Overview of Fiscal 2009 CDM/JI Feasibility Study—Final Report

Name of study

CDM project feasibility study on switching from mixed fuel to biomass for electricity generation in North Sumatra

Name of organization

Sumitomo Forestry Co., Ltd.

Research implementation structure

Organization involved in the research	Role
PT. Canang Indah (hereafter, “CI”)	Study equipment improvements and formulate business plans
	Study plan to secure waste biomass supply
	Conduct environmental impact survey
	Solicit stakeholders’ comments
Carbon and Environmental Research Indonesia (hereafter, “CERINDO)	Provide research assistance
	Provide assistance in preparing the Project Design Document (PDD)
	Assist in providing explanations to the designated national authority (DNA) and stakeholders
PT. Plarenco	Research palm oil and gum tree plantations
Japan Quality Assurance Organization (JQA)	Carry out pre-validation

1. Project overview

This project is a feasibility study for implementing the CDM project to switch fuel used for power generation at PT. Canang Indah (hereafter, “CI”), which is located in Medan City, North Sumatra, Indonesia. CI is a wood processing company that makes particle board (PB) and medium density fibreboard (MDF), with annual production of approximately 65,000 m^3 of PB and 120,000 m^3 of MDF.

CI’s factory has a coal-based power plant with a capacity of 14 MW, as well as diesel generators with a combined capacity of 11.5 MW. Currently the coal-based power plant is employed for the factory’s operations, while the diesel generators are used as back-up facilities for when the power plant is being overhauled or in case of emergency. This project is studying the feasibility of converting the fuel used in the coal-based power plant from a mix of coal and waste biomass to 100% waste biomass.

Employing a coal and waste biomass mixed fuel for power generation system, the power plant used 46,716 tonnes of coal and 23,916 tonnes of waste biomass over the period from January 2007 to August 2009, calculated on an annual basis. The ratio of coal to waste biomass on an energy basis is 7:3. The waste biomass consists of palm kernel shells (PKS) as well as wood fibre generated from the production process at the factory. After this project is implemented, the goal is to use 100% waste biomass from palm oil mills in power generation. If there is a supply shortage of this waste biomass fuel, however, coal and waste biomass mixed fuel will be considered to ensure the steady operation of the power plant. Besides waste biomass from palm oil mills, waste biomass being considered for use includes old gum tree roots and scrap wood.

The coal and waste biomass mixed fuel system employed at present will serve as the baseline. Through implementing the CDM project, greenhouse gas emissions are forecast to decrease by an average of 93,609 tonnes of CO_2 per year. The starting date of the project is envisaged as either a day when a stable supply of waste biomass is highly likely to be guaranteed through the conclusion of a long-term procurement contract, or on the day the project is registered as a CDM project.

Methodologies applied

AMS-I.A. Version 13, "Electricity generation by the user"

2. Research contents

(1) Research issues

The four items below are essential for implementing the project, but it was not possible to gain a complete understanding of them in advance of carrying out research.

(a) Feasibility of using old gum tree roots as fuel

For this project, the effectiveness of using old gum tree roots as a fuel has been studied. In North Sumatra, old gum tree roots have yet to be used as a fuel, and are simply incinerated. Of the total 289,054 tonnes of scrap wood CI used as a raw material for its product manufacturing in 2008, wood from old gum trees made up 80%, or approximately 231,000 tonnes. CI used old gum trees of less than 15 centimetres in diameter as a raw material for its medium-density fibre board and particle board, whereas trees of more than 15 centimetres in diameter are generally used for timber. It is conceivable that these roots constitute from 30 to almost 40% of the total raw materials used by CI.

(b) Feasibility of securing a supply of waste biomass

To implement the project, it is essential to secure a stable supply of waste biomass. To secure this supply, it is necessary to rely on external sources for most of the amount since the volume of wood fibre generated from CI's factory is not considerable. At present, palm kernel shells are used as waste biomass for power generation, and are externally procured from crude palm oil (CPO) mills. The amount of necessary biomass targeted for this project is estimated at 58,168 dry tonnes per year, assuming that palm kernel shells are used exclusively.

If using waste biomass becomes competitive and results in a supply shortage, it will be necessary to identify other users of waste biomass who are in direct competition with CI because they do not have the option of using fossil fuels. It will also be necessary to determine the kinds of waste biomass that can be supplied and at what volume.

(c) Waste biomass procurement system

As a result of (b), above, it is necessary to consider the method for procuring waste biomass targeted for this project as well as the management methods for the procured waste biomass. CI will confirm whether it can apply its existing systems used to procure raw materials for manufacturing its products and fuel used for power generation, with the aim of setting up a highly efficient procurement system.

(d) Risk from using waste biomass in coal-based power plant boilers

For this project, plans are to use 100% waste biomass as fuel without modifying the boilers of the coal-based power plant. The structure of combustion furnaces, however, can differ in boilers used to burn coal and boilers used to burn waste biomass. Therefore, it is necessary to study the scenario of using large volumes of waste biomass in coal-based power plant boilers to fully understand whether it may lead to equipment breakdown.

(2) Research projects

(i) On-site research projects

On-site research project No. 1 (August 23, 2009 – September 5, 2009)	
Participants	CI; PT. Rimba Partikel Indonesia; Indonesia Ministry of the Environment; CERINDO
Research activities	• Kick-off meeting • Confirmation of project implementation system • Inspection of waste biomass collection site • Request for cooperation in research and confirmation of research schedule
Results	• CI acquired ISO 9001 certification, demonstrating that it has properly prepared its management systems. • CI submitted bi-annual environmental reports to government authorities in accordance with its environmental management plan (UKL) and environmental monitoring plan (UPL). In November 2009, CI acquired environmental impact assessment (AMDAL) certification, which replaces the UKL and UPL plans. • It was confirmed that old gum tree roots are not treated as fuel and are simply incinerated. Using these roots as fuel, however, presented numerous issues that must be solved, such as how to remove soil that

	sticks to the roots. • A project overview was presented to the Indonesia Ministry of the Environment, and registering the project appears to pose no major problems.

