Approved baseline methodology AM0004

"Grid-connected biomass power generation that avoids uncontrolled burning of biomass"

Source

This methodology is based on the A.T. Biopower Rice Husk Power Project in Pichit, Thailand whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Mitsubishi Securities, July 2003.
For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0019: "A.T. Biopower rice husk power project" on http://cdm.unfccc.int/methodologies/approved.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment."

Applicability

This methodology is applicable to biomass-fired power generation project activities displacing grid electricity that:

- Use biomass that would otherwise be dumped or burned in an uncontrolled manner
- Have access to an abundant supply of biomass that is unutilised and is too dispersed to be used for grid electricity generation under business as usual (BAU);
- Have a negligible impact on plans for construction of new power plants;
- Not be connected to a grid with suppressed demand;
- Have a negligible impact on the average grid emissions factor;
- Where the grid average carbon emission factor (CEF) is lower (and therefore more conservative as the baseline) than the CEF of the most likely operating margin candidate.

Project Activity

The Project activity is to use for electricity generation biomass that would otherwise be left to decay or be burned in the open air.

Emission Reduction

The project activity reduces the methane (CH_4) emissions due to the decay or burning of the biomass as well as the carbon dioxide (CO_2) emissions due to generation of the electricity by other sources. The project activity generates CH_4 emissions due to combustion of the biomass as well as CO_2, CH_4 and N_2O (nitrous oxide) emissions due to transportation of the biomass to the generation facility and on-site. Thus, the emission reduction by the project activity during a given year is:

$$ER_y = BL\_GHG_y - BBEG\_CH_{4y} - BT\_GHG_y - OT\_GHG_y - FF\_GHG_y$$

Where ER_y is the greenhouse gas emission reduction measured in tonnes of CO_2 equivalents (tonnes CO_2e), BL_GHG_y is the baseline emissions of greenhouse gases during the year, $BBEG\_CH_{4y}$ is the CH_4 emissions during the year due to combustion of the biomass to generate electricity in tonnes CO_2e,

BT_GHG_y is the CO_2, CH_4 and N_2O emissions during the year due to transport of the biomass to the generation facility in tonnes CO_2e, OT_GHG_y is the CO_2, CH_4 and N_2O emissions during the year due to on-site transport of the biomass in tonnes CO_2e, and FF_GHG_y is the CO_2, CH_4 and N_2O emissions during the year due to fossil fuel used by the generation facility for start-up and as auxiliary fuel in tonnes CO_2e. The calculation of each of these values is documented below.

$$BBEG\_CH4_y = BF_y * BF\_HV * EF\_CH_4 * GWP\_CH_4$$

Where BF_y is the biomass used as fuel during the year measured in metric tonnes, BF_HV is the heating value of the biomass fuel used measured in terajoules (TJ) per tonne of biomass, EF_CH_4 is the CH_4 emission factor for the biomass fuel measured in tonnes CH_4 per TJ, and GWP_CH_4 is the approved Global Warming Potential value for CH_4 measured in tonnes of CO_2e per tonne of CH_4 (21).

$$BT\_GHG_y = BF_y/TC * AVD_y * [VEF\_CO2 + VEF\_CH_4 * GWP\_CH_4 + VEF\_N_2O * GWP\_N_2O]$$

Where BF_y is the biomass used as fuel during the year measured in metric tonnes, TC is the truck capacity measured in tonnes of biomass, AVDy is the average return trip distance between the biomass fuel supply sites and the electricity generating unit site in kilometers (km), VEF_CO2 is the CO_2 emission factor for the trucks measured in tCO_2/km, VEF_CH4 is the CH_4 emission factor for the trucks measured in tCH_4/km, VEF_N_2O is the N_2O emission factor for the trucks measured in tN_2O/km, and GWP_N2O is the approved Global Warming Potential value for N_2O measured in tonnes of of CO_2e per tonne of N_2O (310)

$$OT\_GHG_y = OF_y * [VEF\_CO_2 + VEF\_CH_4 * GWP\_CH_4 + VEF\_N_2O * GWP\_N_2O]$$

Where OF_y is the transportation fuel used on-site during the year measured in kilograms, VEF_CO_2 is the CO_2 emission factor for the transportation fuel measured in gCO_2/kg, VEF_CH_4 is the CH_4 emission factor for the transportation fuel measured in gCH_4/kg, and VEF_N_2O is the N_2O emission factor for the transportation fuel measured in gN_2O/kg.

