CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

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- *The title of the project activity*
  Palm Methyl Ester – Biodiesel Fuel (PME-BDF) production and use for transportation in Thailand

- *The version number of the document*
  Version 1

- *The date of the document*
  26/09/2005

A.2. Description of the project activity:

>>

- *the purpose of the project activity*

The purpose of the Project is to produce palm methyl ester – biodiesel fuel (PME-BDF) from palm oil and blend it with petroleum diesel to produce an alternative fuel to petroleum diesel for transportation use in Thailand. The reduction of greenhouse gas (GHG) emissions will occur through the substitution of petroleum diesel with PME-BDF, which is a biomass-based fuel. Biomass-based fuels are renewable and emissions from these fuels are deemed as "carbon neutral*".

The Project envisages the construction of a PME-BDF production plant near the Bangkok metropolitan area. The produced PME-BDF will be blended with petroleum diesel to be used as an alternative to petroleum diesel for use of buses in Bangkok where local air pollution are deteriorated due mainly to ga emissions from diesel vehicles. The PME-BDF plant will have a production capacity of 300 tons per day and PME-BDF produced will be blended with petroleum diesel at a rate of 10%. The raw material to produce PME-BDF is crude palm oil (CPO), and it will be purchased mainly in Suratthani province and transported by vessels to the PME-BDF production plant.

* Although CO_2 will be emitted by combusting biodiesel, this emission is defined as "carbon neutral" under IPCC guidelines. Because this CO_2 is deemed to be absorbed and sequestered by plants during its growth, the net CO_2 emission can be counted as zero when it is burned in the atmosphere.

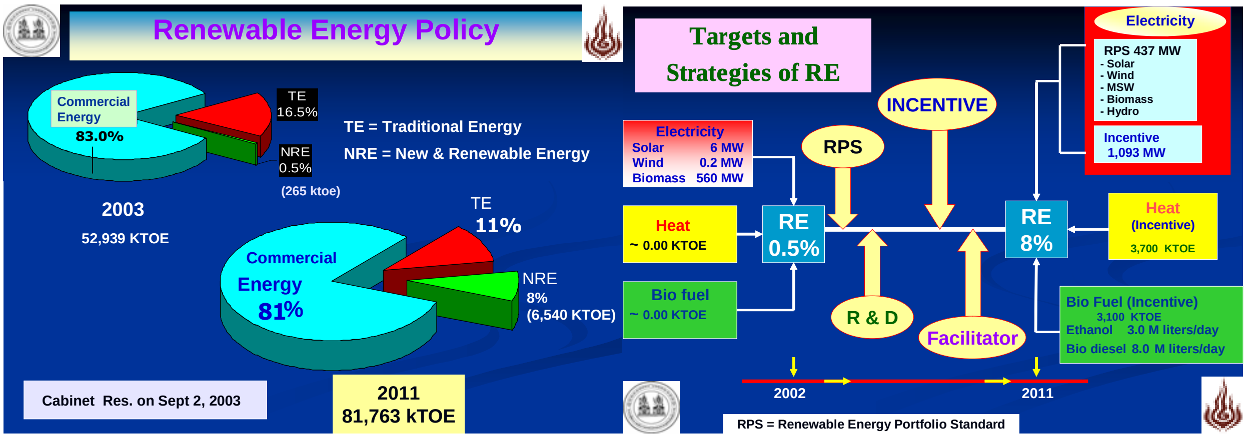
- *the view of the project participants of the contribution of the project activity to sustainable development.*

The project activity will contribute in many aspects to sustainable development in Thailand as described in detail below.

- **Reduce the dependency on imported energy such as crude oil, and promote the use of alternative energy**

  In 2003, crude oil supply in Thailand was 43,500 ktoe (kilo ton of oil equivalent), over 90% of which was imported. With the current trend of continuously rising oil prices, the Thai government is very much concerned with reducing the country's dependence on imported energy as well as in the aspect of energy security. Implementing the proposed project, i.e. producing and using PME-BDF as a local renewable energy source, will help reduce the dependence on imported energy and stabilize the supply of energy in Thailand.

This project activity will also support the policy on using alternative energy in Thailand as shown in the figures below. The government passed this resolution on 2 September 2003, after the adoption by the COP of the CDM M&P (decision 17/CP.7, 11 November 2001). Therefore, the policy may not be taken into account in developing a baseline scenario (Type E- policy, EB16, Report, Annex 3).



*2005/3/15 International Seminar on the Study to Promote Clean Development Mechanism in the Transport Sector to Resolve Global Warming Problem: "Utilization of Biodiesel as Alternative Fuel"

- Ensure steady or increase income of farmers in rural area in Thailand

Oil palm is a major cash crop and important commodity for the rural people especially in the southern part of Thailand where the raw material for the production of PME bio-diesel is produced. Constant purchase of CPO from palm oil millers by the project activity will stabilize the domestic oil palm market and it will contribute to palm oil millers or farmers in the area to ensure steady income and/or creation of new income source. And the project activity will not only enhance the increase of oil palm production in the area, but also it will contribute to increase the income of farmers. The constant revenue for palm oil millers and farmers will form a financial ground to expand or upgrading of palm oil industry in general but particularly in rural area where such value added activity is an earnest desire.

- Improve the air quality in Bangkok Metropolitan Area

Bangkok is one of the most air-polluted cities in the world due mainly to ever increasing vehicle population or acute traffic congestions. A large number of residents suffer from respiratory problems due to the degradation of air quality. The degradation of air quality can be measured by the level of Particulate Matter (PM). In Bangkok, the level of PM is higher than the international standards of this scale of cities and ever increasing because the population of diesel driven vehicle which is the major cause of increased level of PM is quite high. The urgent and cost effective measures to curve the PM level down especially for buses are imperative. Around 16,600 units of large size diesel driven buses are currently in operation in Bangkok alone. Most of which is equipped with second handed diesel engines. Bio-diesel fuels such as PME-BDF is known that the of bio-diesel blended fuel is possible to reduce effectively not only tailpipe PM but also hydrocarbon (HC), as well as carbon monoxide (CO) emissions as stated in 2004 Biodiesel Handling and Use Guidelines (U.S. Department of Energy). Therefore it is effective to improve the air quality of Bangkok especially when such bio-diesel is used by buses operating in Bangkok. The project proponents conducted chassis-dynamo tests using local petroleum diesel blended with PME-BDF which was also locally available, for different type and size of in-use buses in Bangkok in 2004. It is confirmed that a significant amount of air pollutants can be reduced from tailpipe when bio-diesel blended local petroleum diesel is used. Therefore the project activity will contribute to improve the air quality in Bangkok and thereby alleviate the adverse health effects to the residents.

- Lead to the creation of employment

The project activity leads to the creation of employment opportunities through the process from the raw material production to the final product, i.e. oil palm cultivation, palm oil production and PME-BDF production.

The table below shows"CDM Sustainable Development Criteria in Thailand" adapted by the Ministry of Natural Resources and Environment of the Government of Thailand. The Project complies with all of these criteria.

Aspect	Objective	Indicator
Environment	- Promoting Environmental Quality and GHG reduction project. - Promoting reduction of natural resource utilization such as underground water and finite energy sources - Full life cycle plan of the project including plan after CERs contract ended	- Improve environmental quality - GHG emission reduction - Air pollution SO_2, NOx, PM10 - Water pollution - Solid Waste - Land contamination - Include plan to sustain biodiversity - Include underground water conservation plan - Reduce utilization from finite energy source - Promote sustainable use of other natural resource (Reduce, Recycle and Reuse) - Include plan to mitigate environmental impact - Include decommissioning plan or long term maintenance plan after the end of CERs purchase agreement
Social	Public participation is a major part of SD, and in order to avoid community conflict, the project developer must seek permission from both local and national authority.	- In agreement with law and regulations as well as EIA rules - Information Dissemination to the public - Equity in Benefit sharing in the community - Health - Child Education - Improve workers skill - other benefit
Economic	To promote local economy in the project area that would reflect national economy	Employment (in years)

*2005/3/15 International Seminar on Study to Promote Clean Development Mechanism in Transportation sector to Resolve Global Warming Problem: "Utilization of Biodiesel as Alternative Fuel"

A.3. Project participants:

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Name of party involved	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)
Thailand	Private entity : ASB Corporation Group (ACG)	Yes
	Public entity : Ministry of Natural Resources and Environment	No
Japan	Private entity : Sojitz Corporation	Yes
	Public entity : Ministry of Land, Infrastructure and Transport of Japan (MLIT-Japan)	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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A.4.1.1. Host Party(ies):

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Kingdom of Thailand

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

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PME-BDF Production : Bangkok Metropolitan Area
PME-BDF Use : The Greater Bangkok Area

A.4.1.3. City/Town/Community etc:

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PME-BDF Production : Bangkok Metropolitan Area
PME-BDF Use : The Greater Bangkok Area

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

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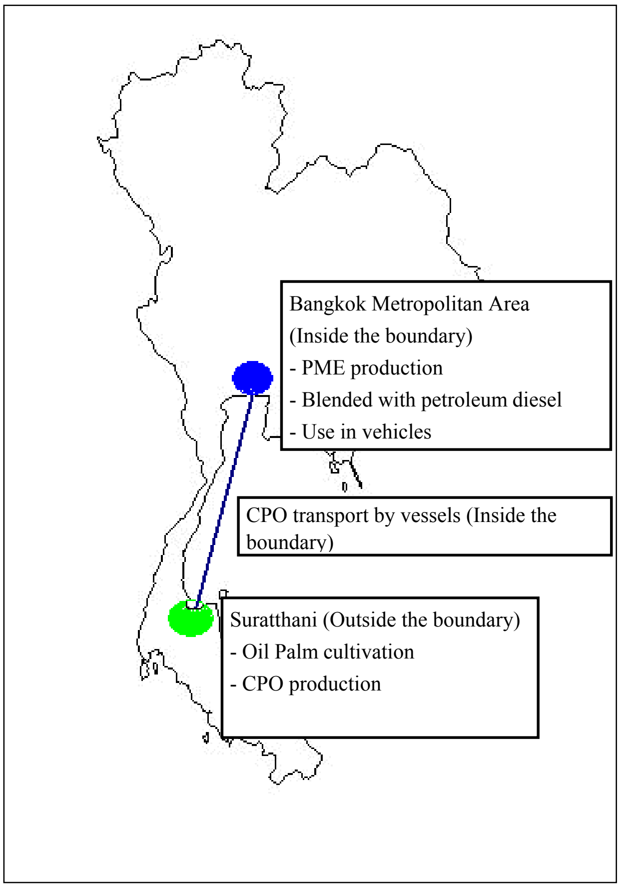
In the project activity, PME-BDF will be produced in a PME-BDF production plant near Bangkok and will be blended with petroleum diesel at 10% level and distributed to filling stations or depots. PME-BDF blended diesel will mostly be used as an alternative fuel to petroleum diesel by buses in Bangkok.