On-site research project No. 2 (October 4, 2009 – October 11, 2009)	
Participants	CI; Perkebunan Nusantara IV (PTPN IV; government-owned plantation); a crude palm oil mill in Aceh Province
Research activities	• Joint meeting held with CI, CERINDO and Sumitomo Forestry • Inspection of waste biomass collection site
Results	• The baseline was 100% coal usage when waste biomass usage was at the testing stage. In light of research results that followed, eventually the baseline was determined as coal and waste biomass mixed fuel. • Although the project aims to use 100% waste biomass, taking into account the stable supply and price of waste biomass, a project scenario allowing coal and waste biomass mixed fuel was deemed a possible alternative. • Empty fruit bunches (EFB) were determined to have high prospects for use as a fuel if their water is removed, as there appears to be a surplus supply despite their use as fertilizer and fuel. • Fresh fruit bunches (FFB) from the crude palm oil (CPO) mill were found to contain 22% EFB and 7% palm kernel shells per load.

On-site research project No. 3 (November 15, 2009 – November 29, 2009)	
Participants	CI Machinery manufacturers: PT. Gikoko Kogyo Indonesia; PT. Suryamasinika Semestaraya
Research activities	• Confirmation of schedule and status of each research activity • Consideration of the status of power generation in Indonesia and matters concerning CDM • Determination of risk from using waste biomass as fuel in the coal-based power plant
Results	**Schedule and status of each research activity:** • Research activities that were proceeding late on schedule, including research on procuring waste biomass, were re-scheduled for a later time. • Research was commissioned to measure exhaust gases in order to determine additional co-benefit effects after the project is implemented.

	Risk from using waste biomass as fuel in coal-based power plant boilers: When comparing coal and waste biomass as fuels, their properties are considerably different in terms of calorific value, moisture content, melting temperature of ash after combustion, etc. For this reason, if waste biomass is used as fuel in a power plant designed to use coal as fuel, combustion efficiency and power generation capacity will be lower. In addition, there is a risk that such usage will lead to equipment breakdown. **Power generation in Indonesia and CDM considerations:** • The designated national authority (DNA) in Indonesia has been transferred to the Dewan Nasional Perubahan Iklim (DNPI) (National Council of Climate Change), based on the presidential ordinance No. 46 of 2008. • Additional funds will not be collected from the issue of CER in Indonesia.

On-site research project No. 4 (January 17, 2010 – January 24, 2010)	
Participants	CI; PT. Mitra Karya Putra Machinery manufacturer: PT. Suryamasinika Semestaraya
Research activities	• Confirmation of research data on co-benefit effects • Meeting with stakeholders • Explanation and check of equipment for processing ash
Results	**Research data on co-benefit effects:** With respect to air quality improvement items, soot and SOx, emission concentrations (mg/m^3) were higher when using palm kernel shells than when using coal. The reason for this is that palm kernel shells burn completely whereas coal does not always reach a state of perfect combustion. This means (according to an explanation from a measurement company) that some elements of coal can be assumed to remain in the ash. **Meeting with stakeholders:** (i) Summary of stakeholders' comments • Stakeholders, particularly government environmental managers, requested that CI take the lead in raising the environmental awareness of other companies. • While coal-derived combustion ash becomes waste matter, in order not to emit waste from biomass-derived combustion ash, implementation of the project should be connected with waste

	reduction measures. • The project should provide employment opportunities for local residents. (ii) CI's response to stakeholders' comments • As CI cannot prevent climate change or solve environmental problems on its own, it would like to work together with local residents and government authorities. • CI intends to hire workers from the local area near the factory, as it has done in the past. Accordingly, it will support employment opportunities in the local community. Furthermore, it will not discriminate on the basis of ethnic origin or other factors when hiring. **Ash block machinery:** • An ash block manufacturing machine can be manufactured at a cost of approximately 15 million rupiah. Special equipment for drying the blocks after they are moulded is unnecessary, since the blocks can be sufficiently dried in the sun. • Authorisation is required for treating coal ash as waste. Accordingly, it is necessary to gain permission to process ash that has been generated from fuel mixed with coal.

On-site research project No. 5 (February 7, 2010 – February 16, 2010)	
Participants	CI; PT. Rimba Partikel Indonesia
Research activities	• Formulation of next business plans for Sumitomo Forestry and CI • Demonstration that the biomass is acceptable for a CDM project • Inspection of ash processing machinery operations
Results	**Formulation of next business plans for Sumitomo Forestry and CI:** If certification as a CDM project is likely, the responsibility to cover validation costs and allocation of CER must be examined, with decisions for future plans based on pre-validation results. **Demonstration that the biomass is acceptable for a CDM project:** In order to collect information on methods for demonstrating that the palm kernel shells used by CI are acceptable as a renewable biomass for a CDM project, Sumitomo Forestry visited PT. Rimba Partikel Indonesia ("RPI"), which has already been registered as a CDM project carrying out biomass power generation.

	Although CI is able to secure the necessary amount of palm kernel shells if there is no competition for this material, it consulted with RPI to consider methods for demonstrating this state of affairs using quantitative data. **Inspection of ash block machinery operations:** • Inspected the new ash block machine, which produced five blocks of roadbed materials using one mould. • The ash block machine can produce blocks at a cost of 14,597 rupiah/m^2, about half the market price of approximately 28,000 rupiah/m^2.

(ii) Research results

(a) Viability of old gum tree roots as fuel

Rubber plantations are located between 100 to 300 kilometres from CI's factory, which results in high transport costs compared to the purchase price of PB and MDF raw materials. Old gum tree roots were found to be unsuitable for use as fuel because of two problems: The low load efficiency due to varying shape and size of the roots, and deterioration of the working environment that would result from chipping roots at CI's factory. CI appraised the use of a mobile chipper at plantations to solve these two problems.

The results show that the price of old gum tree roots per calorific value can be the same level as coal, as their load efficiency can be up to twice as high after chipping. Working conditions at plantations may also become satisfactory with the use of chipper equipment. However, the supply may be problematic, as the roots take 20 to 25 years to grow and rubber plantations are scattered throughout the region. The supply of palm kernel shells and other materials from palm oil mills is stable by comparison, as they are produced in steady quantities every year at established locations. Furthermore, the use of old gum tree roots would require storage sites since they are more accessible in the dry season when rubber plantation roads are not as muddy as in the rainy season. The use of storage sites will compensate for the unavailability of the roots as fuel in the rainy season. A stable supply of old gum tree roots can be resolved if CI can formulate a supply plan that takes into account the location of rubber plantations and the range of tree age. Storage space, however, is limited, and CI concluded that it is difficult at present to allocate storage for old gum tree roots instead of other raw materials.