$$FF\_GHG_y = FFy * [GEF\_CO_2 + GEF\_CH_4 * GWP\_CH_4 + GEF\_N_2O * GWP\_N_2O]$$

Where FFy is the fossil fuel used by the electricity generating unit as start-up and auxiliary fuel during the year measured in TJ, GEF_CO_2 is the CO_2 emission factor for the generating unit measured in tCO_2/TJ, GEF_CH_4 is the CH_4 emission factor for the generating unit measured in tCH_4/TJ, and GEF_N_2O is the N_2O emission factor for the generating unit measured in tN_2O/TJ.

The following emissions are ignored for the purposes of calculating the emission reductions.

	Source	Gas	Justification
Baseline	Grid electricity generation	N_2O	Excluded for simplification. This is conservative.[a]
	Open air burning of surplus biomass	CO_2	CO_2 from biomass is carbon-neutral under IPCC guidelines.
		N_2O	Excluded for simplification. This is conservative.[a]
Project Activity	Biomass electricity generation	CO_2	CO_2 from biomass is carbon-neutral under IPCC guidelines.
		N_2O	Excluded for simplification. This is conservative.[a]
	Biomass storage	CH_4	Biomass will be stored for only a short period of time so the emissions will be minor.[b]

Notes:

a. Grid electricity generation and open air burning of biomass both lead to N_2O emissions, greater than those emitted by the project. Excluding the N_2O emissions from both the baseline and the project is a simplification and is conservative.
b. Currently surplus biomass is piled until there is a substantial amount to be burned. The CH_4 emissions from such storage are not included in the baseline.

Baseline

The baseline assumes continued open air burning of the biomass used by the project activity and generation of electricity supplied by the project activity by other facilities. Open air burning results in lower greenhouse gas emissions than decay of biomass, so open air burning is assumed for the baseline. The baseline emissions are:

$$BL\_GHG_y = BB\_CH_{4y} + EG\_CO_{2y}$$

Where BL_GHG_y is the baseline emissions of greenhouse gases during the year, BB_CH_{4y} is the CH_4 emissions during the year due to open air burning of the biomass used for electricity generation in tonnes CO_2e, and EG_CO2_y is the CO_2 emissions during the year emissions due to generation of the electricity by other sources in tonnes CO_2e. Calculation of these values is documented below.

$$BB\_CH_{4y} = BF_y * BCF * CH_4F * CH_4/C * GWP\_CH_4$$

Where BF_y is the biomass used as fuel during the year measured in metric tonnes, BCF is the carbon fraction of the biomass fuel measured as tonnes of carbon per tonne of biomass, CH_4F is the fraction of the carbon released as CH_4 in open air burning expressed as a fraction, and CH_4/C is a mass conversion measured in tonnes of CH_4 per tonne of carbon (16/12).

$$EG\_CO_{2y} = EG_y * CEF_y$$

Where EG_y is the electricity supplied to the grid by the project activity during the year measured in megawatt hours (MWh) and CEF_y is the CO_2 emission factor for the electricity grid during the year measured in tCO_2e/MWh. The CEF_y is the lower of the grid average CO_2 emission factor or the operating margin CO_2 emission factor calculated *ex post* for the year.
If the proposed project activity is located in a country/region with suppressed demand, the project participants may use a CO_2 emission factor based on the "build margin".

Additionality

Additionality is established using paragraph 48(b) of the CDM modalities and procedures. The methodology first determines whether the project is plausible as a business-as-usual (BAU) project (Step 1). Then determines what will happen in the absence of the project – the baseline scenario – in Step 2.

If any of the questions posed in the following steps are answered with a no, this methodology is not applicable, and another methodology shall be applied to the proposed project activity.

Step 1: Is the project different from BAU?

Some grid-connected biomass power generation projects are implemented as BAU and so may constitute the baseline. However, many projects do not materialize due to the presence of barriers. This step ascertains whether any of the following barriers exist for the proposed project activity:

(a) Investment barrier
(b) Technological barrier
(c) Barrier due to prevailing practice
(d) Other barriers

Examples of barriers typically faced by grid-connected biomass power generation projects include:

(a) Investment barriers
- Return on equity is too low compared to conventional projects;
- Real and/or perceived risk associated with the unfamiliar technology or process is too high to attract investment;
- Funding is not available for innovative projects.

