CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM)
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CONTENTS

SECTION A. Identification of methodology

A.1. Title of the proposed methodology:

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Monitoring of Energy Efficiency Improvements in District Heating Production and Distribution

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

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Energy

Energy Efficiency in Heat Production

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

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The methodology is applicable to CDM in project activities involving improvements in efficiency of heat production and heat distribution. The project activity can be that heat supply from a district heating system will replace heat supply from dispersed boilers and stoves and in projects where improved heat production efficiency (co-generation from thermal power plants) is used as heat source for the district heating system.

The monitoring methodology is applicable in situations in which the buildings are supplied from existing boilers, and also in situations in which buildings are planned to be constructed and supplied from planned (new) dispersed boilers. The monitoring methodology can also be applied in a situation which is a mixture of the two previous mentioned situations, i.e. when the district heating system is planned to supply both existing and future buildings.

It is recommended to study the proposed new baseline methodology "Energy Efficiency improvements in district heating production and distribution" in which the connection between calculations of **emission reductions** based on the table of **emission reduction factors** and the monitored values on **actually supplied energy** to the district heating network are elaborated.

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

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The main strength of the proposed new methodology is that it is simple and easy to apply. The data needed to be monitored can easily be collected by well proven, accurate and commercially available technology. Data collection shall only take place at a few selected sites (the boiler houses / power plant(s) supplying heat to the district heating system), and accordingly data collection from a huge number of buildings is avoided. Data collection and assessment of the quality of the data can be made by professionals. Key data (supplied energy) shall be metered by energy meters. Codes and regulations exist in respect of required meter accuracy, procedures exist for re-calibration of meters and professional, certified institutes for check and re-calibration of energy meters are found world-wide.

One of the main strengths of the proposed new monitoring methodology is that calculation of the CO_2 emission reduction is directly linked to the metered energy, supplied to the district heating network by equations (and project specific (time dependant) factors).

A major strength is that it is very easy to administrate during the crediting period, and only very limited data are needed to be monitored.

The proposed new monitoring methodology does not require monitoring of the emissions in the base line scenario, only monitoring of the emissions in the project scenario are required.

One of the benefits obtained by this principle is that fluctuations in actual energy consumption (e.g. caused by fluctuations in climatic conditions year by year or caused by differences in consumption patterns by consumers) in the project scenario (and subsequent emissions) are covered by the proposed new monitoring methodology. The emission reductions can be directly calculated based on metered data on supplied energy, and (for this purpose) there is no need to monitor and adjust for e.g. climatic data, progress in project implementation and changed consumer habits. However, the emission reduction factors will be updated on an annual basis to reflect the actual heat production efficiency.

The main weakness of the proposed new monitoring methodology is that it requires that the base line scenario can not be changed during the project activity. The proposed new monitoring methodology does not allow for correction of the calculated base line emissions, only the emissions in the project scenario are adjusted according to actual heat production efficiencies.

SECTION B. Proposed new monitoring methodology

B.1. Brief description of the new methodology:

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The proposed new monitoring methodology is a methodology in which the emission reductions can be calculated directly from data collected during the project activity.

The principle is that from data and calculations prepared and agreed in the PDD, the emission reductions are estimated as the difference between the emissions in the baseline scenario and the project scenario. In the project scenario, all emission reductions are caused by the introduction of heat supply from the district heating system (possibly part of the heat supply is produced as co-generation). Accordingly, for each specific year, the emission reduction per energy unit supplied by the district heating system can be calculated (e.g. an emission reduction factor in the unit ton CO_2 emission reduction per GJ heat supplied).

Supply of heat by district heating, heat only boilers

In projects where the project activity is based on heat only boiler technology (HOBs supplying a district heating network), the above mentioned emission reduction factor (ton CO_2 per GJ heat supplied) is calculated based on the heat supplied from the heat only boilers to the district heating network, i.e. the total heat supply to the district heating system.

Supply of heat by co-generation (possibly in combination with district heating, heat only boilers)

To provide an incentive for the maximum utilisation of the technology giving the biggest contribution to the emission reduction (i.e. the co-generation technology), the emission reductions are allocated the energy

supplied by this technology, i.e. the above mentioned emission reduction factor (ton CO_2 emission reduction per GJ heat supplied) is calculated based on the heat supplied from the co-generation facility. No emission reductions are allocated the heat supplied by the heat only boilers.