Nevertheless, investment towards the use of equipment such as mobile chippers and storage sites for old gum tree roots may be conducted in the future, depending on the waste biomass supply and demand conditions in North Sumatra.

Photo 1: Collected old gum tree roots

Photo 2: Old gum tree roots being burned for reforestation

(b) Feasibility of securing a supply of waste biomass

According to the results of a study commissioned to an external party, the calorific value and moisture content of palm kernel shells used by CI was 4,489 kcal/kg and 12%, respectively. CI conducted trial tests in February and March 2009 that demonstrated the viability of power generation using 100% palm kernel shells. It was also able to secure the necessary supply for power generation. Therefore, CI will use palm kernel shells as the main fuel.

CI concluded that it is difficult to use old gum tree roots as main fuel at present based on the research results in (2)(ii)(a) above. Palm kernel shells have emerged as a highly competitive biomass fuel, while old gum tree roots from abandoned plantations represent an untapped fuel source, though an uncompetitive one. As such, there is no need to consider leakage from the competing uses for this waste biomass. Conservatively assuming that 30% of total raw materials used are old gum tree roots, the amount of old gum tree roots would total 69,373 tonnes per year. This represents 119% of CI's total fuel requirements, and is therefore a surplus of biomass material.

Besides palm kernel shells, other types of waste biomass that can be used are palm oil extraction residues such as empty fruit bunches (EFB) and fibre. EFB is currently disposed at palm plantations as fertilizer and may be used as a less competitive fuel in the future.

(c) Waste biomass procurement system

CI is located four kilometres from Belawan port, the only container handling port in North Sumatra. Commodities shipped to Belawan from inside and outside Indonesia are loaded on to trucks and transported to outlying rural areas from 100 to 300 kilometres from CI's factory. After delivering their cargo, the trucks generally return to Belawan empty. Taking advantage of this, CI employs the empty trucks to transport raw materials for its products as well as waste biomass from the rural areas, thereby keeping transport costs relatively low.

In contracts that CI has concluded with suppliers of palm kernel shells, the price of the shells is determined by moisture content, as standard measure for pricing. The contracts stipulate target amounts in units, such as 1,000 tonnes, for the suppliers to provide each month. If a supplier meets the targeted amount, the next amount is determined and the contract is renewed. Moisture content is confirmed by taking a sample from a delivery and measuring it onsite at the CI internal laboratory.

The moisture content of palm kernel shells is about 20%, which is considered to be relatively low. During transport, however, spraying the shells with water to increase their weight has been known to occur. Therefore, contracts that stipulate moisture content standards are undertaken to ensure the quality of the supplied palm kernel shells.

In order to secure a stable supply for the CDM project, CI aims to sign contracts of longer than one month, such as annual contracts.

(d) Risk from using waste biomass in coal-based power plant boilers

To determine the general risks involved with using large amounts of waste biomass in coal-based boilers, Sumitomo Forestry consulted with users of boilers and the manufacturer of the boilers it uses. The following three risks were identified.

(i) Risk related to combustion furnace capacity

Waste biomass has a lower calorific value than coal, so a comparatively larger amount must be used in the combustion furnace to attain the same output. This reduces the air capacity inside the furnace, resulting in lower combustion efficiency. Accordingly, if 100% waste biomass is used, the power plant can only generate from 70% to 80% of its design-specified output of electricity.

(ii) Risk related to temperature management inside the combustion furnace

The combustion furnace of a coal-based boiler is designed so that heat comes in direct contact with water pipes. Because waste biomass has higher moisture content than coal, it is more difficult to control the temperature inside the combustion furnace when using it. If the temperature inside the furnace falls due to the introduction of biomass with high moisture content, exhaust gas will increase, resulting in a greater burden on exhaust equipment that can lead to equipment damage. The water pipes can also be damaged by the dirt and soil that is invariably mixed in with the biomass, so bricks are often placed between the pipes and combustion furnace in boilers using biomass. The number of water pipes can differ in coal-based boilers and biomass boilers, affecting combustion efficiency.

It should be noted that generalising the problems above is difficult since furnace systems and designs vary according to their manufacturers.

(iii) Risk related to ash

The dissolution temperature of ash from waste biomass is lower than that of coal ash. When waste biomass is burned in a coal-based boiler, which is designed for higher temperatures, the ash dissolves but clinker ash may remain. The presence of clinkers not only hinders combustion, but also blocks air vents on the furnace floor, lowering combustion efficiency and leading to equipment breakdown. Combustion efficiency is further reduced by waste biomass ash adhering to water pipes and hardening.

To prevent the negative effects of clinker ash, some companies have installed step-like stocker furnaces, a European technology. Such systems channel the constant movements of the combustion furnace floor into vibration that prevents clinkers from blocking air vents and building up.

It is unclear how much time would elapse after initiating the use of waste biomass for the three risks described above to manifest into problems. Nevertheless, the use of 100% waste biomass can generate 70% to 80% of the power plant's total electrical output—a sufficient amount for CI's operations—and appears feasible if the negative effects of the ash are resolved. CI would increase the frequency of boiler maintenance after implementing the CDM project, resulting in increased maintenance costs estimated at approximately US$62,000 per year.

3. Investigation results concerning CDM project implementation

(1) Setting the baseline scenario and project boundary

(i) Validity of the methodology

The electricity generated by CI's power plant, which has a capacity of less than 15 MW, will only be consumed within the CI group. Since waste biomass will be used as the fuel, the AMS-I.A. methodology was adopted.

