CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM)
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SECTION A. Identification of methodology

A.1. Title of the proposed methodology:

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Fuel switching and changes in self-generation and/or cogeneration at an industrial facility.

A.2. List of category(ies) of project activity to which the methodology may apply:

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The UNFCCC CDM web site appears not to provide a list of categories of project activities, from which one might choose that applicable for this proposed new methodology.

If one were to use the "Sectoral Scope" classification as applied to Designated Operational Entities, we would recommend the categories (1) Energy industries (renewable / non-renewable sources) and (5) Chemical industry.

A more specific category of project activity might be "industrial fuel switching, self-generation and cogeneration".

A.3. Conditions under which the methodology is applicable to CDM project activities:

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This methodology would apply to the case where the project activity involves any one or any combination of the following activities at the industrial site:

- Fuel switching for any equipment generating thermal energy
- Changes in electricity self-generation equipment
- Changes in electricity cogeneration equipment

The methodology only considers the *production* of heat and electricity, including emissions reductions to be achieved through fuel switching and improvements in thermodynamic cycles. It is therefore *not* applicable to project activities involving improvements in end-use efficiency, i.e. where thermal energy and/or electricity is used more efficiently. The methodology proposed here can be applied to projects where end-use efficiency improvements also take place. However, resulting emissions reductions will not be accounted in the procedure described here.

A.4. What are the potential strengths and weaknesses of this proposed new methodology?

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The potential strengths of the proposed new methodology include the following:

- it is applicable to a number of types of project activities
- it is straightforward to apply

SECTION B. Proposed new monitoring methodology

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B.1. Brief description of the new methodology:

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The methodology is based on monitoring fuel used to produce heat and/or electricity for use at an industrial facility. Besides meeting industrial demand, electricity may also be sold through a power grid to which the industry is connected. Emissions are directly related to fuel consumption at the industrial facility, so that only project fuel consumption needs to be monitored in order to determine project emissions.

Changes in electricity purchase or sale from the connected power grid as a result of the project activity would cause changes in emissions elsewhere in the grid. A determination of these emissions requires monitoring of key parameters in the connected grid. To this end, this new methodology incorporates the following methodology: Approved consolidated monitoring methodology ACM0002 "Consolidated monitoring methodology for zero emissions grid-connected electricity generation from renewable sources."

One alternative for determining baseline emissions is a dynamic process, based on monitoring heat output, electricity demand, or other surrogate variable representing industrial production. Selecting the dynamic baseline option may thus requiring additional monitoring following project implementation. One example of such a procedure was part of the earlier methodology: AM0008 "Industrial fuel switching from coal and petroleum fuels to natural gas without extension of capacity and lifetime of the facility."

Leakage emissions are small and would be estimated without the need for additional monitoring.

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

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B.2.1. Data to be collected or used 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 B.7)*	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
P.1.	FC_i	*Industrial facility*	*GJ*	*m*	*monthly*	*100%*	*Electronic (paper can be used for field record)*	*For each fuel* **i** *used at the industrial facility in the project scenario*

B.2.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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The project activity involves replacing some or all fossil fuels currently being used by other lower carbon fuels for providing heat and electricity at the industrial facility. The project activity may also include increased electricity generation or cogeneration at the facility with increased export to the connected power grid. Either of these components would reduce GHG emissions compared to the baseline.

The project emissions E (expressed in tonnes of CO_2 equivalent per year, tCO_2e/yr) are given by:

$$E = \sum_i FC_i \cdot (EF_i + MEF_i \cdot GWP(CH_4) + NEF_i \cdot GWP(N_2O))$$

where:

FC_i	consumption of fuel *i* used in the project scenario, measured in energy units (e.g. gigajoule, GJ)
EF_i	carbon dioxide emission factor per unit energy of fuel *i* (e.g. tCO_2e/GJ) (combustion)
MEF_i	methane emission factor per unit energy of fuel *i* (e.g. tCH_4/GJ) (combustion)
$GWP(CH_4)$	global warming potential of CH_4 set as 21 tCO_2e/tCH_4 for the 1st commitment period
NEF_i	nitrous oxide emission factor per unit energy of fuel *i* (e.g. tN_2O/GJ) (combustion)
$GWP(N_2O)$	global warming potential of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period