(b) Technological barriers
- The project represents one of the first applications of the technology in the country, leading to technological concerns even when the technology is proven in other countries;
- Skilled and/or properly trained labour to operate and maintain the technology is not available, leading to equipment disrepair and malfunctioning.

(c) Barriers due to prevailing practice
- There is a lack of will to change the current biomass disposal practice with or without regulations. If so, indicate how the biomass used for power generation by the project would be used in the baseline scenario;
- Developers lack familiarity with state-of-the-art technologies and are reluctant to use them.

(d) Other barriers
- Management lacks experience using state-of-the-art technologies, so such projects require too much management time and receive low priority by management;
- The local community may fail to see the environmental benefits of biomass power generation and so may oppose the project;
- Experience and/or procedures for collecting the biomass from dispersed sources may be lacking.

Step 2: Determine the appropriate CO_2 emission actor for electricity supplied to the grid

First, determine whether the project activity will displace the electricity supply from the operating margin or the build margin. The operating margin usually is more relevant for grid-connected biomass generating units even if the demand for electricity is growing rapidly because:

- The relatively small size of the biomass power generation project means that it has little impact on plans for constructing major new power stations;
- Due to the priority accorded renewable energy sources by the energy policies of many host countries and the small size of the biomass project, the project is unlikely to cause the cancellation of another planned renewable energy plant of similar size (build margin displacement). They will both be built.

If the proposed project activity is located in a country/region with suppressed demand, the project participants may use a CO_2 emission factor based on the "build margin".

Then calculate the appropriate CO_2 emission factor for the electricity supplied to the grid. Where particular units can be identified as the operating margin for the grid, the weighted average CO_2 emission factor for those units is the factor for the operating margin. Where particular units can not be identified as the operating margin for the grid, the grid average CO_2 emission factor can be used. If both are available, use the lower of the grid average CO_2 emission factor or the operating margin CO_2 emission factor. The CO_2 emission factor for the electricity supplied to the grid is calculated *ex post* each year to determine the emission reductions achieved.

The project developer must indicate which plant(s) constitute the operating margin. This is done ex post so in the Project Design Document it is sufficient to demonstrate that accurate information will be available to calculate the operating margin and/or grid average emission factor for each year of the crediting period. The plant(s) that constitute the operating margin may change over the crediting period.

Leakage

The main source of potential leakage is that the project diverts biomass from other users and thereby increases fossil fuel use.

A proposed project activity must demonstrate that:
- The project will not deplete the supply of the biomass in question to the extent that it will affect the construction of planned biomass power plants;
- There is no competition for supply of the biomass that will result in a decrease in the load factor of other biomass-fuelled plants;
- The project will not deplete the supply of biomass to current users.

To ensure that there is an abundance of surplus biomass a proposed project activity shall demonstrate that:
- The surplus supply of biomass, for which there is no use is more than double the biomass required to fuel all grid-connected electricity generating plants (including the proposed plant) using same biomass;
- The surplus supply in this calculation is equivalent to the total biomass minus biomass consumed for conventional purposes (i.e. other than for grid electricity generation).

The supply of biomass must be monitored to ensure that an abundant surplus of biomass is maintained for the duration of the crediting period.

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Applicability

This methodology is applicable to project activities displacing grid electricity that use the baseline methodology for biomass-fired power generation.

Monitoring Methodology

The monitoring methodology involves monitoring of the following:

- Project emission from biomass electricity generation
- Project emission from fossil fuel use
- Project emission from transportation (including transportation distance)
- Biomass supply and demand for the biomass sources used by the proposed project.
- Baseline emissions from grid electricity generation
- Baseline emissions from biomass disposal (open air burning)

Project Emissions

Data to be collected or used to monitor emissions from the project activity, and how this data will be archived