Title	Reference documentation
"Electricity generation by the user"	AMS-I.A. /version13 EB42 Valid from 10 Oct 08 onwards

(ii) Determination of the baseline

The following scenarios were considered in developing the baseline

(a) Current status of the coal and waste biomass mixed fuel power generation system
(b) Usage of diesel generators
(c) Switchover to gas power generation
(d) Purchase of electricity from power grids
(e) Switchover to waste biomass fuel

Among the items listed above, for item (c), a switchover would have necessitated the installation of equipment to supply natural gas (such as pipelines) and the construction of natural gas power generation facilities, requiring a significant amount of investment. Therefore, this option was not considered for the baseline. With respect to item (d), the purchase of electric power from the PLN grid was deemed unfeasible due to a history of power shortages and the high risk of power outages. Turning to item (b), CI already possesses diesel generators with enough capacity for onsite power requirements. However, national policy in Indonesia is directed at lowering the proportion of its energy derived from oil while raising the proportion derived from coal. Moreover, usage of diesel oil poses major risks to achieving stable operations, since Indonesia is an oil importing country vulnerable to the impact of fluctuations in international oil prices. Item (e) was not considered for determining the baseline because the switchover to waste biomass would require additional costs for the maintenance of boiler equipment and procurement of waste biomass fuel. As a result of the above, the baseline was determined according to item (a), the current status of the coal and waste biomass mixed fuel power generation system, which does not require investment costs.

(iii) Project boundary

The project boundary is shown below in Figure 1. The only greenhouse gas (GHG) targeted by the project is carbon dioxide (CO_2).

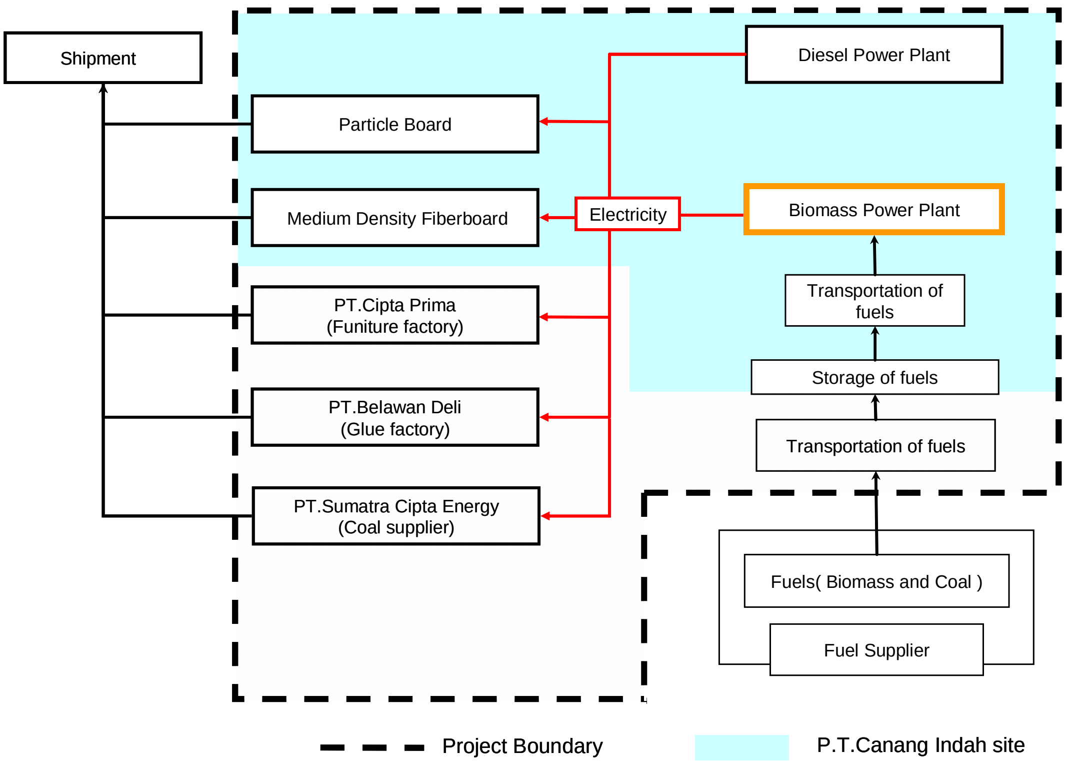

Figure 1. Project boundary

(iv) Calculation method for amount of emission reduction

The amount of CO_2 emissions to be reduced by the project is calculated as follows.

ER = BE – PE – LE (1)

ER	Emissions reductions (tCO_2/yr)
BE	Baseline emissions (tCO_2/yr)
PE	Project emissions (tCO_2/yr)
LE	Leakage emissions (tCO_2/yr)

(v) Calculation method for baseline emissions

Based on AMS-I.A., Paragraph 7, Option 3, the baseline emissions are calculated using historical average results of coal and diesel oil usage for electrical generation. The following equations were used for calculations.

$$BE = BE_{coal} + BE_{diesel\ oil} \quad (1)$$

BE_{coal}	Baseline emissions from coal consumption (tCO_2/yr)
$BE_{diesel\ oil}$	Baseline emissions from diesel oil consumption (tCO_2/yr)

- **Baseline for emissions from coal consumption (BE_{coal})**

The baseline for emissions from coal consumption (BE_{coal}) is calculated using the following equation:

$$BE_{coal} = FC_{coal\text{-}baseline} \times NCV_{coal} \times EF_{coal} \quad (2)$$

BE_{coal}	Baseline emissions from coal consumption (tCO_2/yr)
$FC_{coal\text{-}baseline}$	Baseline amount of coal consumption (tonnes/yr)
NCV_{coal}	Net calorific value of coal (TJ/tonne)
EF_{coal}	Emission factor of coal (tCO_2/TJ)

The baseline amount of coal consumption ($FC_{coal\text{-}baseline}$) and the emission factor of coal (EF_{coal}) are values that can be specified in advance of the project. The net calorific value of coal (NCV_{coal}) is calculated using the following equation.

Net calorific value of coal (NCV_{coal})

$$NCV_{coal} = (GCV_{coal} \times Inc - (SE_{water} \times MC_{coal})) / 10^6$$

NCV_{coal}	Net calorific value of coal (TJ/tonne)
GCV_{coal}	Gross calorific value of coal (kcal/kg)
Inc	International caloric unit (kJ/kcal)
SE_{water}	Specific enthalpy of H2O vaporization (kJ/kg)
MC_{coal}	Moisture content of coal (%)

The gross calorific value of coal (GCV_{coal}), the international caloric unit (Inc), the specific enthalpy of H2O vaporization (SE_{water}), and the moisture content of coal (MC_{coal}) are values that can be specified in advance of the project.