B.2.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of greenhouse gases (GHG) within the project boundary and how such data will be collected and archived:

ID number *(Please use numbers to ease cross-referencing to table B.7)*	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
B.1. ES	*Electricit*	*Industrial*	*MWh*	*m*	*monthly*	*all*	*Electronic (paper can be*	

	y supplied to grid	*facility / electricity purchaser*					*used for field record)*	
B.2. EP	*Electricity purchased from grid*	*Industrial facility / electricity supplier*	*MWh*	*m*	*monthly*	*all*	*Electronic (paper can be used for field record)*	
B.3 $\eta_{n,i}$	*Efficiency of boiler*	*Industrial facility*	*%*	*m*	*yearly*	*all*	*Electronic (paper can be used for field record)*	*For each equipment and fuel combination involved in the project scenario.*

B.2.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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The baseline scenario for the project, which is eligible to use this methodology, is that the current fuels (coal and/or petroleum fuels; denoted by *i* in the formula below) are continued to be used in the existing facility to produce heat and electricity without any substantial investments in equipment to increase the electric power output of the facility. Existing equipment is expected to have a lifetime exceeding that of the crediting period.

Baseline emissions *BE* (expressed in tonne CO_2equivalent per year, tonne CO_2e/yr) are given by:

$$BE = \sum_i BFC_i (EF_i + MEF_i \cdot GWP(CH_4) + NEF_i \cdot GWP(N_2O)) + (NBEP + NPES) \cdot EF_{elec\ gen}$$

where:

BFC_i	consumption of fuel *i* used in the baseline scenario, measured in energy units (e.g. gigajoule, GJ)
EF_i	carbon dioxide emission factor per unit energy of fuel *i* (e.g. tCO_2/GJ) (combustion)
MEF_i	methane emission factor per unit energy of fuel *i* (e.g. tCH_4/ GJ) (combustion)
$GWP(CH_4)$	global warming potential of CH_4 set as 21 tCO_2e/tCH_4 for the 1st commitment period
NEF_i	nitrous oxide emission factor per unit of energy of fuel *i* (e.g. tN_2O/ GJ) (combustion)
$GWP(N_2O)$	global warming potential of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period
NBEP	net electricity purchased (electricity purchased less electricity sold) through the grid in the baseline (e.g. MWh)
NPES	net electricity sold (electricity sold less electricity purchased) through the grid in the project scenario (e.g. MWh)

$EF_{elec\ gen}$ baseline "combined margin" emission factor for grid electricity generation (e.g. kg CO_2e/MWh)

Baseline emissions correspond to the emissions from fuels burnt at the industrial facility in the baseline scenario. Electricity purchased through the connected power grid to meet a part or all of the demand at the facility would cause emissions elsewhere in the power grid. Such emissions are included. If, following project implementation, electricity is sold from the industrial facility through the power grid, then emissions would be offset elsewhere in the grid. In the absence of such electricity supply in the baseline scenario, there would be additional emissions in electricity generation, which are also included in baseline emissions.

Note that we consider *net* electricity purchase from the grid in the baseline scenario and *net* electricity sold through the grid in the project scenario, as explained in the definitions of *NBEP* and *NPES*. This equation allows for one or other of these quantities to be negative. To avoid confusion these emissions are included in the baseline emissions equation only. In the typical project, both terms are expected to be positive.

The emissions associated with electric power generation depend on the sum $NBEP + NPES$ and $EF_{elec\ gen}$, the emissions factor for electricity generation in the connected power grid.
The CDM Methodology Panel and Executive Board have already proposed a consolidated methodology for determining $EF_{elec\ gen}$. We recommend the Approved consolidated monitoring methodology ACM0002 "Consolidated monitoring methodology for zero-emissions grid-connected electricity generation from renewable sources" as a component of the proposed new methodology, for the purpose of determining $EF_{elec\ gen}$. ACM0002 offers some alternative pathways for determining $EF_{elec\ gen}$, and each specific PDD should adopt a specific procedure, according to its circumstances.