ID number	Data Type	Data variable	Data unit	Measured (m), calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?
1 EF_CH_4	Quantitative	Methane in stack gas	%	m	minimum of four times per year	-	electronic	minimum of two years after last issuance of CERs
2 BF_y	Quantitative	Amount of biomass combusted	t fuel	m	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs
3 FF_y	Quantitative	Fuel oil use	L	m	continuous	100%	electronic	minimum of two years after last issuance of CERs
4 OF_y	Quantitative	On-site use of transport fuel	L	m	continuous	100%	electronic	minimum of two years after last issuance of CERs
5 AVD_y	Quantitative	Off-site transport distance	km	m (by a third party)	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs
6 EP_y	Quantitative	Electricity produced	MWh	yes	electronic	100%	electronic	minimum of two years after last issuance of CERs
7 HR	Quantitative	Efficiency (heat rate) of the boiler	t fuel/ MWh	m	minimum of four times per year	-	electronic	minimum of two years after last issuance of CERs

Spectroscopic measurements (Data 1) are performed quarterly to obtain the proportion of methane in the stack gas emitted to the atmosphere. This data, together with the aggregated monthly report on biomass usage (Data 2), will be used to calculate the total methane emissions from biomass combustion.

The project must include a system for monitoring the amount of biomass combusted. If the amount of biomass combusted is estimated from the amount of biomass delivered to the site, a procedure for estimating the biomass inventory at the beginning and end of each verification period must be provided.

Emissions from fuel oil used as supplementary and start-up fuel are expected to be small. Flow meters will continuously record the amount of fuel fed into the boilers (Data 3). This will be double-checked against fuel purchase receipts.

Transportation of biomass will occur both on- and off-site. On-site emissions can be calculated from the amount of transport fuel used (Data 4). Off-site emissions can be calculated from the distance traveled by the trucks (Data 5). If the biomass is supplied from a limited number of sites the distance can be calculated using standard distances and records of deliveries from and/or payments to each of the sources. If the sources of the biomass vary, the project proponents must provide an alternative means of monitoring the distance traveled or the fuel sued for off-site transportation.

The project should meter the total amount of electricity generated (Data 6), as well as the quantity supplied to the grid, and periodically measure the efficiency of the boiler (Data 7) so that the quantity of biomass fuel supplied to the boiler can be checked.

Baseline Emissions

Baseline emissions will be calculated using the following variables:

ID number	Data Type	Data variable	Data unit	Will data be collected on this item?	How will data be archived? (electronic/ paper)	For how long is archived data kept?
8 EG_y	Quantitative	Electricity exported by the project to the grid	MWh	yes	electronic	minimum of two years after last issuance of CERs
9 CEF_y	Quantitative	Grid CO_2 emission factor	tCO_2e/ MWh	yes	electronic	minimum of two years after last issuance of CERs
2 BF_y	Quantitative	Amount of biomass combusted	t fuel	yes	electronic	minimum of two years after last issuance of CERs

Electricity supplied to the grid is metered and will be supported by records of payments by the electric utility. Emissions from grid electricity generation displaced will be obtained by multiplying the amount of electricity exported by the project to the grid (Data 8) by the CO_2 emission factor for the grid (Data 9). The CO_2 emission factor for the grid, if not obtained directly from the grid operator, can be calculated from grid fuel consumption and generation data.

The amount of biomass consumed by the plant (Data 2) will be used together with the carbon content of biomass and the IPCC default factor for methane emissions to calculate the methane emitted from open-air burning for the baseline.

Leakage

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

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?
10	Quantitative	Amount of grid electricity generated using same biomass as the project	MWh	Obtained from official data	annually	100%	electronic	minimum of two years after last issuance of CERs
11	Quantitative	Biomass required for grid electricity generation	t	c	annually	100%	electronic	minimum of two years after last issuance of CERs
12	Quantitative	Surplus biomass supply	t	Obtained from official data	annually	100%	electronic	minimum of two years after last issuance of CERs

The surplus biomass (unused biomass) must be at least double the amount used for grid electricity generation.

The calculation of the surplus biomass supply relative to the quantity used for grid electricity generation is made using official data for the region, possibly the entire country, that encompasses the biomass supply for the project. If, based on the official data, the surplus biomass is less than double the quantity used for grid electricity generation, a survey of the supply situation shall be undertaken by an independent party. The survey will assess the quantity of surplus biomass within the region affected by the project, say the area within 200% of the project's maximum procurement distance. Depending on the results of the survey, an appropriate measure will be developed to account for potential leakage, such as a discount factor. The proposed adjustment for potential leakage shall be submitted to the Methodology Panel (or the relevant authority at that time) for approval.