➢ **Baseline emissions from diesel oil consumption ($BE_{diesel\ oil}$)**

The baseline emissions from diesel oil consumption is calculated using the following equation:

$$\mathbf{BE_{diesel\ oil} = FC_{diesel\ oil\text{-}baseline} \times NCV_{diesel\ oil} \times EF_{diesel\ oil}} \quad (3)$$

$BE_{diesel\ oil}$	Baseline emissions from diesel oil consumption (tCO_2/yr)
$FC_{diesel\ oil\text{-}baseline}$	Baseline amount of diesel oil consumption (tonnes/yr)
$NCV_{diesel\ oil}$	Net calorific value of diesel oil (TJ/tonne)
$EF_{diesel\ oil}$	Emission factor of diesel oil (tCO_2/TJ)

The baseline amount of diesel oil consumption ($FC_{diesel\ oil\text{-}baseline}$), the net calorific value of diesel oil ($NCV_{diesel\ oil}$), and the emission factor of diesel oil ($EF_{diesel\ oil}$) are values that can be specified in advance of the project. Calculations used a diesel oil density value of 0.837 kg/litre, which is provided by Indonesia's national oil company, Pertamina.

(2) Project emissions

(i) Method for calculation of project emissions (PE)

Project emissions comprise emissions from diesel oil used in diesel generators that operate during maintenance of the power plant, and emissions from the coal added to waste biomass when the biomass is in short supply. The following equations are used for calculations.

$$\mathbf{PE = PE_{coal} + PE_{diesel\ oil}} \quad (1)$$

PE_{coal}	Project emissions from coal consumption (tCO_2/yr)
$PE_{diesel\ oil}$	Project emissions from diesel oil consumption (tCO_2/yr)

➢ **Project emissions from coal consumption (PE_{coal})**

The project emissions from coal consumption is calculated using the following equation:

$$\mathbf{PE_{coal} = FC_{coal\text{-}project} \times NCV_{coal} \times EF_{coal}} \quad (2)$$

PE_{coal}	Project emissions from coal consumption (tCO_2/yr)
$FC_{coal\text{-}project}$	Project amount of coal consumption (tonnes/yr)
NCV_{coal}	Net calorific value of coal (TJ/tonne)
EF_{coal}	Emission factor of coal (tCO_2/TJ)

The project amount of coal consumption ($FC_{coal\text{-}project}$) in the project scenario was calculated using (3)(ii) as reference. The emission factor of coal (EF_{coal}) is a value that can be specified in advance of the project. The net calorific value of coal (NCV_{coal}) has also been calculated.

- **Project emissions from diesel oil consumption ($PE_{diesel\ oil}$)**

The project emissions from diesel consumption is calculated using the following equation:

$$PE_{diesel\ oil} = FC_{diesel\ oil\text{-}project} \times NCV_{diesel\ oil} \times EF_{diesel\ oil} \quad (3)$$

$PE_{diesel\ oil}$	Project emissions from diesel oil consumption (tCO_2/yr)
$FC_{diesel\ oil\text{-}project}$	Project amount of diesel oil consumption (tonnes/yr)
$NCV_{diesel\ oil}$	Net calorific value of diesel oil (TJ/tonne)
$EF_{diesel\ oil}$	Emission factor of diesel oil (tCO_2/TJ)

The project amount of diesel oil consumption ($FC_{diesel\ oil\text{-}project}$) in the project scenario was calculated using (3)(ii) as reference. The emission factor of diesel oil ($EF_{diesel\ oil}$) and the net calorific value of diesel oil ($NCV_{diesel\ oil}$) are values that can be specified in advance of the project.

- **Specific fuel consumption of fuel i (SFCi)**

According to AMS I.A. Paragraph 16, in projects that mix fossil fuels and waste biomass, the specific fuel consumption of each type of fuel must be determined, and a predetermined equation must be used. In CI's case, this applies to the specific fuel consumption of coal and palm kernel shells (whereas in the event it uses other fuels, the amounts of those particular fuels must also be provided).

The equation is presented below:

$$SFCi = (PTE \times 10^3) / ((NCVi \times 10^9) / Inc) \quad (1)$$

SFCi	Specific fuel consumption of fuel i (tonnes/MWh)
PTE	Calorific value required for electricity production (kcal/kWh)
NCVi	Net calorific value of fuel i (TJ/tonne)
Inc	International caloric unit (kJ/kcal)

The calorific value required for electricity production (PTE) and the international caloric unit (Inc) are values that can be specified in advance of the project. The net calorific value of fuel i (NCVi) was obtained through the following equation.

Net calorific value of fuel i (NCVi)

$$NCVi = (GCVi \times Inc - (SE_{water} \times MCi)) / 10^6$$

NCVi	Net calorific value of fuel i (TJ/tonne)
GCVi	Gross calorific value of fuel i (kcal/kg)
Inc	International caloric unit (kJ/kcal)
SE_{water}	Specific enthalpy of H2O vaporization (kJ/kg)

MCi Moisture content of fuel i (%)

The international caloric value (Inc) and the specific enthalpy of H2O vaporization (SE_{water}) are values that can be specified in advance of the project. The gross calorific value of fuel i (GCVi) and the moisture content of fuel i (MCi) are specified in the case that palm kernel shells are used as the waste biomass (see (3) (ii)).

(ii) Leakage emissions (LE)

The methodologies applied to this project activity stipulate that leakage during the transfer of equipment is to be noted (AMS I.A. paragraph 13). In addition, simplified guidelines for small-scale CDM project activities indicate the policy on leakage resulting from competition among users of waste biomass. (Refer to Attachment C to Appendix B, EB47 General guidance on leakage in biomass project activities [version 03])

It is unnecessary to consider leakage related to the diversion of equipment in this project because existing equipment is being used and no equipment is being relocated. It is also unnecessary to consider leakage with respect to waste biomass collection as it has been confirmed that old gum tree roots remain unused and a sufficient surplus supply of waste biomass exists.

Accordingly, the leakage emissions (LE) for this project is 0t-CO_2/yr.