Note that ACM0002 is actually designated "Consolidated baseline methodology for grid-connected electricity generation from renewable sources." When the project involves electricity generation from renewable sources, project emissions for electricity generation are negligible, and the baseline emissions are emissions avoided elsewhere in the power grid. The new methodology being proposed here is related to electricity generation at an industrial facility using fuels which need not be renewable. However, the emissions from these fuels are being estimated and counted as part of project emissions, and thus, as far as the baseline is concerned, ACM0002 should be perfectly applicable. Indeed, another of our new methodology submissions, "Natural gas-based package cogeneration", was accepted as AM0014 under the condition that the consolidated methodology for grid-connected electricity generation from renewable sources be used.

AM0014 offers an alternative procedure for estimating $EF_{elec\ gen}$, namely the "Simplified Methodology for Small-scale CDM Project activities" which would be applicable in case electricity displaced is less than or equal to 15 MW equivalent.

Thus, this proposed new methodology recommends the use of either ACM0002 or the simplified methodology for small-scale projects, as appropriate.

According to one alternative proposed in the associated baseline methodology, *ex-ante* baseline emissions are determined using values of FC_i based on trends in consumption prior to project implementation, e.g. assuming a fixed growth rate in increase in fuel consumption.

In the other approach proposed, *ex-ante* emissions would be determined from a thermodynamic analysis of the heat and electricity producing system.

Clearly, neither alternative for *ex-ante* estimates require monitoring following project implementation, though each requires previous measurements.

Ex-post baseline emissions may be considered fixed, based on historical data on fuel consumption trends. Again, this will not require any monitoring.

Where past trends in fuel consumption FC_i shows that fuel consumption and therefore emissions have been growing, or that there are significant variations in consumption, then *ex post*, baseline emissions may be determined in a dynamic manner from project monitoring data. The scaling factor for baseline emissions could be some measured surrogate variable that defines activity levels, e.g. the heat output of equipment involved in fuel switching at the industrial facility (as in AM0008) or the electricity output of the power plant at an industrial facility subject to fuel switching and/or equipment changes. In each case, the approach is the same: to calculate, from past data, what would be the fuel consumption levels in the baseline scenario at the activity levels indicated by the surrogate variable actually monitored. An appropriate surrogate variable should be selected and justified in the PDD for a specific project covered by this methodology.

One possible surrogate variable is the heat output from the equipment involved in the project activity. The procedure for determining the dynamic baseline for this case is given below.

The variables in the baseline emissions and the project emissions are linked with the constraint relation:

$$\sum_i BFC_{n,i} \bullet \eta_{n,i} = \sum_i FC_{n,i} \bullet \eta_{n,i}$$

for each element process (or equipment) n which uses the fuel i in either the baseline or the project scenario. Here $\eta_{n,i}$ is the efficiency of process (or equipment) n for use of fuel i, measured either in unit of output per unit of thermal energy (e.g., tonne of steam output/Joule) or ratio of the output thermal energy to the input energy (i.e. percentage). To the extent possible, $\eta_{n,i}$ should be representative of actual operating conditions, such as typical load factor. In this sense a direct measurement of heat output vs. fuel input provides a more reliable indicator than an efficiency measurement based on flue gas analysis, which usually correspond to full-load conditions, and moreover does not take into account jacket losses from boilers and furnaces.

For equipment and fuel combinations that are used in the baseline but not in the project scenario, it will not be possible to monitor the efficiency of the equipment as it would apply to the baseline scenario. In such cases, and in any other data limitations, conservative values should be assumed, i.e. assumptions that would tend to reduce baseline emissions and increase project emissions. Thus conservative assumptions for efficiency estimates imply high values for the baseline and low for the project scenarios.

The methodology proposed here is applicable to industrial facilities that may be producing electricity as well as thermal energy.