The proposed principle is that the energy supplied to the district heating system is metered, and based on the metered data and the agreed emission reduction factors (the factors change year by year, ref. the assumptions and data applied in the baseline and project scenarios), the GHG emission reduction is calculated.

The monitoring methodology is easy to administrate, and data required to be monitored are limited and easy to monitor with good accuracy. Furthermore, the principle is flexible and will adjust for natural fluctuations in the heat supply to the system, i.e. the methodology automatically adjusts the calculated emission reductions for changes in climate (not all years have identical climate). Also in case the actual implementation of the district heating system does not follow the (assumed) time schedule, the proposed monitoring methodology will adjust for this, e.g. if less consumers are connected (the implementation of the project is experiencing delays), also less heat will be supplied to the district heating system, and a reduced emission reduction will be calculated.

The actual heat production efficiencies are calculated based on monitored data, and the efficiencies are applied for recalculation of the emission reduction factors.

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

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No data shall be monitored in the base line scenario.

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

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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Emissions are not monitored in the project scenario.

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.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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Emissions are not monitored in the base line scenario.

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

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The methodology is based on direct monitoring of emission reductions in the project activity.

The value to be monitored are:

a) The heat supplied to the district heating network
b) The fuel consumption
c) The electric power supply to the grid (in case of heat supplied as co-generation)

Re. a) Heat supply to the district heating network will typically take place from a number of boiler houses and/or possibly power plants operating as co-generation plants. In a typical large-scale district heating system, the number of individual boiler houses (and other heat sources) will be from 3 up to 15, i.e. a relatively limited number of physical locations.

In the proposed monitoring methodology, the meter readings shall be made at the border point between the boiler house and the district heating network and/or the heat supplied from the co-generation facility, i.e. the energy supplied to the network is metered.

The internal consumption at the boiler house shall not be included in the metered data.

For heat produced by co-generation, the suitable metering point will be on the water side of the heat exchangers utilising the steam extracted from the turbines to heat the district heating water.

Re. b) The fuel consumption shall be continuously monitored. On an annual basis, data shall be compiled. In case the fuel is coal, this requires monitoring of the weight of the coal used and information on the calorific value for the coal used. In case the fuel is natural gas, this requires continuous monitoring of the

volume of natural gas used and information on the calorific value of the natural gas. The data shall be used for calculation of either the actual annual average boiler efficiency (in case of supply from HOBs) or for calculation of the marginal fuel efficiency in case of supply of co-generated heat.

Re. c) The electric power supply from the power plant to the electric grid shall be monitored continuously. On an annual basis, data shall be compiled. The electric power supply shall not include internal power consumption at the power plant. The data shall be used for calculation of the marginal fuel efficiency in case of supply of co-generated heat.

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

E 1	*Heat supplied to the district heating system*	*Energy Meter*	*GJ/year*	*m*	*Continuously monitored values stored in memory at a frequency of 5 min intervals or shorter. In case accumulated energy (GJ) is recorded on a mechanical display, the value shall be recoded on paper on a daily basis.*	*100%*	*paper / electronic*	*Energy metering shall be made by an approved and calibrated energy meter. The meter technology shall be based on an either ultrasonic meter type of a magnetic inductive meter type in which the calculation of energy includes enthalpy corrections.* *The metered energy consumption (GJ) (accumulated value) shall be supplemented with metered data on actual flow (m^3/h), accumulated water flow water flow (m^3), supply temperature (°C), return temperature (°C), differential temperature (°C) and actual load MW. All above data shall be furnished with a time stamp. The energy meter shall be able to store data and data must not be lost in case of power failure. The energy meter shall record number of operation hours.*