(3) Monitoring plan

(i) Monitoring system

CI acquired ISO 9001 certification for its PB and MDF factory. Therefore, CI is recording the details of its monitoring system in ISO documents to enable it to maintain this system. Moreover, CI has also created a new company division, comprised of staff from its power generation division, to fully enhance its CDM monitoring system. Data subject to monitoring will be collected daily and summarized monthly and annually in reports. The recorded data will not only comprise information obtained from electrical generation equipment, but also the amounts of collected waste biomass, supplier information such as their distance from the plant, and the prices paid for the waste biomass. The collected waste biomass will be sampled at the time of collection, and the calorific value and moisture content will be measured onsite at the CI internal laboratory. Data will also be recorded if coal is used during a shortage of waste biomass.

Equipment used for the analysis is calibrated internally by CI's QA/QC sub-department, while the calibration tools and equipment are calibrated externally at relevant national institutions. The plant management system can be adapted to collect the necessary monitoring data.

Competition for waste biomass will be investigated at the renewal of each crediting period to ensure that 25% or more of the biomass used for the project is surplus.

CI's management structure for the project is shown below in Figure 2.

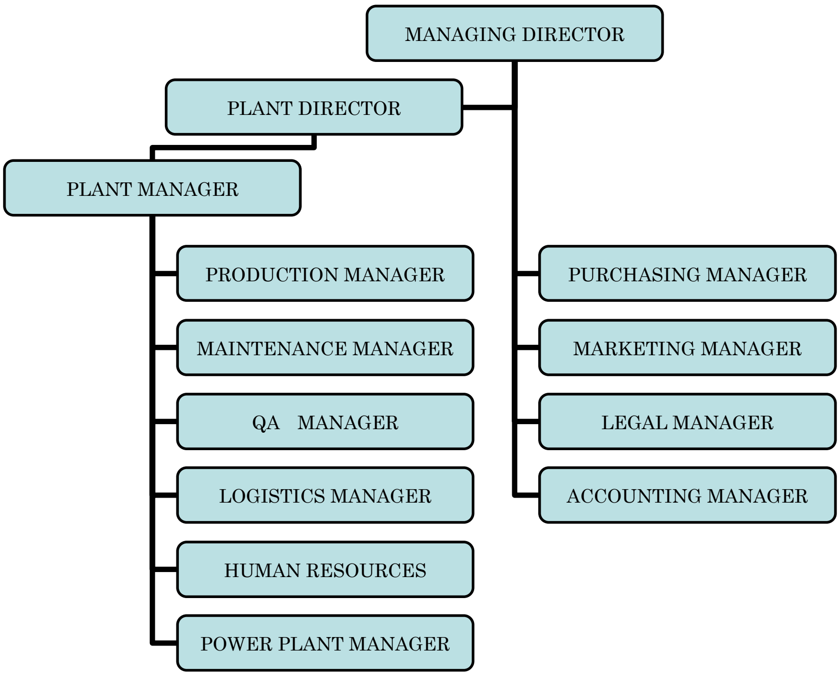

Figure 2 Management Structure

(ii) Monitoring items

Item	Value	Unit	Description	Data Source
$FC_{coal\text{-}project}$	0	tonnes/yr	Project amount of coal consumption	Monitoring by CI
$FC_{diesel\ oil\text{-}project}$	232.49	tonnes/yr	Project amount of diesel oil consumption	Monitoring by CI
FC_{kernel}	58,168	tonnes/yr	Project amount of palm kernel shells consumption	Monitoring by CI
FCi	—	tonnes/yr	Project amount of fuel i consumption	Monitoring by CI
GCVi	—	kcal/kg	Gross calorific value of fuel i	Monitoring by CI
MCi	—	%	Moisture content of fuel i	Monitoring by CI
EG	59,784	MWh/yr	Amount of electricity generation from coal power plant	Monitoring by CI

(4) Greenhouse gas emission reductions

Emission reductions based on calculations using the equations in 3.(1)(iv) and 3.(2) are shown below.

Year	Estimation of baseline emissions (t-CO_2)	Estimation of project emissions (t-CO_2)	Estimation of leakage (t-CO_2)	Estimation of overall emission reductions (t-CO_2)
2011	94,350	741	0	93,609
2012	94,350	741	0	93,609
2013	94,350	741	0	93,609
2014	94,350	741	0	93,609
2015	94,350	741	0	93,609
2016	94,350	741	0	93,609
2017	94,350	741	0	93,609
TOTAL	**660,450**	**5,187**	**0**	**655,263**

(5) Duration of the project activity and crediting period

The plan is to renew the seven-year crediting period twice, for a total of 21 years. The starting date of the project is envisaged as either a day when a stable supply of waste biomass is highly likely to be guaranteed through the conclusion of a long-term procurement contract, or on the day the project is registered as a CDM project.

(6) Environmental impacts and other indirect impacts

In November 2009, CI acquired Environmental Impact Assessment (Analysis Mengenai Dampak Lingkungan: AMDAL) certification. CI submits the results of its environmental impact surveys to the Medan City government twice per year. Data is measured by the Health Laboratory and the Superintending Company of Indonesia (SUCOFINDO), a research agency. In the event that measurement results exceed standard limits, improvements are carried out within one month and reported. The specific items of the surveys are listed below.

- Air pollution
- Noise
- Vibration
- Water pollution
- Flood protection
- Soil contamination
- Toxic substances
- Health of employees and surrounding residents

(7) Stakeholders' comments

(i) Stakeholder meeting held

Date and time: Tuesday January 19, 2010; 9:30 a.m. to 1:00 p.m.

Location: Nuri Meeting Room at Hotel Garuda Plaza in Medan

Participants: 5 people from CI
2 people form CERINDO
2 people from Sumitomo Forestry Co., Ltd.
13 stakeholders

(ii) Stakeholders' comments

Stakeholders, particularly those from local environmental agencies, supported the implementation of project activities. They stated that the project could serve as an example for other companies to increase their level of environmental awareness, as well as provide an effective solution to the issue of ash removal. Community representatives asked for more information regarding climate change issues, and the possibility of more employment opportunities for local people.

(iii) Response to stakeholders' comments

CI is taking into consideration suggestions of holding activities to educate local communities on climate change related issues. Regarding work opportunities, CI has mostly hired its staff from nearby areas, thereby providing work opportunities for local people. As for skilled workers, CI does not discriminate based on nationality or region, and welcomes qualified local candidates.