An electronic spreadsheet file will be kept in which all monitored variables are accumulated. All hardcopy material relating to these variables will also be stored for reference.

Quality Control (QC) and Quality Assurance (QA) Procedures

All variables, except one related to off-site transportation, used to calculate project and baseline emissions are directly measured or are publicly available official data. To ensure the quality of the data, in particular those that are measured, the data are double-checked against commercial data. The quality control and quality assurance measures planned for the Project are outlined in the following table.

ID number	Uncertainty level of data (High, medium,low)	Are QA/QC procedures planned for these data?	Outline the QA/QC procedures or explain why they are not being planned
1	Low	Yes	The sampling instruments will undergo maintenance subject to appropriate industry standards. The spectroscopy results will be compared to the IPCC default emission factor. The larger of the two values will be used to ensure conservatism.
2	Low	Yes	Trucks carrying biomass will be weighed twice, upon entry and exit. Meters at the weigh station will undergo maintenance subject to appropriate industry standards. This quantity will be checked against purchase receipts and inventory data.
3	Low	Yes	Meters will undergo maintenance subject to appropriate industry standards. The meter readings will be checked against purchase receipts and inventory data.
4	Low	Yes	Fuel pump readings will be compared against fuel purchase invoices.
5	Low	Yes	The distance records submitted by the truckers will be compared to the average distance between the plant and the fuel supply site.
6, 8	Low	Yes	The electricity meters will undergo maintenance/calibration subject to appropriate industry standards. The accuracy of the meter readings for electricity sold to the grid will be verified by receipts issued by the purchasing power company.
7	Low	NA	Standard test procedures will be used to calculate the heat rate of the boiler.
9	Low	NA	Calculation of the CO_2 emission coefficient for grid electricity involves the use of official data released by the power generating company. Quality control of this data is beyond the control of the project operators. However, if the data are considered unreasonable, they may be replaces by more accurate data according to methods verified by the DOE.
10	Low	NA	This involves the use of official data released by the power generating company. Quality control of this data is beyond the control of the project operator.
11	Low	Yes	The fuel consumption per unit of electricity generated by the project will be a fair indication of the

			consumption for other grid-connected biomass plants, which are all likely to be of similar size. Thus, quality control for the project activity will in effect be quality control for this variable also.
12	Low	NA	This involves the use of official data on biomass supply and biomass use for grid electricity generation provided by the national government and the power generating company respectively. Quality control of this data is beyond the control of the project operators.

Baseline Data

Source	Variable	Value
Electricity generation by project*	Total electricity generated/year	147,627 MWh/yr
	Electricity exported to the grid/year	132,864 MWh/yr
	CO_2 emission coefficient for grid electricity	0.624 tCO_2/MWh (calculated, grid average)
Open air burning of surplus biomass*	C fraction of biomass	0.3713 tC/t biomass (lab analysis)
	CH_4 emission factor	0.005
	Biomass used by project	144,632 t/yr (calculated)
Biomass electricity generation*	Heat value of biomass	0.013607 TJ/t (lab analysis)
	CH_4 emission factor	30 kg/TJ (IPCC default value)
Transportation emissions*	Truck capacity	15 t
	Return trip distance	120 km (average)
	CO_2 emission factor[a]	1097 g/km 3172.31 g/kg
	CH_4 emission factor[a]	0.06 g/km 0.18 g/kg
	N_2O emission factor[a]	0.031 g/km 0.09 g/kg
Start-up/auxiliary fuel use (assumed to be heavy oil)	Fraction of C oxidised	0.99 (IPCC default value)
	C emission factor	21.1 tC/TJ (IPCC default value)
	CH_4 emission factor	3 kg/TJ (IPCC default value)
	N_2O emission factor	0.6 kg/TJ (IPCC default value)
Other data	GWP CH_4	21 (UNFCCC official value)
	GWP N_2O	310 (UNFCCC official value)
	Mass conversion C to CO_2	44/12 (tCO_2/tC)
	Mass conversion C to CH_4	16/12 (tCH_4/tC)

Note:
a) IPCC default values for US heavy duty diesel vehicles, uncontrolled. These are conservative values,
*) These values are illustrative examples and should be replaced by corresponding specific project data, as necessary.