CPO the raw material to produce PME-BDF, will be purchased mainly around Suratthani province and will be stored for a certain period in oil tanks in Suratthani river port and transported by vessels to the

PME-BDF plant near Bangkok. After unloading CPO from vessels at a river port in Bangkok, CPO will be carried by pipelines to the PME-BDF production plant located beside the river port.



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

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Transport

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

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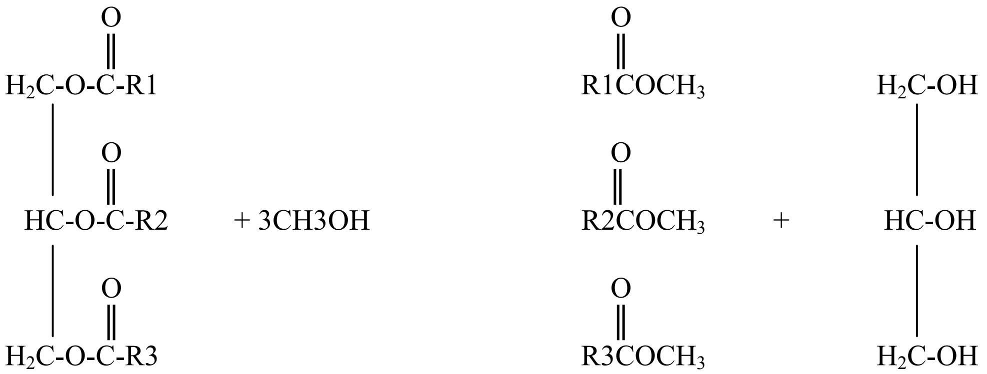
The core technology of the Project is to produce PME-BDF based on palm oil as an alternative fuel to petroleum diesel. The chemical reaction during the esterification process is illustrated below.



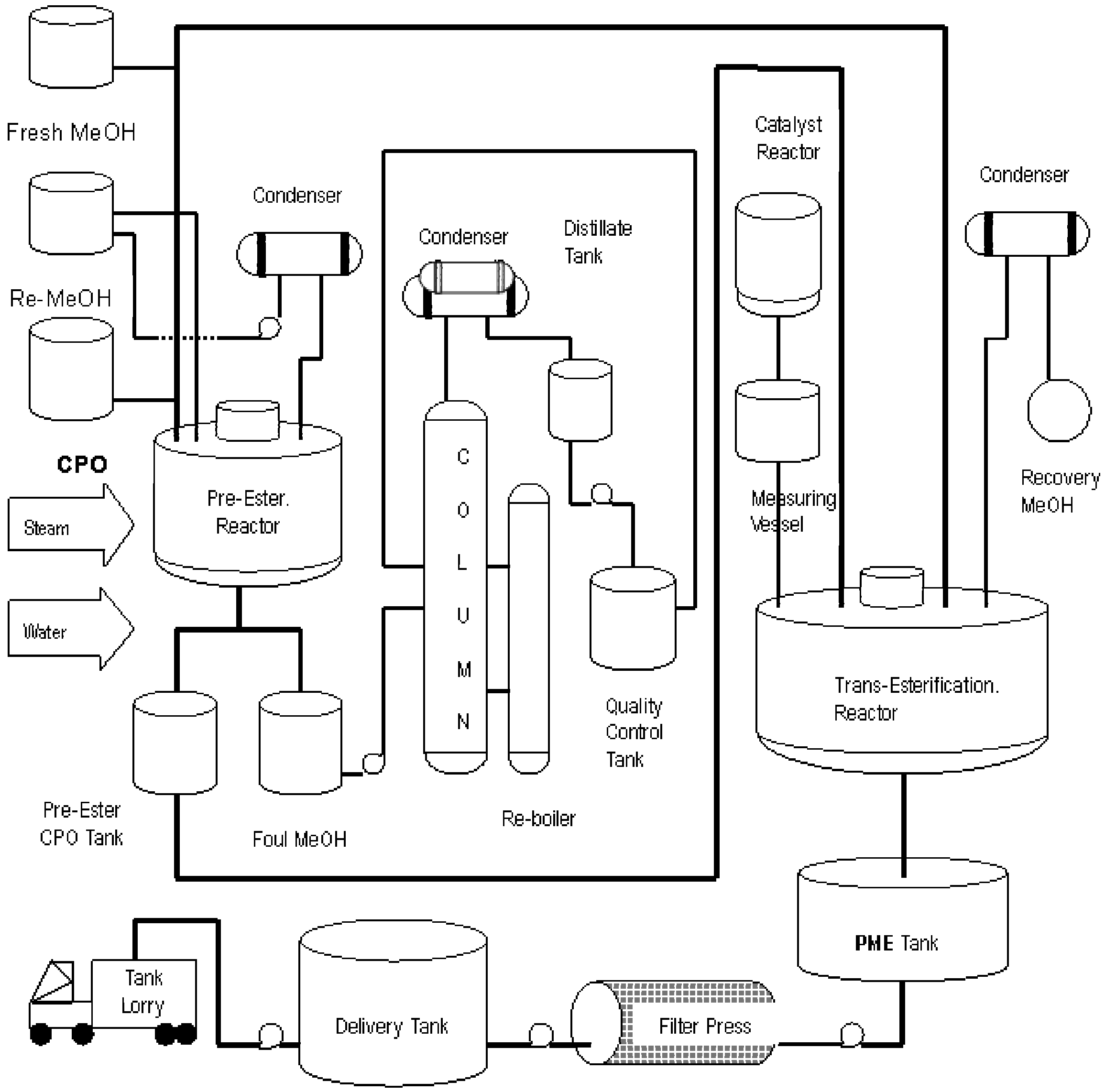
Vegetable Oil (Triglyceride) Methanol Methyl-ester Glycerol

Process outline

CPO is pre-esterified to get rid free fatty acids. Free fatty acids are esterified in acid-catalyzed conditions with a methanol level of 60ºC. The reaction is carried until the acid value of the mixture becomes 0.5. The pre-esterified CPO is transferred to the trans-esterification reactor. The basic catalyst and the methanol are added into the reactor to effect trans-esterification. The reactor is kept at reflux condition until the total glycerin level meets the specification.

Upon reaching the desired total glycerin level in the biodiesel, the residual methanol is distilled. Agitation is stopped to allow PME phase to separate from the glycerol phase. The glycerol phase is drained into another vessel. PME is washed with hot water to remove free glycerol and soap. The water is subsequently drained into the wastewater stream for treatment.

The methyl ester is dehydrated under a vacuum at 90ºC to meet the specification for moisture. The filter aid and the activated carbon are added into the dehydrated methyl ester. The mixture is agitated while being cooled to 40ºC. The biodiesel is filtered through a plate and frame filter and stored in a quarantine vessel. After quality assurance, the biodiesel is transferred into finished good tanks.


Fresh MeOH
Re-MeOH
Condenser
Condenser
Distillate Tank
Catalyst Reactor
Condenser
CPO
Steam
Water
Pre-Ester. Reactor
C O L U M N
Measuring Vessel
Recovery MeOH
Quality Control Tank
Trans-Esterification. Reactor
Pre-Ester CPO Tank
Foul MeOH
Re-boiler
PME Tank
Tank Lorry
Delivery Tank
Filter Press

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

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In the project activity, the reduction of GHG emissions will occur through the substitution of petroleum diesel currently used mainly in buses in Bangkok with PME-BDF that would be produced in the PME-BDF plant which would have a capacity of 300 tons per day (90,000 tons per year, 330 days per year running). CO_2 emission will be reduced by substituting petroleum diesel, as combusting PME-BDF can be counted as zero, or "carbon neutral", under IPCC guidelines. The blending ratio of PME-BDF to petroleum diesel is set at 10%. This is within the level proposed in the methodology, that is 20%, and it can be used in equipment designed to use diesel fuel without changing engine performance (2004 Biodiesel Handling and Use Guidelines, U.S. Department of Energy).

Baseline emissions and project activity emissions are calculated as lifecycle emissions including raw material production and transportation, production fuel and its transportation as well as fuel consumption. Baseline emissions are calculated at 295,643tCO_2e per year, which is the lifecycle GHG emission of petroleum diesel substituted by about 90,000 tons of PME-BDF produced by the project. Project emissions are calculated at 37,973tCO_2e per year, which is mostly from the PME-BDF production plant. Leakage is calculated at 37,973tCO_2e per year, most of which comes from soil by using fertilizers. From these emissions, emission reduction is calculated at 217,755tCO_2e per year.

The Thai government has been setting policies to utilize domestic renewable energy or natural gas to reduce the dependence on imported energy such as crude oil. In this situation, there was the Cabinet resolution about biodiesel supply on 18 January 2005 to supply biodiesel up to 10% of petroleum diesel demand until 2012.

The demand for petroleum diesel is estimated at about 85 million liters per day in 2012. Therefore, under the government policy, 8.5 million liters per day of biodiesel fuel are needed. This means about 27 plants with capacities of 300 tons per year have to be constructed within 7 years from now. In this situation, some private companies are studying the setting up of biodiesel businesses. Until now, however, there is no plant supplying biodiesel and there is no prospect that some companies will certainly start the business because of the many barriers to it such as stable supply of raw materials or regulations on the retail price of biodiesel. Thus, it would be extremely difficult to reach the target the Thai government set within only 7 years.

