102)
N- 101	Number of collecting vehicles to cross-check tipping fee (I-101) and input waste (W-101)
$Rate_y^{compliance}$	Compliance rate
S-101	Sampling of waste collected to determine waste composition
S-102	Sampling of compost to determine the fraction of compost that degrades anaerobically (temperature + O_2)
S-103	Sampling of compost to prove that is a stabilized compost (temperature + O_2)
S-104	Sampling of waste water released to determine COD
S-105	Sampling of stack gas to determine concentration of N_2O ($MC_{N2O,a,y}$)
S-106	Sampling of stack gas to determine concentration of CH_4 ($MC_{CH4,a,y}$)
SP-101	Sorting process
T-101	Combustion temperature of the flare
VC-101	On-site vehicles consumption
V-101	Visual control of collected before sorting.
W-101	Weight input municipal waste to cross-check the tipping fee (I-101)
W-102	Weight of inert waste to dump
W-103	Weight of selected recyclable material
W-104	Weight of output compost
WC-101	Waste collection
WR-101	Water recycling

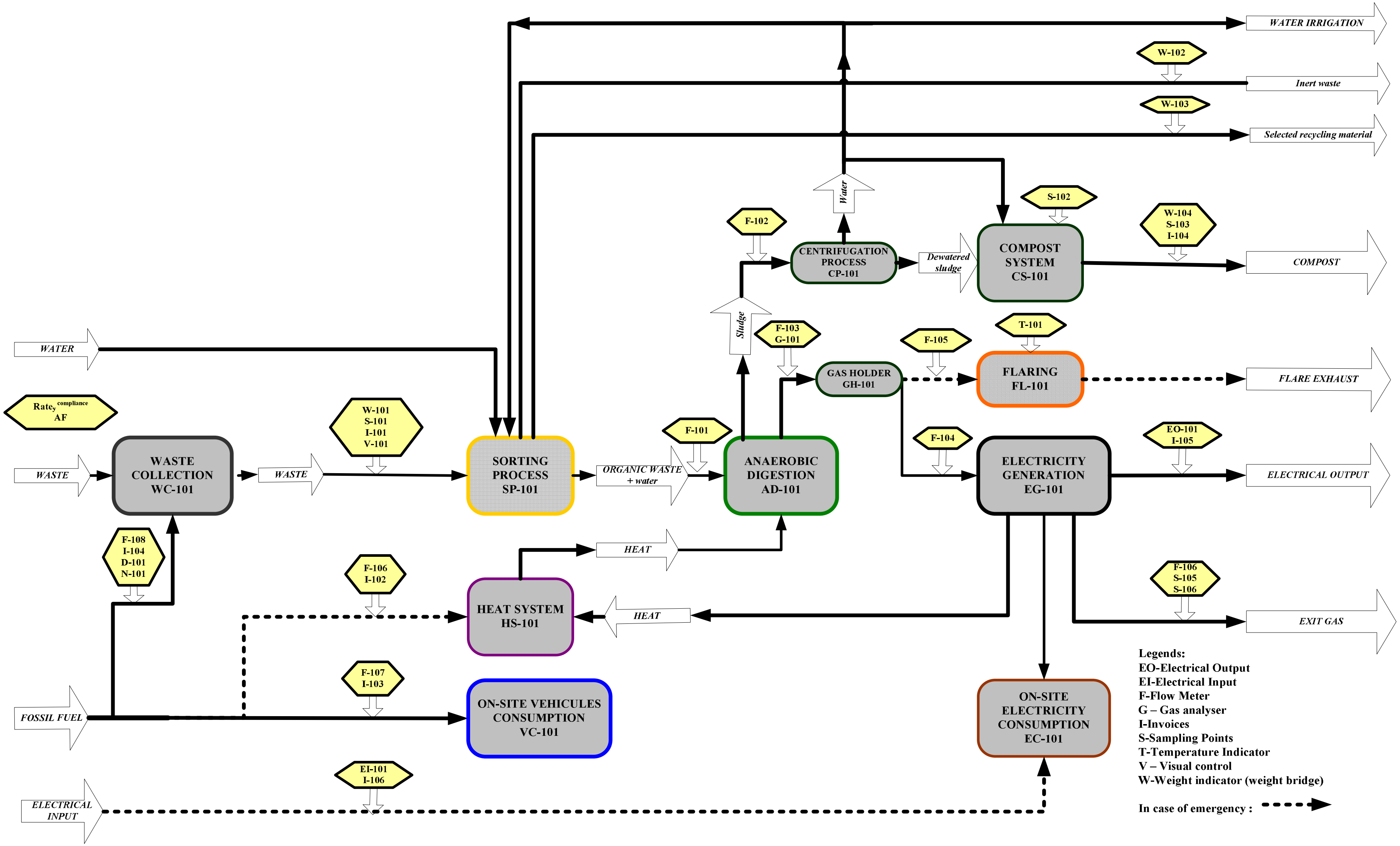

Figure 10 : Monitoring process flow diagram.

Annex 5

Figures and Tables