Another possible surrogate variable is the electricity demand of the industrial facility. This would be applicable to project activities involving power plants located within an industrial facility intended basically to provide electricity to the rest of the facility. The power plants may provide more or less than the demand, exporting or importing electricity from an interconnected power grid. However, the electricity exported or imported is not a measure of industrial production, and should not be included as the surrogate variable.

The two examples given above are applicable to project activities that principally involve changes in equipment providing heat and electricity respectively. Potential project activities may involve changes in heat and electricity output. In this case, other surrogate variables would be needed. One possibility is to use the primary energy concept, whereby the electricity demand is multiplied by three prior to adding to the heat demand, reflecting the higher thermodynamic (and economic) value of electricity. While the scaling parameter of three is somewhat arbitrary, especially nowadays with high efficiency combined cycle power plants, we may note that this may not be important. Since industrial output is likely to scale equally with heat and electricity demand, in most cases this assumption is unlikely to introduce a significant error in estimating fuel consumption.

B.3. Option 2: Direct monitoring of emission reductions from the project activity:

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NOT APPLICABLE

B.3.1. Data to be collected or used 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 B.7)*	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

B.3.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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B.4. Treatment of leakage in the monitoring plan:

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Fugitive CH_4 emissions from fuel production and transport, and CO_2 emissions from fuel transportation are categorized as leakage. Emissions from fuel production/transportation is counted only if the fuel is produced/transported in a non-Annex I country.

Since emissions associated with leakage are very small compared with project and baseline emissions, they are estimated from IPCC default values, without any requirement for monitoring.

B.4.1. 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 B.7)*	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

B.4.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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The leakage LE_y is expressed as

$$LE = (FC_i - BFC_i) \bullet FE_i(CH_4) \bullet GWP(CH_4) + \sum_j TF_j \bullet EF_j - \sum_k BTF_k \bullet EF_k$$

where $FE_i(CH_4)$ is the IPCC default methane emission factor of fuel *i* associated with fugitive emissions. Typical fuels might be natural gas and coal, the former more likely in the project scenario and that latter more likely in the baseline. Fugitive methane emissions are associated with natural gas production and pipeline leakage. Fugitive methane emissions are also associated with coal mining. In case that the effect of these methane emissions cannot be neglected, they should be included here.

The second line in the above formula refers to emissions from fuel transportation, shown as a product of the transportation fuels used and the corresponding CO_2 emissions factor for the fuel. The first sum applies to transport fuels used in the project scenario while the second corresponds to the baseline scenario (such as marine, railroad or truck). In case those information and data are not available due to uncertainties and diversities in energy market, the IPCC default value could apply. Otherwise, it could be estimated qualitatively in view of the relatively small magnitude of CO_2 emissions from fuel transportation in typical industrial fuels.

B.5. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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The emission reductions ER by the project activity are given by:

$ER = BE - E - LE$ expressed in tonnes of CO_2 equivalent (tCO_2e/yr).

Where
BE are baseline emissions determined in a dynamic manner as explained in section B.2.4,
E are project emissions determined as indicated in section B.2.2, and
LE are leakage emissions estimated as indicated in section B.4.2.

Note that an important component of determining emissions reductions depends on baseline emissions associated with electric power generation connected to the grid. The corresponding procedures can be found in the Approved consolidated monitoring methodology ACM0002 "Consolidated monitoring methodology for zero-emissions grid-connected electricity generation from renewable sources"

B.6. Assumptions used in elaborating the new methodology:

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Assumptions have been expressed in sections above.

B.7. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items 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.
P.1.	*Low*	*These data will be directly used for calculation of emission reductions.*
B.1.	*Low*	*These data will be directly used for calculation of emission reductions.*
B.2.	*Low*	*These data will be directly used for calculation of emission reductions.*

B.3.	*Low*	*These data will be used to determine baseline emissions in a dynamic manner. When adequate QA/QC procedures are not possible, conservative default values may be used.*

B.8. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

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A simpler version of the methodology was proposed with AM0008 for determining emission reductions from fuel switching at an industrial plant. However, the proposed new methodology also involves electric power generation at the industrial facility connected to the power grid. Other approved methodologies have been developed for power generation, and are similar to that proposed here.

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