The situation of biodiesel production using trans-esterification technology in Thailand is in the research and development, or field test, stage. Previously, there were some problems with vehicle engines using refined CPO, or biodiesel which did not undergo trans-esterification. The research and development of high-quality biodiesel using the trans-esterification technology have been carried out only in the past few years. Therefore, there is still no supply for commercial purposes, and only a few small test plants, producing 2 tons per day and using waste cooking oil, have been operating temporarily. Thus the Thai government needs technical or financial assistance from foreign countries to promote biodiesel.

There are also some issues to be cleared such as quality standard and price of biodiesel. Generally, biodiesel production cost is higher than that of petroleum diesel, and it is supposed to be difficult to introduce biodiesel without any financial support from the government, such as subsidies or tax breaks, but there is no such support in Thailand.

Considering situations in Thailand above, the same kind of the project would not implemented and the emission reductions would not occur in the absence of the proposed project activity. This is elaborated in Section B.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

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Years	Annual estimation of emission reductions in tonnes of CO_2e
Year 1	217,755
Year 2	217,755
Year 3	217,755
Year 4	217,755
Year 5	217,755
Year 6	217,755
Year 7	217,755
Year 8	217,755
Year 9	217,755
Year 10	217,755
Total estimated reductions (tons of CO_2e)	2,177,550
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tons of CO_2e)	217,755

A.4.5. Public funding of the project activity:

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No public funding will be used in this project.

SECTION B. Application of a baseline methodology

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

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Since to date, there is no baseline methodology approved by the CDM EB which is applicable to the project activity, a new methodology is proposed.

The title of the new methodology is :

"Baseline Methodology for Palm Methyl Ester or Coconut Methyl Ester Biodiesel Fuel Production for Transportation using Life Cycle Assessment approach"

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

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The proposed project activity is to produce PME-BDF (Palm Methyl Ester – Biodiesel Fuel) and using them in transportation, thus this methodology is chosen (or proposed).

The baseline methodology shows the following applicability conditions.

1. *Produce Palm Methyl Ester – Biodiesel Fuel (PME-BDF) from crude palm oil(CPO) or Coconut Methyl Ester – Biodiesel Fuel (CME-BDF) from coconut oil (CNO) as a raw material through trans-esterification.*

2. *PME-BDF or CME-BDF will be blended with petroleum diesel and used as an alternative to petroleum diesel in transportation vehicles such as cars, ships and railway.*

3. *Production of PME-BDF or CME-BDF will be implemented by an independent entity whose business aim is to produce and sell PME-BDF or CME-BDF. The by-products of PME-BDF or CME-BDF production processes are limited to crude or medical glycerin and not higher-value chemical products.*

4. *PME-BDF or CME-BDF will be blended with petroleum diesel sold in the market at a maximum level of 20%.*

5. *In the host country, there does not exist effective policies, mandates or regulations on the production and use of biodiesel in the transportation sector. Even if there are, the actual condition is far short of the target, making it difficult to implement them because of technological, institutional or financial barriers.*

Applying each applicability condition to the proposed project activity as described below.

1. *Produce Palm Methyl Ester – Biodiesel Fuel (PME-BDF) from crude palm oil(CPO) or Coconut Methyl Ester – Biodiesel Fuel (CME-BDF) from coconut oil (CNO) as a raw material through trans-esterification.*

In the proposed project activity, produce PME-BDF from CPO as a raw material through trans-esterification. CPO will be purchased from several palm oil mills operating in Suratthani, south of Thailand.

2. *PME-BDF or CME-BDF will be blended with petroleum diesel and used as an alternative to petroleum diesel in transportation vehicles such as cars, ships and railway.*

   PME-BDF produced by the Project will be blended with petroleum diesel and will mostly be used in buses in Bangkok. In Thailand, compressed natural gas (CNG) and liquefied petroleum gas (LPG) are also used as vehicle fuels. Petroleum diesel will still be used. This is elaborated in Section B.2.

3. *Production of PME-BDF or CME-BDF will be implemented by an independent entity whose business aim is to produce and sell PME-BDF or CME-BDF. The by-products of PME-BDF or CME-BDF production processes are limited to crude or medical glycerin and not higher-value chemical products.*

   The entity for the project is an independent entity whose business aim will be produce and sell PME-BDF and crude glycerin.

4. *PME-BDF or CME-BDF will be blended with petroleum diesel sold in the market at a maximum level of 20%.*

   The blending ratio of PME-BDF to petroleum diesel is set at 10%.

5. *In the host country, there does not exist effective policies, mandates or regulations on the production and use of biodiesel in the transportation sector. Even if there are, the actual condition is far short of the target, making it difficult to implement them because of technological, institutional or financial barriers.*

   On 18 January 2005 the Thai government set the policy on biodiesel, i.e. to supply biodiesel up to 10% of the petroleum diesel demand until 2012. Under this government policy, 8.5 million liters per day of biodiesel fuel are needed. This means about 27 plants with production capacities of 300 tons per year have to be constructed within 7 years from now. The situation of biodiesel production using trans-esterification technology in Thailand is in the R&D, or field test, stage. There is still no commercial supply. Thus technical assistance from foreign countries is needed to produce biodiesel in large- capacity plants. Biodiesel production cost is higher than that of petroleum diesel, so that some financial support by the government, such as subsidies or tax breaks, is needed. But there is no such support in Thailand. With these technical, financial and institutional barriers, it seems extremely difficult to reach the target that the Thai government set within only 7 years.

The proposed project activity meets all the applicability conditions described in the methodology, thus the methodology can apply to the project.

B.2. Description of how the methodology is applied in the context of the project activity:

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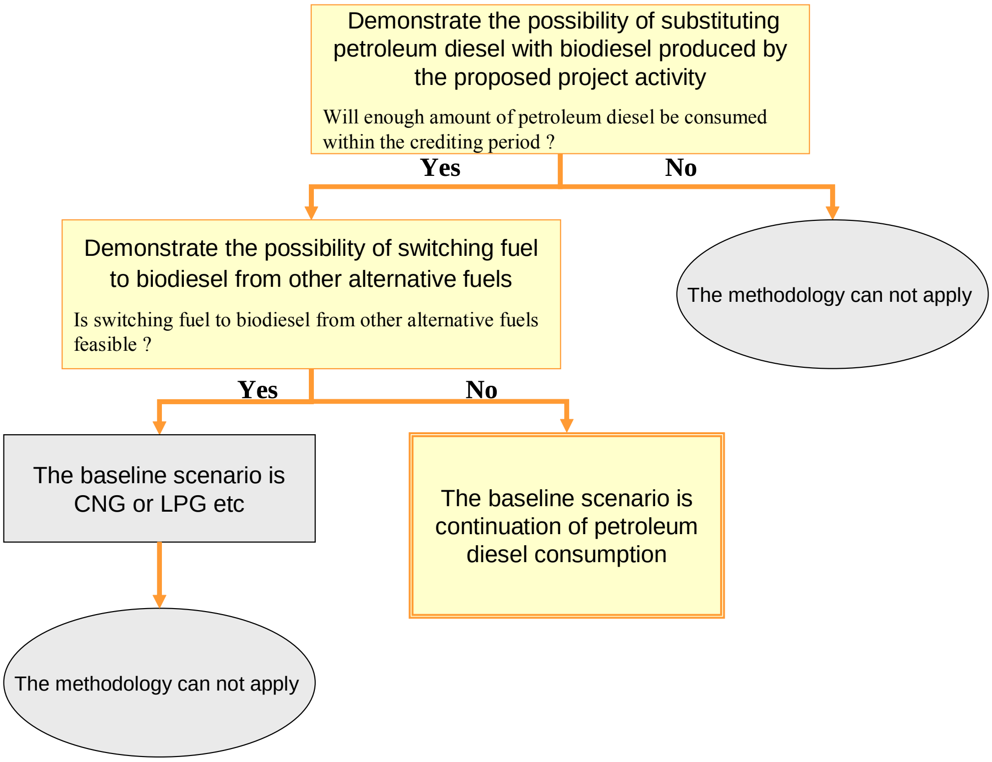
The methodology is applied to the proposed project activity in following five main steps.

Step I : Checking the applicability conditions
Step II : Description of the project boundary
Step III : Determination of baseline scenario
Step IV : Assessment of additionality
Step V : Calculation of emission reduction

Following the above methodology, this section determines the baseline scenario stepwise.
Step I is already elaborated in B.1.1. Steps II, IV, and V are elaborated in sections B.4., B.3., and E., respectively.



1. *Demonstrate the possibility of substituting petroleum diesel with biodiesel produced by the proposed project activity.*
   The project proponent must demonstrate whether or not enough amount of petroleum diesel for transportation will be consumed in the host country or specific organizations (in case the project proponent supplies biodiesel fuel to specific organizations, such as bus companies or local governments, not to the market) within the crediting period compared to biodiesel fuel amount produced by proposed project activity. In demonstrating this, the project proponent should take into account the current situation and future prospect of petroleum diesel consumption in the host country or specific organizations.

In 2003 diesel consumption in Thailand's transportation sector was 10,880 ktoe, or about 52% of total energy consumption in the sector (Thailand Energy Balance 2003, Ministry of Energy). In 2013 it is predicted to increase up to 19,300 ktoe (Calculated based on the data of Ministry of Energy). Bus service companies, the main users of the proposed project product, have 98.7% (3,339 units) diesel vehicles and use almost the same rate of diesel fuel.

The amount of PME-BDF to be supplied by the project will be 85ktoe and the necessary amount of petroleum diesel will be 765 ktoe for a 10% biodiesel blending. Based on these figures, it can be concluded that there will be enough amount consumed within the crediting period.