(8) Project implementation system

As the project implementation site, CI will bear the responsibility of operating and managing the project. Sumitomo Forestry will carry out the CDM procedures. Their main roles are shown below in Table 1.

Table 1. Roles for project implementation

Sumitomo Forestry (Responsible for CDM procedures)	CI (Responsible for project operation and management)
PDD preparation Inspection procedures for the DOE Application and explanation to the DNA in Japan Credit purchasing	Funds procurement Application and explanation to the DNA in Indonesia Facility management Monitoring

(9) Financing plan

No significant initial investment is required for the project since investment in equipment has not been planned. Accordingly, public funds or the diversion of official development assistance (ODA) funds are unnecessary. CI, which will operate and manage the project, will be responsible for covering maintenance costs after the project is implemented.

(10) Economic analysis

Based on provisional calculations for the items below, the net present value (NPV) has been estimated for each of the scenarios of not implementing the CDM project, referred to as “Case 1 (baseline scenario),” and implementing the CDM project, referred to as “Case 2 (project scenario),” which has been further broken down into “Case 2 (without CER)” and “Case 2 (with CER).”

Provisional calculation items:

- Investment capital US$250,000
- Time period of project calculations 10 years
- Discount rate 15.12%
- Price of coal 430 Rp/kg
- Price of palm kernel shells 450 Rp/kg
- Price of diesel fuel 5,900 Rp/liter
- Price of CER US$10/tonne

Based on results of provisional calculations for the items above, Table 2 below shows that the amount for Case 2 (without CER) is lower than Case 1 (baseline scenario), confirming that the project cannot proceed feasibly without revenue from CER.

Table 2. Trial calculations of NPV

	NPV (US$)
Case 1 (baseline)	0
Case 2 (without CER)	-1,174,701
Case 2 (with CER)	1,755,285

A sensitivity analysis was calculated to show scenarios more optimum than current conditions. In Case 1 (baseline scenario), the variable values are the purchasing prices of palm kernel shells and coal, which have a major impact on the CDM project. In Case 2 (project scenario), for which coal prices are not a factor, NPV varies according to the price of CER and palm kernel shells. Table 3. and Table 4. show these results in comparison with the baseline of zero NPV from the data above. The results are also presented graphically in Figure 3.

Table 3. NPV sensitivity analysis results for Case 1 (baseline)

(US$)

Palm kernel shell price	Coal price		
	387 Rp/kg	430 Rp/kg	473 Rp/kg
405 Rp/kg	1,632,104	528,612	-574,881
450 Rp/kg	1,103,493	0	-1,103,493
495 Rp/kg	574,881	-528,612	-1,632,104

Table 4. NPV sensitivity analysis results for Case 2 (project scenario)

(US$)

Palm kernel shell price	with CER				without CER
	US$8/CER	US$10/CER	US$12/CER	US$14/CER	
405 Rp/kg	2,595,988	3,193,196	3,790,405	4,387,613	263,210
450 Rp/kg	1,158,077	1,755,285	2,352,494	2,949,703	-1,174,700
495 Rp/kg	-528,612	317,375	914,583	1,511,792	-2,612,611

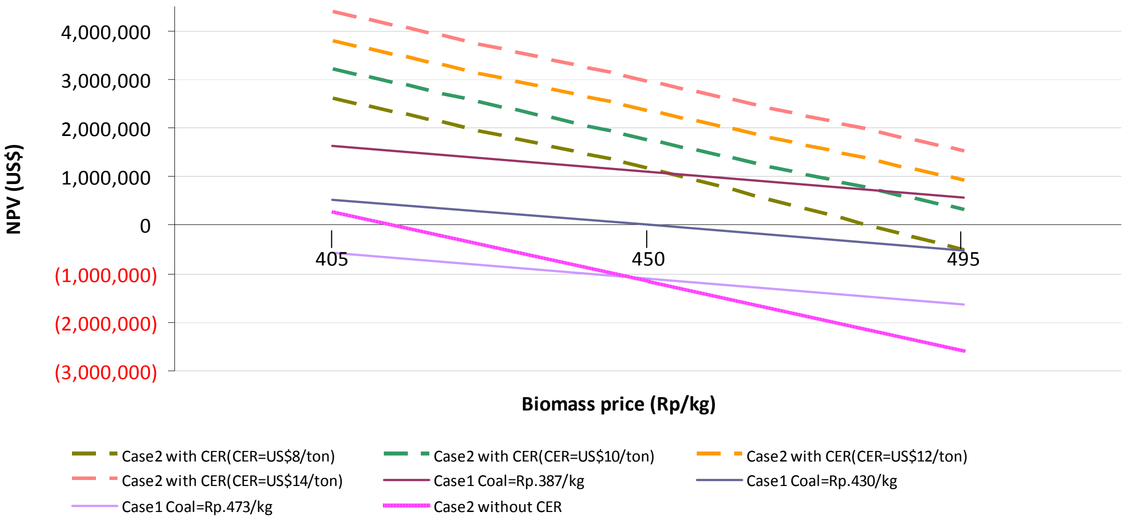

Figure 3. NPV sensitivity analysis results

As shown in Figure 3., if the price of palm kernel shells is 405 Rp/kg, the project may be possible to carry out even without revenue from CER. At this price, the NPV for Case 2 (without CER) is higher than that of Case 1 when the price of coal is 473 Rp/kg.

The price of palm kernel shells, however, is expected to rise in the future, and there are recent cases of transactions ranging from 500 – 600 Rp/kg. This makes revenue from CER essential for the project to continue. Moreover, revenue from CER can alleviate the risk of fluctuations in the price of coal, which is affected by global economic conditions.

(11) Demonstration and assessment of additionality

(i) Investment barriers

To implement the CDM project, CI will need to conclude long-term contracts with waste biomass suppliers in order to secure a stable supply. Currently, CI concludes purchasing contracts with suppliers, however, the terms are limited to short periods such as one month. CI gives suppliers an incentive bonus if they succeed in meeting its requested amounts and quality standards.

Along with CDM investigation fees of US$250,000, additional maintenance and management costs for the power plant will be needed to use waste biomass, totalling US$104,507 per year. Consequently, the project cannot be undertaken without revenue from the sale of CER, meaning that investment barriers exist. (For more details, refer to (10) Economic Analysis.)