2. *Demonstrate the possibility of switching fuel to biodiesel from other alternative fuels (such as CNG, LPG, Electricity, etc.)*
   The project proponent must demonstrate that whether or not individuals or organizations who own CNG or LPG or electric vehicles will switch to biodiesel to be supplied by the project. In demonstrating this, the project proponent should take into account the current situation and future prospect of these alternative fuels such as penetration rate and price, and conversion cost in the host country.

Situations of other alternative fuels such as CNG or LPG for transportation use in Thailand are as follows.

- CNG

In 2003, CNG consumption by vehicles was 13 ktoe, or 0.06% of the total energy consumption of the transportation sector (Thailand Energy Balance 2003, Ministry of Energy) . In 2013, it will increase up to 309 ktoe, or 0.75% of the total energy consumption of the transportation sector. However, it is very small compared to other fuels. For bus service companies, which will be the main PME-BDF users, 82 units of CNG vehicles were introduced but only 44 are operating, or 1.3% of the total number of the company's buses.
It should be noted that project proponents tested CO_2 emissions from CNG buses using chassis dynamometers. Results showed that the CO_2 emission of CNG buses was higher than diesel buses especially when they ran at lower speeds. This is attributed to the composition of natural gas in Thailand which has a CO_2 content of up to 30%. Therefore, using CNG vehicle may result in increasing GHG in Thailand, and higher the baseline emissions.

- LPG

In 2003, LPG consumption by vehicles is 245 ktoe, or 1.2% of total energy consumption in the transportation sector (Thailand Energy Balance 2003, Ministry of Energy). LPG consumption by vehicles will increase in the future, but the proportion of LPG for vehicles to all petroleum products is expected to decrease from 12.2% (2003) to 10.5% (2013) (Ministry of Energy). Bus service companies, which are the potential main users of PME-BDF, have no LPG buses now, but plan to introduce them.

- Other alternatives (Electricity, Electric-and-diesel hybrid)

There are few electric or hybrid vehicles in Thailand. The Thai government has no policy promoting them, and the bus service companies have no plans of introducing them.

As described above, there are CNG or LPG vehicles in Thailand. Therefore, it should be analyzed whether or not switching to biodiesel would occur if biodiesel is introduced in the market.
CNG or LPG vehicles require conversion to utilize biodiesel. There are some subsidies for CNG or LPG in Thailand and their retail prices are lower than those of petroleum diesel. Biodiesel prices will be the same as those of petroleum diesel, and conversion cost for CNG and LPG vehicles is more than 500,000 baht. Therefore, it is unlikely to result in a fuel switch from CNG or LPG to biodiesel. (This will be analyzed more precisely in the final PDD following the movement of fuel prices).

3. Determine the baseline scenario
If the proposed project activity satisfies both 1 and 2, the baseline scenario (baseline fuel) is identified as the continuation of petroleum diesel consumption. Otherwise, the baseline scenario is not the continuation of petroleum diesel consumption, and the methodology cannot apply to the proposed project activity.

The proposed project activity satisfies both 1 and 2, thus the baseline scenario (baseline fuel) is identified as the continuation of petroleum diesel consumption.

B.3. 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:

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Following the methodology, demonstrate additionality of the proposed project activity using "*Tool for the demonstration and assessment of additionality (Annex 1, EB16)"* prepared by the CDM executive board, applying both investment and barrier analysis.

As determined in Section B.2., the baseline scenario is the continuation of petroleum diesel consumption.
And the project scenario is to produce PME-BDF, blend it with petroleum diesel, and use it as an alternative to petroleum diesel in the transportation sector, mainly buses in Bangkok. GHG emissions are reduced corresponding to the amount of petroleum diesel substituted by PME-BDF, as emissions from biomass-derived energy, such as PME-BDF, are defined as "carbon neutral" under IPCC guidelines.

Step 0. Preliminary screening based on the starting date of the project activity

The project will supply PME-BDF from August of 2007. Therefore, after the date 31 December 2005 and do not claim for a crediting period starting before the date of registration.

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

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

The possible alternatives to the project activity are as follows:

a) The proposed project activity not undertaken as a CDM project activity
b) Continuation of the current situation (no project activity undertaken)

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

All the alternatives defined above are in compliance with applicable laws and regulations in Thailand.

Step 2. Investment analysis

As outlined in the methodology, Sub-step2b-Option III "Bench Mark Analysis" is adopted to the investment analysis of the Project. For the investment analysis, all financial components (i.e. all expenses including preparatory expenses, plant construction cost, raw material purchase cost, operation and maintenance expenses, product distribution cost, etc.) and all revenue derived from the Project (i.e. sale of product and its by-products) are incorporated to compute the financial internal rate of return (FIRR) and net present value (NPV) in the preliminarily established project period. At this stage, financial expenditure incurred due to financial obligations (i.e. amortization, tax, etc.) is not considered. The cut-off rate applied to the Project is set at the prevailing rate of the London Inter-bank Offered Rate + 2.5%. The financial feasibility of the Project shall not be more than this rate. In other words, the Project is considered as financially viable in commercial terms. A comparison of such cut-off rate of the Project FIRR and a negative NPV will be the benchmark to judge the feasibility of the Project. If the FIRR is lower than the benchmark and the NPV shows negative or less than the initial capital investment amount, the Project is deemed not feasible.

If the FIRR shows more than such benchmark when CER revenue is incorporated into the revenue stream and the NPV shows more than the initial capital investment amount, the Project is considered eligible as a CDM project.

The FIRR of the Project is 3.2% without CDM registration and sale of CER. This will increase to 12.0% when CER is added on revenue. The sale prices of PME-BDF or biodiesel which are relatively higher than those of petroleum diesel can be reduced.

Step 3. Barrier analysis

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

Technical barriers exist in implementing the proposed project activity.
Although biodiesel (methyl ester) production using trans-esterification technology in Thailand is still in the research and development, or field test, stage. While the Thai government on 18 January 2005 already set a policy to supply biodiesel up to 10% of petroleum diesel demand until 2012, there is still no commercial supply of biodiesel. There is lack of technologies or skills to produce biodisel or operate as the large-capacity plant proposed in the Project. If the proposed project will be registered as a CDM project, it will be the first commercial biodiesel plant in Thailand.

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

The baseline scenario is to continue the current practice (i.e. consumption of petroleum diesel). Therefore, the above-mentioned barriers do not pose as obstacles to its promotion.

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:

As described earlier, there are no similar project activities in Thailand. The project will be the first of its kind (evidences are to be prepared at the final PDD).

Sub-step 4b. Discuss any similar options that are occurring:

As there are no similar project activities, this step is not relevant.

Step 5. Impact of CDM registration

As demonstrated in Step 2, the FIRR of the Project is 3.2% without CDM registration and sale of CER. This will increase to 12.0% when CER is added on revenue. The sale prices of PME-BDF or biodiesel which are relatively higher than those of petroleum diesel can be reduced.

The logic above from Step 0 to Step 5 can lead to the conclusion that the project activity is additional.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

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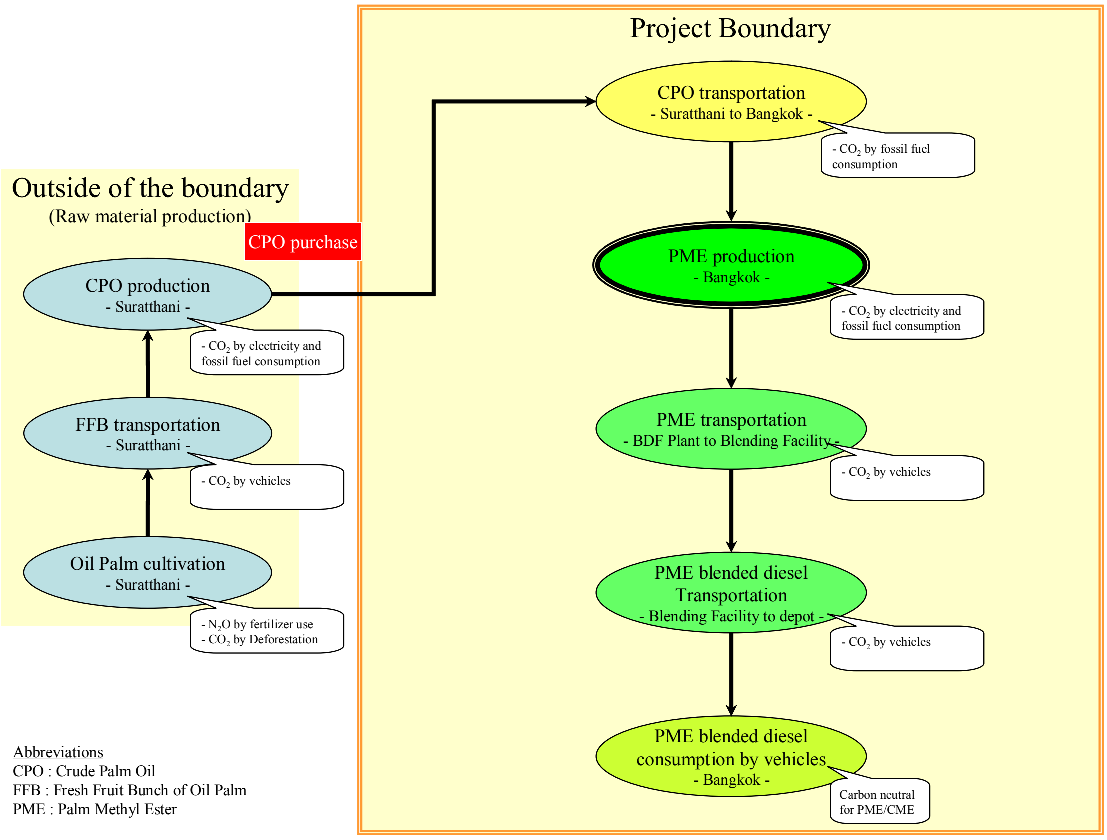
Following the methodology, the project boundary of the proposed project activity is shown in the figure below. Processes that should be included in the project boundary are transportation of CPO purchased by the project proponents, production and transportation of PME-BDF, transportation of PME-BDF-blended diesel, and PME-BDF-blended diesel consumption by vehicles.

Oil palm cultivation and CPO production processes are not included in the project boundary, because the project proponents cannot directly control these processes.

However, as the methodology deals with biomass-based fuel, the Life Cycle assessment approach is applied, and emissions from oil palm cultivation or CPO production processes outside of the project boundary are also calculated as leakage to complete the Life Cycle GHG emissions of PME-BDF. The same theory is also applied for baseline fuel (i.e. petroleum diesel). Please see the table below.


Project Boundary
CPO transportation
- Suratthani to Bangkok -
- CO_2 by fossil fuel consumption
PME production
- Bangkok -
- CO_2 by electricity and fossil fuel consumption
PME transportation
- BDF Plant to Blending Facility -
- CO_2 by vehicles
PME blended diesel Transportation
- Blending Facility to depot -
- CO_2 by vehicles
PME blended diesel consumption by vehicles
- Bangkok -
Carbon neutral for PME/CME
Outside of the boundary
(Raw material production)
CPO purchase
CPO production
- Suratthani -
- CO_2 by electricity and fossil fuel consumption
FFB transportation
- Suratthani -
- CO_2 by vehicles
Oil Palm cultivation
- Suratthani -
- N_2O by fertilizer use
- CO_2 by Deforestation
Abbreviations
CPO : Crude Palm Oil
FFB : Fresh Fruit Bunch of Oil Palm
PME : Palm Methyl Ester

		Source	Gas	Inside or Outside of the boundary	Explanation
Baseline	Raw material production	Grid electricity and fossil fuel consumption and CH_4 leakage in mining and transportation of crude oil	CO_2	Outside	Outside of the boundary, but calculated as a part of LCA emission
			CH_4	Outside	Outside of the boundary, but calculated as a part of LCA emission
	Fuel Production	Grid electricity and fossil fuel consumption in crude oil refining	CO_2	Inside	
		Fossil fuel consumption in petroleum diesel transportation	CO_2	Inside	
	Fuel consumption	Petroleum diesel consumption by vehicles	CO_2	Inside	Calculate emissions from petroleum diesel consumption substituted by PME-BDF
Project Activity	Raw material production	Fertilizer use in cultivation	N_2O	Outside	Outside of the boundary, but calculated as a part of LCA emission, considered as leakage
		Deforestation and land clearing	CO_2	Outside	Outside of the boundary, but calculated as a part of LCA emission, considered as leakage
		Fossil fuel consumption in FFB transportation	CO_2	Outside	Outside of the boundary, but calculated as a part of LCA emission, considered as leakage
		Grid electricity and fossil fuel consumption in CPO production	CO_2	Outside	Outside of the boundary, but calculated as a part of LCA emission, considered as leakage
	Fuel Production	Fossil fuel consumption in CPO transportation	CO_2	Inside	
		Grid electricity and fossil fuel consumption in PME-BDF production	CO_2	Inside	
		Fossil fuel consumption in PME-BDF transportation	CO_2	Inside	
		Fossil fuel consumption in PME-BDF blended diesel transportation	CO_2	Inside	
	Fuel consumption	PME-BDF blended diesel consumption by vehicles	CO_2	Inside	Deemed as “Carbon neutral”

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

>>

September 2005

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SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>

01/08/2007

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

>>

20y-0m

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:

>>

C.2.1.2. Length of the first crediting period:

>>

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>

01/01/2008

C.2.2.2. Length:

>>

10y-0m

SECTION D. Application of a monitoring methodology and plan

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

>>

Since to date, there is no monitoring methodology approved by the CDM EB which is applicable to the project activity, a new methodology is proposed.

The title of the new methodology is :

"Monitoring Methodology for Palm Methyl Ester or Coconut Methyl Ester Biodiesel Fuel Production for Transportation using Life Cycle Assessment approach"

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

>>

The proposed monitoring methodology closely relates to the baseline methodology applied to the Project. The applicability of the monitoring methodology is the same as that of the baseline methodology, which is already certified as applicable.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Fuel oil consumption by vessels to transport CPO (FC_{tCPO_M})	*Transportation service company*	*liter/yr*	*m*	*Monthly*	*100%*	*Electronic*	
2	Net calorific value of fuel oil ($NCV_{fueloil}$)	*National data*	*MJ/liter*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
3	Carbon emission factor of fuel oil ($EF_{fueloil\text{-}C}$)	*National Statistics*	*MJ/liter*	*e*	*Annually*	*100%*	*Electronic*	
4	Total distance travelled by trucks to transport CPO (DT_{tCPO_L})	*Transportation service company*	*km/yr*	*m*	*Monthly*	*100%*	*Electronic*	*Not applicable to the proposed project activity.*
5	CO_2 emission factor of heavy duty truck ($EF_{hdt\text{-}CO2}$)	*Scientific study*	*gCO_2/km*	*e*	*Annually*	*100%*	*Electronic*	
6	CO_2 emission factor of grid electricity	*Electric Power company*	*gCO_2/kWh*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored and recalculated annually.*

	($EF_{grid\text{-}CO2}$)							
7	Grid electricity consumption in PME-BDF production (EC_{pPME_E})	*BDF plant*	*kWh/yr*	*m*	*Monthly*	*100%*	*Electronic*	
8	Fuel oil consumption in PME-BDF production (FC_{pPME})	*BDF plant*	*liter/yr*	*m*	*Monthly*	*100%*	*Electronic*	
9	Total distance travelled by trucks to transport PME-BDF from PME-BDF production plant to blending facility (DT_{tPME})	*Transportation service company*	*km/yr*	*m*	*Monthly*	*100%*	*Electronic*	
10	Total distance travelled by trucks to transport PME-BDF blended diesel from blending facility to filling stations or depots (DT_{tBF})	*Petroleum Company*	*km/yr*	*m*	*Monthly*	*100%*	*Electronic*	
11	Volume of PME-BDF produced	*BDF plant*	*liter*	*m*	*Daily*	*100%*	*Electronic*	*Cross-checking 11, 12, 13 and 15, confirm the volume of PME-BDF used in transport sector in Thailand.*
12	Volume of	*BDF plant*	*liter*	*m*	*Daily*	*100%*	*Electronic*	*Cross-checking 11, 12, 13 and 15,*

	PME-BDF sold (factory to petroleum company)							*confirm the volume of PME-BDF used in transport sector in Thailand.*
13	Volume of PME-BDF exported	*BDF plant or Petroleum Company*	*liter*	*m*	*Monthly*	*100%*	*Electronic*	*Cross-checking 11, 12, 13 and 15, confirm the volume of PME-BDF used in transport sector in Thailand. The amount of PME-BDF exported to Annex I countries are also monitored*
14	The place and name of company from where CPO was procured	*BDF plant*	-	*m*	*Monthly*	*100%*	*Electronic*	*The places including other county to purchase CPO are monitored*

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>

Project activity emissions include emissions from following processes.
- CPO transportation
- PME-BDF production
- PME-BDF transportation
- PME-BDF-blended diesel transportation
- PME-BDF-blended diesel consumption by vehicles

1. CPO transportation

There is no land transportation for CPO in this project activity.

$$EP_{tCPO\_M} = FC_{tCPO\_M} \text{ x } NCV_{fueloil} \text{ x } 10^{-6} \text{ x } EF_{fueloil\text{-}C} \text{ x } OX_{fueloil} \text{ x } 44/12$$

EP_{tCPO_M} : CO_2 emission from fuel oil consumption by vessels to transport CPO (tCO_2/yr)

FC_{tCPO_M} : Fuel oil consumption by vessels to transport CPO (liter/yr)

$NCV_{fueloil}$: Net calorific value of fuel oil (MJ/liter)

$EF_{fueloil\text{-}C}$: Carbon emission factor of fuel oil (tC/TJ)
$OX_{fueloil}$: Oxidization factor of fuel oil

$EP_{tCPO} = EP_{tCPO\_M}$

2. PME-BDF production

2-1 Grid electricity consumption

$EP_{pPME\_E} = EC_{pPME\_E} \times EF_{grid\text{-}CO2} \times 10^{-6}$
EP_{pPME_E} : CO_2 emission from grid electricity consumption in PME-BDF production (tCO_2/yr)
EC_{pPME_E} : Grid electricity consumption in PME production (kWh/yr)
$EF_{grid\text{-}CO2}$: CO_2 emission factor of grid electricity (gCO_2/kWh)

2-2 fossil fuel consumption

$EP_{pPME\_F} = FC_{pPME} \times NCV_{fueloil} \times 10^{-6} \times EF_{fueloil\text{-}C} \times OX_{fueloil} \times 44/12$
EP_{pPME_F} : CO_2 emission from fuel oil consumption in PME-BDF production (tCO_2/yr)
FC_{pPME} : Fuel oil consumption in PME-BDF production (liter/yr)
$NCV_{fueloil}$: Net calorific value of fuel oil (MJ/liter)
$EF_{fueloil\text{-}C}$: Carbon emission factor of fuel oil (tC/TJ)
$OX_{fueloil}$: Oxidization factor of fuel oil

2-3 Total

$EP_{pPME} = EP_{pPME\_E} + EP_{pPME\_F}$
EP_{pPME} : CO_2 emission from grid electricity and fossil fuel consumption in PME-BDF production (tCO_2/yr)

3. PME-BDF transportation

$EP_{tPME} = DT_{tPME} \times EF_{hdt\text{-}CO2} \times 10^{-6}$
EP_{tPME} : CO_2 emission from fossil fuel consumption by trucks to transport PME-BDF (tCO_2/yr)
DT_{tPME} : Total distance travelled by trucks to transport PME-BDF from PME-BDF production plant to blending facility (km/yr)
$EF_{hdt\text{-}CO2}$: CO_2 emission factor of heavy duty truck (gCO_2/km)

4. PME-BDF blended diesel transportation

$$EP_{tBF} = DT_{tBF} \times EF_{hdt\text{-}CO2} \times 10^{-6}$$

EP_{tBF} : CO_2 emission from fossil fuel consumption by trucks to transport PME-BDF blended diesel (tCO_2/yr)

DT_{tBF} : Total distance travelled by trucks to transport PME-BDF blended diesel from blending facility to each filling stations or depots (km/yr)

$EF_{hdt\text{-}CO2}$: CO_2 emission factor of heavy duty truck (gCO_2/km)

5. PME-BDF blended diesel consumption by vehicles

CO_2 emissions from biodiesel combusted in the proposed project activity are deemed as zero. This is because biodiesel is one of the biomass-derived energy sources, and CO_2 emissions from them are defined as "carbon neutral" under IPCC guidelines.