(ii) Technological barriers

As the power plant was originally designed for coal, the use of 100% waste biomass fuel will affect the plant's ability to reach full capacity due to biomass' lower combustibility, and there is a possibility that the power plant equipment could break down. (For more details, refer to 2.(2)(ii)(d).)

(iii) Barrier related to the stability of biomass supply

In Indonesia, wood processing factories generally use their own waste wood material as fuel to generate electricity in onsite power plants. CI, however, as well as other companies, procures waste biomass for power generation from external sources. According to the latest information available, among companies generating power on a similar scale to CI in North Sumatra, none have a facility equivalent to CI's that can generate power using 100% biomass waste procured externally.

Based on the barriers described above, this project can be regarded as having additionality since it is a small-scale CDM project.

(12) Project implementation outlook

The project feasibility study performed under current conditions does not support implementing the project activity without additional revenue from CER, as the palm kernel shell price per calorific value is lower than that of coal, and costs for power plant maintenance will increase. However, as the result of the pre-validation, there are many issues that cannot be cleared without CDM registration, and it is necessary to confer and conduct a reinvestigation with CI. In particular, crude palm oil mills within a 100km radius of the CI factory derive palm kernel shells from the palm oil purification process, uses them as waste biomass fuel and also sells them. Although CI cannot confirm their disposal site, it is able to secure the required amount of palm kernel shells without competition. CI will examine the surplus supply of palm kernel shells and aim for CDM registration. Moreover, Sumitomo Forestry will consult with CI about CDM projects using other waste biomass including empty fruit bunches and old gum tree roots, although new capital investment will be necessary.

4. Pre-validation

(1) Pre-validation outline

The Japan Quality Assurance Organization (JQA) was commissioned to perform the pre-validation examination on February 8, 2010. As the examination scope was limited to a desk review, JQA submitted a Desk Review Report.

(2) Progress of correspondence with the DOE

The DOE gave numerous comments regarding additionality and the baseline. The content of the Corrective Action Request (CAR), which concerns the major impact on CDM registration, received from the DOE and the measures taken in response are summarized below. Based on these opinions, Sumitomo Forestry consulted with CI, revised its Project Design Document (PDD), and re-examined relevant issues.

Corrective Action Request (CAR)	Measures Taken
It is not clear how the baseline scenario was determined.	The PDD was revised in accordance with the methodological tool, “Combined tool to identify the baseline scenario and demonstrate additionality”
There is insufficient documentation and evidence to demonstrate additionality.	CI and Sumitomo Forestry will undergo consultations in order to obtain necessary documentation.
It is necessary to indicate the monitoring items according to the methodology.	The items that do not require monitoring were deleted, and items relating to usable biomass were added. Accordingly, Sumitomo Forestry will collect information on the waste biomass fuel that might be used.

5. Results of co-benefit investigation

(1) Assessment of environmental pollution effects in the host country

(i) Assessment items

Fields of air quality improvement		
(a) Soot emissions	(b) NOx emissions	(c) SOx emissions

(ii) Co-benefit baseline and project scenario

The co-benefit baseline and project scenario for the project is as follows.

Fields of air quality improvement
As in the project baseline scenario, the co-benefit baseline is the current status of coal and waste biomass mixed-fuel power generation in the existing coal-based power plant. The project scenario is the emissions from burning 100% waste biomass fuel.

(iii) Baseline evaluation method and monitoring plan

The baseline evaluation will be carried out using the Manual for Quantitative Evaluation of the Co-Benefits Approach to Climate Change Projects Version 1.0, from the Japanese Ministry of the Environment. In accordance with AMDAL, smokestack emissions (m^3/h) and soot, NOx and SOx levels (mg/m^3) will be measured by an external party. To measure SOx emissions, the same equation for soot and NOx emissions (emissions quantity x density) from the aforementioned manual will be used. Data has been obtained for burning either 100% coal or 100% palm kernel shells at CI. This data was used to estimate co-benefit effects for this report. Accordingly, the ratio of coal to waste biomass on an energy basis, which equalled 7:3, was taken into account when calculating baseline emissions. The monitoring system to be employed will be the same as the CDM project monitoring system.

(iv) Calculations before project implementation

The following table shows previously measured data and air pollution standards of the Indonesian government.

Table 5. Measured data and air pollution standards of the Indonesian government

	Baseline	Project Scenario	
	Measured data	Measured data	Air pollution standards*
Soot (mg/m^3)	0.115	0.164	＜300
NOx (mg/m^3)	0.550	0.379	＜800
SOx (mg/m^3)	0.427	0.573	＜600
Dry emissions (m^3/h)	1.06	1.16	—
Annual operation hours (h/yr)	8,223	8,223	—

* Air pollution standards are based on the State Minister for Environment Decree No. 07 of 2007

Using the data above, the following results were obtained.

	Baseline emissions (t/yr)	Project scenario emissions (t/yr)	Difference (t/yr)
Soot	1.13	1.56	-0.43
NOx	4.79	3.62	1.17
SOx	3.69	5.47	-1.78

Based on the above data, implementing the CDM project would lead to a decrease in NOx emissions and an increase is SOx emissions. The reason for this is that burning coal in the baseline scenario requires less fuel and emits less gas than burning 100% waste biomass in the project scenario.

Comparing Indonesian air pollution standards for burning coal and palm kernel shells, soot emission standards are notably higher for palm kernel shells than for coal. In following the country's air pollution standards as a whole, there is no guarantee that burning palm kernel shells instead of coal will lead to lower air pollution. The standards are presented below in Table 5.

Table 6. Comparison of air pollution standards* for coal and palm kernel shells

	Burning coal		Burning palm kernel shells
Soot	230 mg/m^3	＜	300 mg/m^3
NOx	825 mg/m^3	＞	800 mg/m^3
SOx	750 mg/m^3	＞	600 mg/m^3

* Air pollution standards are based on State Minister for Environment Decree No. 07 of 2007

The reason for the standards above, according to a monitoring company commissioned by CI, is that palm kernel shells burn completely, whereas coal does not always reach complete combustion. Furthermore, all of the components in the palm kernel shells are emitted in exhaust gas, while components in coal may remain in the ash. As a result, emission levels for coal may be lower than those of palm kernel shells.

6. Results of investigation concerning contribution towards sustainable development

N.A.