6. Total

$$EP = EP_{tCPO} + EP_{pPME} + EP_{tPME} + EP_{tBF}$$

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
15	Volume of PME-BDF sold to filling stations or depots ($FC_{biodiesel}$)	*Petroleum Company*	*liter*	*m*	*Daily*	*100%*	*Electronic*	*Cross-checking 11, 12, 13 and 15, confirm the volume of PME-BDF used in transport sector in Thailand.*

16	Net calorific value of PME-BDF ($HV_{biodiesel}$)	*National data or scientific literatures or results by project participants*	*MJ/liter*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
17	GHG emission factor of mining and transportation of crude oil, refining and transportation of petroleum diesel (EF_{wtt})	*Scientific literatures*	*gCO_2/MJ*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
18	Carbon emission factor of petroleum diesel ($EF_{diesel-C}$)	*IPCC data*	*tC/TJ*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>

Baseline emissions include emissions from following processes.
- Mining and transportation of crude oil, refining and transportation of petroleum diesel
- Petroleum diesel consumption by vehicles

1. Mining and transportation of crude oil, refining and transportation of petroleum diesel

$$EB_{wtt} = FC_{diesel} \text{ x } EF_{wtt} \text{ x } 10^{-6}$$

$$FC_{diesel} = FC_{biodiesel} \text{ x } HV_{biodiesel}$$

EB_{wwt} : GHG emissions from mining and transportation of crude oil, refining and transportation of petroleum diesel (tCO_2/yr)

FC_{diesel} : Petroleum diesel consumption substituted by PME-BDF (GJ)

$FC_{biodiesel}$: PME-BDF consumption (kilo-liter) = Volume of PME-BDF sales to filling stations or depots (kilo-liter)
$HV_{biodiesel}$: Net calorific value of PME-BDF (MJ/L)
EF_{wtt} : GHG emission factor of mining and transportation of crude oil, refining and transportation of petroleum diesel (gCO_2/MJ)

2. Petroleum diesel consumption by vehicles

$$EB_v = FC_{diesel} \times EF_{diesel\text{-}C} \times 10^{-3} \times OX_{diesel} \times 44/12$$

EB_v : CO_2 emission from petroleum diesel consumption substituted by PME-BDF that is used by vehicles (tCO_2/yr)
FC_{diesel} : Petroleum diesel consumption substituted by PME-BDF (GJ)
$EF_{diesel\text{-}C}$: Carbon emission factor of petroleum diesel (tC/TJ)
OX_{diesel} : Oxidization factor of diesel

3. Total

$$EB = EB_{wtt} + EB_v$$

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

>>

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
19	CPO use in PME-BDF production plant (P_{CPO})	*BDF plant*	*ton*	*m*	*Daily*	*100%*	*Electronic*	
20	Fertilizer use per ha (SF_{1ha})	*Local data or scientific literatures*	*ton/ha/yr*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
21	CPO average yield from 1 ha of oil palm (Y_{CPO})	*Local data or scientific literatures*	*ton/ha*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
22	Nitrogen weight fraction of fertilizer (R_N)	*Local data or scientific literatures*	*ratio*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
23	CO_2 emission factor of heavy duty truck ($EF_{hdt-CO2}$)	*Scientific study*	*gCO_2/km/ton*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
26	Distance travelled by truck per FFB	*Local data*	*km/ton/yr*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*

	1ton (DT_{1t-FFB})							
27	CPO average yield per FFB 1 ton ($R_{CPO-FFB}$)	*Local data*	*ratio*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
28	Grid electricity consumption in CPO production per CPO 1 ton ($EC_{p1t-CPO}$)	*Local data or scientific literatures*	*kWh/ton*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually and recalculated.*
29	Fossil fuel consumption in CPO production per CPO 1 ton ($FC_{p1t-CPO}$)	*Local data or scientific literatures*	*liter/ton*	*Constant value*	*Annually*	*100%*	*Electronic*	*Constant value, but should be monitored annually.*
30	CO_2 emission factor of grid electricity ($EF_{grid-CO2}$)	*Electric Power company*	*gCO_2/kWh*	*Constant value*	*Annually*	*100%*	*Electronic*	*Same as No.6*
31	Annual area of forest converted to oil palm field (A_{conv})	*Palm Farmer Association*	*ha/yr*		*Annually*	*100%*	*Electronic*	

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>

Leakage include emissions from the following processes.
- Oil Palm cultivation
- FFB transportation
- CPO production

1. Oil Palm cultivation

1-1 Direct and indirect emissions of N_2O from fertilizer use in cultivation

$$EL_{pf} = SF \times R_N \times ((1-F_{GASF}) \times EF_{f\text{-}N2Oa} + F_{GASF} \times EF_{f\text{-}N2Ob}) \times (44/28) \times GWP_{N2O}$$

$$SF = SF_{1ha} \times A_{plant} = SF_{1ha} \times (P_{CPO}/Y_{CPO})$$

EL_{pf} : N_2O emission from fertilizer use in cultivation (tCO_2/yr)
SF : Fertilizer use (ton/yr)
R_N : Nitrogen weight fraction of fertilizer
F_{GASF} : Fraction of synthetic fertilizer nitrogen applied to soils that volatilizes as NH3 and NOx (kg NH3-N and NOx–N/kg of N input)
$EF_{f\text{-}N2Oa}$: Emission factor for direct soil emissions (kgN_2O-N/kg-N)
$EF_{f\text{-}N2Ob}$: Emission factor for atmospheric deposition (kgN2O-N/kgNH3-N and NOx–N emitted)
SF_{1ha} : Fertilizer use per ha (ton/ha/yr)
GWP_{N2O} : =310
A_{plant} : Oil Palm cultivation area (ha)
P_{CPO} : CPO use in PME-BDF production plant (ton)
Y_{CPO} : CPO average yield from 1 ha of oil palm cultivation (ton/ha)

1-2 Land use change

$$EL_{LC} = (\Delta C_{LB} + \Delta C_{soils}) \times 44/12$$

$$\Delta C_{LB} = A_{conv} \times (L_{conv} - \Delta C_{growth})$$

$$\Delta C_{soils} = \Delta C_{mineral} - \Delta C_{organic} - \Delta C_{liming}$$

$$L_{conv} = C_{before} - C_{after}$$

EL_{LC} : Total CO_2 emission from land conversion from forests to oil palm field, (tCO_2/yr)
ΔC_{LB} : Change in carbon stocks in living biomass in forest converted to oil palm field (tC/yr)
ΔC_{Soils} : Change in carbon stocks in soil in forest converted to oil palm field (tC/yr)
A_{conv} : Annual area of forest converted to oil palm field (ha/yr)
L_{conv} : Carbon stock change per area for that type of conversion when forest is converted to oil palm field (tC/ha)
ΔC_{growth} : Changes in carbon stocks from one year of oil palm growth (tC/ha)
C_{after} Carbon stocks in biomass immediately after conversion to oil palm field (tC/ha)
C_{before} : Carbon stocks in biomass immediately before conversion to oil palm field (tC/ha)
$\Delta C_{mineral}$: Change in carbon stocks in mineral soils in forest converted to oil palm field (tC/ha)
$\Delta C_{organic}$: Annual C emissions from cultivated organic soils converted to oil palm field (estimated as net annual flux) (tC/ha)

ΔC_{liming} : Annual C emissions from agricultural lime application on forest converted to oil palm field (tC/ha)

2. FFB transportation

$EL_{tFFB} = DT_{tFFB} \times EF_{hdt\text{-}CO2} \times 10^{-6}$

$DT_{tFFB} = DT_{1t\text{-}FFB} \times P_{FFB} = DT_{1t\text{-}FFB} \times (P_{CPO}/R_{CPO\text{-}FFB})$

EL_{tFFB} : CO_2 emission from fossil fuel consumption by trucks to transport FFB (tCO_2/yr)
DT_{tFFB} : Total distance travelled by trucks to transport FFB (km/yr)
$EF_{hdt\text{-}CO2}$: CO_2 emission factor of heavy duty truck (gCO_2/km)
$DT_{1t\text{-}FFB}$: Distance travelled by truck per FFB 1ton (km/ton/yr)
P_{FFB} : FFB equivalent to produce CPO used in PME-BDF production plant (ton)
P_{CPO} : CPO use in PME-BDF production plant (ton)
$R_{CPO\text{-}FFB}$: CPO average yield per FFB 1 ton

3. CPO production

3-1. Grid electricity consumption

$EL_{pCPO\text{-}E} = EC_{pCPO} \times EF_{grid\text{-}CO2} \times 10^{-6}$

$EC_{pCPO} = EC_{p1t\text{-}CPO} \times P_{CPO}$

$EL_{pCPO\text{-}E}$: CO_2 emission from grid electricity consumption in CPO production (tCO_2/yr)
EC_{pCPO} : Grid electricity consumption in CPO production (kWh/yr)
$EF_{grid\text{-}CO2}$: CO_2 emission factor of grid electricity (gCO_2/kWh)
$EC_{p1t\text{-}CPO}$: Grid electricity consumption in CPO production per CPO 1 ton (kWh/ton)
P_{CPO} : CPO use in PME-BDF production plant (ton)

3-2. Fossil fuel consumption

$EL_{pCPO\text{-}F} = FC_{pCPO} \times NCV_{fueloil} \times 10^{-6} \times EF_{fueloil\text{-}C} \times OX_{fueloil} \times 44/12$

$FC_{pCPO} = FC_{p1t\text{-}CPO} \times P_{CPO}$

$EL_{pCPO\text{-}F}$: CO_2 emission from fuel oil consumption in CPO production (tCO_2/yr)
FC_{pCPO} : Fuel oil consumption in CPO production (liter)
$NCV_{fueloil}$: Net calorific value of fuel oil (MJ/liter)
$EF_{fueloil\text{-}C}$: Carbon emission factor of fuel oil (tC/TJ)
$OX_{fueloil}$: Oxidization factor of fuel oil

$FC_{p1t\text{-}CPO}$: Fuel oil consumption in CPO production per CPO 1 ton (liter/ton)
P_{CPO} : CPO use in PME-BDF production plant (ton)

3-3. Total

$EL_{pCPO} = EL_{pCPO\text{-}E} + EL_{pCPO\text{-}F}$
EL_{pCPO} : CO_2 emission from grid electricity and fossil fuel consumption in CPO production (tCO_2/yr)

4. Total

$EL = EL_{pf} + EL_{LC} + EL_{tFFB} + EL_{pCPO}$

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>

Emission reductions (ERs) are calculated as

$ERs = EB - EP_{total} = EB - (EP + EL)$
EB : Baseline emissions (tCO_2/yr)
EP_{total} : Project total emissions (tCO_2/yr)
EP : Project emissions (tCO_2/yr)
EL : Leakage (tCO_2/yr)

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1, 4, 9	*Low*	*Check against the purchase receipts or sales records.*
2, 3, 6, 18, 23, 30	*Low*	*Value based on IPCC, national or company data.*
7, 8, 11, 12, 13, 14, 19	*Low*	*Measurable at the plant by equipment or purchase receipts or sales records. Maintenance and calibration of equipment will be done well.*
10, 13, 15	*Low*	*To set up QA/QC system with Petroleum Company to maintain quality of data*

16	*Low*	*Measured in well-maintained and calibrated equipment, and check against national or other credible data.*
5, 17, 23	*Low*	*Check more resent studies and consider their appropriateness.*
16, 20, 21, 22, 26, 27, 28, 29, 31	*Low*	*Check against national or other credible data, if possible.*

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

>>

Project proponents will prepare “Monitoring Plan of biodiesel CDM project”. The plan includes a monitoring method for each monitoring item and the process of QA/QC and shall conduct monthly and annual surveys based on such plan. And to ensure the quality of the data monitored, meetings related to monitoring will be held to keep everyone well informed about the process, etc.

D.5 Name of person/entity determining the monitoring methodology:

>>

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SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

>>

Following the methodology, project activity emissions are calculated for each process below.
- CPO/CNO transportation
- PME-BDF/CME-BDF production
- PME-BDF/CME-BDF transportation
- PME-BDF/CME-BDF blended diesel transportation
- PME-BDF/CME-BDF blended diesel consumption by vehicles

1. CPO transportation

1-1 Maritime transportation

$$EP_{tCPO\_M} = FC_{tCPO\_M} \text{ x } NCV_{fueloil} \text{ x } 10^{-6} \text{ x } EF_{fueloil\text{-}C} \text{ x } OX_{fueloil} \text{ x } 44/12$$

Parameters	Value	References or how the values are to be selected
EP_{tCPO_M} : CO_2 emission from fossil fuel consumption by vessels to transport CPO (tCO_2/yr)	923	Calculated on an ex-post basis
FC_{tCPO_M} : Fuel oil consumption by vessels to transport CPO (liter/yr)	303,030	Variable to be monitored, but estimated for ex-ante calculation (to be studied further) : = 5(ton of fuel consumption from Suratthani to Bangkok ; obtained by transportation company) x 2 x 90,000(production of CPO in ton) / 3,000 (transportation of CPO in one time in ton)/0.990(t/kl))
$NCV_{fueloil}$: Net calorific value of fuel oil (MJ/liter)	39.77	Thailand Energy Situation 2003, Energy Content of Fuel (Net Calorific Value), The Department of Energy Development and Promotion, Ministry of Energy
$EF_{fueloil\text{-}C}$: Carbon emission factor of fuel oil (tC/TJ)	21.1	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories : Reference Manual, p.1.14
$OX_{fueloil}$: Oxidization factor of fuel oil	0.99	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories : Reference Manual, p.1.29

1-2 Land transport

There is no land transportation of CPO in this project activity.

1-3 Total

$EP_{tCPO} = EP_{tCPO\_M} + EP_{tCPO\_L} = 923$ (tCO_2/yr)

EP_{tCPO} : CO_2 emission from fossil fuel consumption by CPO transportation (tCO_2/yr)

2. PME-BDF production

2-1 Grid electricity consumption

$$EP_{pPME\_E} = EC_{pPME\_E} \times EF_{grid\text{-}CO2} \times 10^{-6}$$

Parameters	Value	References or how the values are to be selected
EP_{pPME_E}: CO_2 emission from grid electricity consumption in PME-BDF production (tCO_2/yr)	5,477	Calculated on an ex-post basis
EC_{pPME} : Grid electricity consumption in PME-BDF production (kWh/yr)	8,820,000	Variable to be monitored, but estimated for ex-ante calculation (to be studied further)
$EF_{grid\text{-}CO2}$: CO_2 emission factor of grid electricity (gCO_2/kWh)	621	Calculated as simple operating margin emission factor based on EGAT Annual Report 2004 (to be studied further)

2-2 Fossil fuel consumption

$$EP_{pPME\_F} = FC_{pPME} \times NCV_{fueloil} \times 10^{-6} \times EF_{fueloil\text{-}C} \times OX_{fueloil} \times 44/12$$

Parameters	Value	References or how the values are to be selected
EP_{pPME_F}: CO_2 emission from fuel oil consumption in PME-BDF production (tCO_2/yr)	24,923	Calculated on an ex-post basis
FC_{pPME} : Fuel oil consumption in PME-BDF production (liter/yr)	8,100,000	Calculated on an ex-post basis
$NCV_{fueloil}$: Net calorific value of fuel oil (MJ/liter)	39.77	Thailand Energy Situation 2003, Energy Content of Fuel (Net Calorific Value), The Department of Energy Development and Promotion, Ministry of Energy
$EF_{fueloil\text{-}C}$: Carbon emission factor of fuel oil (tC/TJ)	21.1	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories : Reference Manual, p.1.14
$OX_{fueloil}$: Oxidization factor of fuel oil	0.99	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories : Reference Manual, p.1.29

2-3 Total

$$EP_{pPME} = EP_{pPME\_E} + EP_{pPME\_F} = 30{,}400\ (tCO_2/yr)$$

EP_{pPME} : CO_2 emission from grid electricity and fossil fuel consumption in PME-BDF production (tCO_2/yr)

3. PME-BDF transportation

$$EP_{tPME} = DT_{tPME} \times EF_{hdt\text{-}CO2} \times 10^{-6}$$

Parameters	Value	References or how the values are to be selected
EP_{tPME} : CO_2 emission from fossil fuel consumption by trucks to transport PME-BDF (tCO_2/yr)	1,108	Calculated on an ex-post basis
DT_{tPME} : Total distance travelled by trucks to transport PME-BDF from PME-BDF production plant to blending facility (km/yr)	450,000	Variable to be monitored, but Estimated for ex-ante calculation (to be studied further) : = 90,000/20(ton per one time)x100(km)
$EF_{hdt\text{-}CO2}$: CO_2 emission factor of heavy duty truck (gCO_2/km)	2,463	Emission factor of in-use heavy duty truck in Bangkok; Study to Promote Clean Development Mechanism(CDM) in Transport Sector to Resolve Global Warming Problem, Ministry of Land Infrastructure and Transport of Japan (MLIT-Japan), 2004

4. PME-BDF blended diesel transportation

$$EP_{tBF} = DT_{tBF} \times EF_{hdt\text{-}CO2} \times 10^{-6}$$

Parameters	Value	References or how the values are to be selected
EP_{tBF} : CO_2 emission from fossil fuel consumption by trucks to transport PME-BDF blended diesel (tCO_2/yr)	5,542	Calculated on an ex-post basis
DT_{tBF} : Total distance travelled by trucks to transport PME-BDF blended diesel from blending facility to each filling stations or depots (km/yr)	2,250,000	Variable to be monitored, but estimated for ex-ante calculation (to be studied further) : = 900,000/0.1/20(ton per one time)x50(km)
$EF_{hdt\text{-}CO2}$: CO_2 emission factor of heavy duty truck (gCO_2/km)	2,463	Emission factor of in-use heavy duty truck in Bangkok; Study to Promote Clean Development Mechanism(CDM) in Transport Sector to Resolve Global Warming Problem, Ministry of Land Infrastructure and Transport of Japan (MLIT-Japan), 2004

5. PME-BDF blended diesel consumption by vehicles

CO_2 emissions from biodiesel combusted in the proposed project activity are deemed as zero. This is because biodiesel is a biomass-derived energy whose CO_2 emission is defined as “carbon neutral” under IPCC guidelines.

6. Total

$$EP = EP_{tCPO} + EP_{pPME} + EP_{tPME} + EP_{tBF} = 37{,}973\ tCO_{2e}/yr$$

E.2. Estimated leakage:

>>

Following the methodology, leakage emissions are calculated for each process below.
- Oil Palm cultivation
- FFB transportation
- CPO production

1. Oil Palm cultivation

1-1 Direct and indirect emissions of N_2O from fertilizer use in cultivation

$$EL_{pf} = SF \times R_N \times ((1-F_{GASF}) \times EF_{f\text{-}N2Oa} + F_{GASF} \times EF_{f\text{-}N2Ob}) \times (44/28) \times GWP_{N2O}$$
$$SF = SF_{1ha} \times A_{plant} = SF_{1ha} \times (P_{CPO}/Y_{CPO})$$

Parameters	Value	References or how the values are to be selected
EL_{pf} : N_2O emission from fertilizer use in cultivation (tCO_2/yr)	31,933	Calculated on an ex-post basis
SF : Fertilizer use (ton/yr)	25,481	Calculated on an ex-post basis
R_N : Nitrogen weight fraction of fertilizer	0.21	Local data (to be studied further)
F_{GASF} : Fraction of synthetic fertilizer nitrogen applied to soils that volatilizes as NH3 and NOx (kg NH3-N and NOx–N/kg of N input)	0.1	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, p.4.94
$EF_{f\text{-}N2Oa}$: Emission factor for direct soil emissions (kgN_2O-N/kg-N)	0.0125	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, p.4.89
$EF_{f\text{-}N2Ob}$: Emission factor for atmospheric deposition (kgN2O-N/kgNH3-N and NOx–N emitted)	0.01	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, p.4.105
SF_{1ha} : Fertilizer use per ha (ton/ha/yr)	1.0	Local data (to be studied further)
GWP_{N2O}	310	Constant value
A_{plant} : Oil Palm cultivation area (ha)	25,481	Calculated
P_{CPO} : CPO use in PME-BDF production plant (ton)	90,000	Variable to be monitored, but estimated for ex-ante calculation (to be studied further)
Y_{CPO} : CPO average yield from 1 ha of oil palm cultivation (ton/ha)	3.532	Local data (to be studied further)

1-2 Land use change

In the project activity, land use changes that result in a net decrease of carbon pools such as the conversion from forests are to be monitored, and if applicable, CO_2 emissions will be calculated as the formulae proposed in the methodology. (This is elaborated further in final PDD.)

2. FFB transportation

$$EL_{tFFB} = DT_{tFFB} \text{ x } EF_{hdt\text{-}CO2} \text{ x } 10^{-6}$$
$$DT_{tFFB} = DT_{1t\text{-}FFB} \text{ x } P_{FFB} = DT_{1t\text{-}FFB} \text{ x } (P_{CPO}/R_{CPO\text{-}FFB})$$

Parameters	Value	References or how the values are to be selected
EL_{tFFB} : CO_2 emission from fossil fuel consumption by trucks to transport FFB (tCO_2/yr)	1,478	Calculated on an ex-post basis
DT_{tFFB} : Total distance travelled by trucks to transport FFB (km/yr)	1,800,000	Calculated on an ex-post basis
$EF_{hdt\text{-}CO2}$: CO_2 emission factor of heavy duty truck (gCO_2/km)	821	Emission factor of in-use heavy duty truck in Bangkok; Study to Promote Clean Development Mechanism(CDM) in Transport Sector to Resolve Global Warming Problem, Ministry of Land Infrastructure and Transport of Japan (MLIT-Japan), 2004
$DT_{1t\text{-}FFB}$: Distance travelled by truck per FFB 1ton (km/ton/yr)	4	Local data (to be studied further)
P_{FFB} : FFB equivalent to produce CPO used in PME-BDF production plant (ton)	450,000	Calculated
P_{CPO} : CPO use in PME-BDF production plant (ton)	90,000	Variable to be monitored, but Estimated for ex-ante calculation (to be studied further)
$R_{CPO\text{-}FFB}$: CPO average yield per FFB 1 ton	0.20	Local data (to be studied further)

3. CPO production

3-1. Grid electricity consumption

$$EL_{pCPO\text{-}E} = EC_{pCPO} \text{ x } EF_{grid\text{-}CO2} \text{ x } 10^{-6}$$
$$EC_{pCPO} = EC_{p1t\text{-}CPO} \text{ x } P_{CPO}$$

Parameters	Value	References or how the values are to be selected
$EL_{pCPO\text{-}E}$: CO_2 emission from grid electricity consumption in CPO production (tCO_2/yr)	4,037	Calculated on an ex-post basis
EC_{pCPO} : Grid electricity consumption in CPO production (kWh/yr)	6,500,000	Calculated on an ex-post basis
$EF_{grid\text{-}CO2}$: CO_2 emission factor of grid electricity (gCO_2/kWh)	621	Calculated as simple operating margin emission factor based on EGAT Annual Report 2004 (to be studied further)
$EC_{p1t\text{-}CPO}$: Grid electricity consumption in CPO production per CPO 1 ton (kWh/ton)	72	Local data (to be studied further)
P_{CPO} : CPO use in PME-BDF production plant (ton)	90,000	Variable to be monitored, but estimated for ex-ante calculation

3-2. Fossil fuel consumption

$$EL_{pCPO\text{-}F} = FC_{pCPO} \text{ x } NCV_{fueloil} \text{ x } 10^{-6} \text{ x } EF_{fueloil\text{-}C} \text{ x } OX_{fueloil} \text{ x } 44/12$$
$$FC_{pCPO} = FC_{p1t\text{-}CPO} \text{ x } P_{CPO}$$

Parameters	Value	References or how the values are to be selected
EL_{pCPO-F} : CO_2 emission from fuel oil consumption in CPO production (tCO_2/yr)	2,467	Calculated on an ex-post basis
FC_{pCPO} : Fuel oil consumption in CPO production (liter)	810,000	Calculated on an ex-post basis
$NCV_{fueloil}$: Net calorific value of fuel oil (MJ/liter)	39.77	Thailand Energy Situation 2003, Energy Content of Fuel (Net Calorific Value), The Department of Energy Development and Promotion, Ministry of Energy
$EF_{fueloil-C}$: Carbon emission factor of fuel oil (tC/TJ)	21.1	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories : Reference Manual, p.1.14
$OX_{fueloil}$: Oxidization factor of fuel oil	0.99	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories : Reference Manual, p.1.29
$FC_{p1t-CPO}$: Fossil fuel consumption in CPO production per CPO 1 ton (liter/ton)	9	Local data (to be studied further)
P_{CPO} : CPO use in PME-BDF production plant (ton)	90,000	Variable to be monitored, but estimated for ex-ante calculation

3-3. Total

$EL_{pCPO} = EL_{pCPO-E} + EL_{pCPO-F} = 6{,}529\ (tCO_2/yr)$

EL_{pCPO} : CO_2 emission from grid electricity and fossil fuel consumption in CPO production (tCO_2/yr)

4. Total

$EL = EL_{pf} + EL_{tFFB} + EL_{pCPO} = 39{,}915\ tCO_{2e}/yr$

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

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The project activity emissions are calculated as,

$EP_{total} = EP + EL = 77{,}888\ tCO_{2e}/yr$

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

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Following the methodology, baseline emissions are calculated for each process below.
- Mining and transportation of crude oil, refining and transportation of petroleum diesel
- Petroleum diesel consumption by vehicles

1. Mining and transportation of crude oil, refining and transportation of petroleum diesel

$EB_{wtt} = FC_{diesel} \times EF_{wtt} \times 10^{-6}$

$FC_{diesel} = FC_{biodiesel} \times HV_{biodiesel}$

Parameters	Value	References or how the values are to be selected
EB_{wtt} : GHG emissions from mining and transportation of crude oil, refining and transportation of petroleum diesel (tCO_2/yr)	20,488	Calculated on an ex-post basis
FC_{diesel} : Petroleum diesel consumption substituted by PME-BDF (GJ)	3,752,490	Calculated on an ex-post basis
$FC_{biodiesel}$: PME-BDF consumption (kilo liter) = Volume of PME-BDF sales to filling stations or depots (kilo liter)	103,034	Variable to be monitored, but estimated for ex-ante calculation
$HV_{biodiesel}$: Net calorific value of PME-BDF (MJ/L)	36.42	= Diesel , Thailand Energy Situation 2003, Energy Content of Fuel (Net Calorific Value), The Department of Energy Development and Promotion, Ministry of Energy (To be analyzed for PME-BDF)
EF_{wtt} : GHG emission factor of mining and transportation of crude oil, refining and transportation of petroleum diesel (gCO_2/MJ)	5.46	Well to Tank emission factor of petroleum diesel; Well-to-Wheel analysis of transportation fuels, November 2004, Toyota Motor Corporation, Mizuho Information & Research Institute, Inc. (to be studied further for Thailand case)

2. Petroleum diesel consumption by vehicles

$$EB_v = FC_{diesel} \times EF_{diesel\text{-}C} \times 10^{-3} \times OX_{diesel} \times 44/12$$

Parameters	Value	References or how the values are to be selected
EB_v : CO_2 emission from petroleum diesel consumption substituted by PME-BDF that is used by vehicles (tCO_2/yr)	275,155	Calculated on an ex-post basis
FC_{diesel} : Petroleum diesel consumption substituted by PME-BDF (GJ)	3,752,490	Calculated, same as 1.
$EF_{diesel\text{-}C}$: Carbon emission factor of petroleum diesel (tC/TJ)	20.2	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories : Reference Manual, p.1.13
OX_{diesel} : Oxidization factor of diesel	0.99	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories : Reference Manual, p.1.29

3. Total

The baseline emissions are calculated as:

$$EB = EB_{wtt} + EB_v = 295{,}643\ tCO_{2e}/yr$$

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

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Emission reductions (ERs) are calculated as:

ERs = EB - EP_{total} = 295,643 - 77,888 = 217,755 tCO_{2e}/yr

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

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Years	Estimate of project activity emissions (tons of CO_2e)	Estimate of baseline emissions (tons of CO_2e)	Estimate of leakage (tons of CO_2e)	Estimate of emission reductions (tons of CO_2e)
Year 1	39,915	295,643	37,973	217,755
Year 2	39,915	295,643	37,973	217,755
Year 3	39,915	295,643	37,973	217,755
Year 4	39,915	295,643	37,973	217,755
Year 5	39,915	295,643	37,973	217,755
Year 6	39,915	295,643	37,973	217,755
Year 7	39,915	295,643	37,973	217,755
Year 8	39,915	295,643	37,973	217,755
Year 9	39,915	295,643	37,973	217,755
Year 10	39,915	295,643	37,973	217,755
Total (tonnes of CO_2e)	399,150	2,956,430	379,730	2,177,550

SECTION F. Environmental impacts

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

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To be completed.

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

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To be completed.

SECTION G. Stakeholders' comments

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

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To be completed.

G.2. Summary of the comments received:

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To be completed.

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

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To be completed.

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding will be used in this project.

Annex 3

BASELINE INFORMATION

Annex 4

MONITORING PLAN

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