F 1(coal)	*Fuel combusted*	*Records on coal supplied*	*ton/year*	*e*	*Data will be recorded at the intervals coal is supplied to the coal yard of the boiler house or power plant (records from log books)*	*100%*	*paper / electronic*	*The weight of the coal supplied to the coal yard shall be monitored by a method and with and accuracy accepted by the purchaser as basis for payment for delivered coal.*
Cal 1	*Calorific value*	*Lab. test for coal samples*	*MJ/kg*	*m*	*At intervals agreed between the seller and the buyer*	*Samples of coal (a very small fraction of the weight of coal supplied)*	*paper / electronic*	*The lab test of coal shall follow recognised standards for sampling and testing of coal.*

F 2(n.gas)	*Fuel consumed*	*Gas meter(volume meter)*	*m3/year*	*m*	*Continuously monitored values stored in memory at a frequency of 5 min intervals or shorter. In case accumulated volume (m^3) is recorded on a mechanical display, the value shall be recoded on paper on a daily basis.*	*100%*	*paper / electronic*	*Natural gas metering shall be made by an approved and calibrated natural meter.*
Cal 2	*Calorific value*	*Lab. test for natural gas samples*	*MJ/1000 m3*	*m*	*At intervals agreed between the seller and the buyer*	*Samples of natural gas (a very small fraction of the volume of natural gas supplied)*	*paper / electronic*	*The lab test of coal shall follow recognised standards for sampling and testing of coal.* *The values applied may be the natural gas companies data for supplied gas to the natural gas network (i.e. it is not required that the samples are taken at the individual consumer)*
P 1 (electric power)	*Electric power supplied to grid*	*Electrical meter for high voltage application*	*MWh/year*	*m*	*Continuously monitored values*	*100%*	*paper/ electronic*	*The supplied quantity of electric power to the grid shall be monitored by an approved and recognised metering technology*

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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The monitoring methodology does not include calculation of project emissions, but emission reductions. Reference is made to Section B.5 and the Propoposed New Baseline Methodology "Energy Efficiency improvements in district heating production and distribution".

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

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Contributions from leakage are not included in the proposed methodology and accordingly not in the monitoring plan.

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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Contributions from leakage are not included in the proposed methodology and accordingly not in the monitoring plan.

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 CO_2 emission in the base line and the project scenario is calculated by applications of equations (1) through (30), and the CO_2 emission reduction is calculated by application of equation (31). Reference is made to the attached Proposed New Methodology: Baseline (CDM-NMB): "Energy Efficiency improvements in district heating production and distribution".

The CO_2 emission reduction per supplied energy unit to the district heating system is calculated as:

The equations listed below are identical to the equations listed in "Energy Efficiency improvements in district heating production and distribution", reference is made to **Step 5: Calculation of Emission Reduction Factors**.

a) Projects only involving supply of heat by heat only boilers:

(32 a) CO_2 emission red. factor, supply DH network = CO_2 emission, reduction / $E_{DH\ network,\ HOB,\ Project\ Scenario}$

where:

CO_2 emission red. factor, supply DH network:	The agreed CO_2 emission reduction factor based on supplied energy to the DH network	[ton CO_2/GJ]
CO_2 emission, reduction:	CO_2 emission reduction, ref. equation (31)	[ton/year]
$E_{DH\ Network,HOB,\ project\ scenario}$:	Annual heat supplied to the DH network from HOBs, project scenario, ref. equation (20 a) [GJ/year]	

b) and c) Projects only involving supply of heat by co-generation:

(32 b) CO_2 emission red. factor, supply DH network = CO_2 emission, reduction / $Q_{Heat\ co\text{-}gen}$

where:

CO_2 emission red. factor, supply DH network:	The agreed CO_2 emission reduction factor based on supplied energy to the DH network	[ton CO_2/GJ]
CO_2 emission, reduction:	CO_2 emission reduction, ref. equation (31)	[ton/year]

$Q_{Heat\ co\text{-}gen}$: Annual heat supplied to the DH network from co-generation, project scenario, ref. equation (20 b) [GJ/year]

The calculation of the emission reductions actually obtained shall be calculated based on the equation below:

(33) CO_2 emission red., actual = CO_2 emission red. factor, supply DH network * $E_{monitored,\ DH\ network}$

where:

CO_2 emission red., actual:	The actual obtained CO_2 emission reduction	[ton CO_2/year]
CO_2 emission red. factor, supply DH network:	The agreed CO_2 emission reduction factor based on supplied energy to the DH network	[ton CO_2/GJ]
$E_{monitored,\ DH\ network}$	The monitored energy supply to the district heating network (one year)	[GJ/year]

In projects involving supply of heat from both heat only boilers and co-generated heat, equation (33) shall be applied. The heat source operating with the highest heat production efficiency shall be allocated the emission reductions. This principle provides an incentive during the project activity for maximum utilisation of the production unit operating with the highest efficiency

Step 6:
Updating of emission reduction factors based on monitored data

The emission reduction factors shall be adjusted according to the monitored data. The principle is that the emissions calculated for the base line scenario are not changed.

The emissions in the project scenario are re-calculated based on actual efficiencies. Step 4 and Step 5 are repeated, and a set of emission reduction factors valid for the specific year are obtained. The actual emission shall be calculated reflecting the actual fuel used (i.e. fuel consumption in terms of coal and gas shall be monitored).

Project involving supply of heat from HOBs

For projects involving heat supply from heat only boilers, the calculation of the actual emissions during the project activity shall be updated by application of the actual annual average boiler efficiency for the specific year. The actual annual average boiler efficiency is defined to be

$\eta_{HOB, actual}$ = Heat Supplied, DH network / Fuel consumed * 100%

where:

$\eta_{HOB, actual}$:	Actual heat only boiler efficiency (annual average) [%]
Heat Supplied, DH network:	Heat supplied to the DH network [GJ/year]
Fuel consumed:	Fuel consumed by the boiler [GJ/year]

Project involving supply of co-generated heat
For each year, the actual marginal heat production efficiency is calculated by application of equations (26 a) through (26 d) ref. below.

For co-generated heat the additional fuel consumption (and marginal fuel efficiency for heat production) is subject to verification during the project activity.

Based on historical data (3 years data prior to the start of the project activity) on electric power production (electric power supplied to the grid) and fuel consumption, the fuel consumption per unit of electric power supplied shall be calculated as:

26 a) Spec. Fuel con. per MWh $_{(historic)}$ = Elec. power to grid $_{(historic)}$ / Fuel consumption $_{(historic)}$

where:

Spec. Fuel per MWh $_{(historic)}$:	Specific Fuel consumption for electric power production [GJ/MWh] (historic data)
Elec. power to grid $_{(historic)}$	Electric power Supplied to grid [MWh/year] (historic data)
Fuel consumption $_{(historic)}$	Fuel consumption at power plant [GJ/year] (historical data)

The average value of the 3 years shall be applied.

During the project activity, data on electric power production (electric power supplied to the grid), thermal energy extracted from the turbine and fuel consumption shall be monitored. For each year during the project activity, the fuel consumption per unit of electric power supplied (during the project activity) shall be calculated as:

26 b) Spec. Fuel con. per MWh $_{(project)}$ = Elec. power to grid $_{(project)}$ / Fuel consumption $_{(project)}$

where:

Spec. Fuel per MWh $_{(project)}$: Specific Fuel consumption for electric power production [GJ/MWh] (project data)
Elec. power to grid $_{(project)}$ Electric power Supplied to grid [MWh/year] (project data)
Fuel consumption $_{(project)}$ Fuel consumption at power plant [GJ/year] (project data)

The additional fuel consumption is calculated as:

26 c) $Q_{Fuel, marginal}$ = Elec. power to grid $_{(project)}$* (Spec. Fuel per MWh $_{(project)}$ - Spec. Fuel per MWh $_{(historic)}$)

where:
$Q_{Fuel, marginal}$: the marginal fuel consumption at the power plant [GJ/year]

Elec. power to grid $_{(project)}$ Electric power Supplied to grid [MWh/year] (project data)

Spec. Fuel per MWh $_{(project)}$: Specific Fuel consumption for electric power production [GJ/MWh] (project data)

Spec. Fuel per MWh $_{(historic)}$: Specific Fuel consumption for electric power production [GJ/MWh] (historic data)

The actual marginal efficiency for co-generation is calculated as:

26 d) $\eta_{h,m\ (actual)} = Q_{Heat,\ co\text{-}gen\ (act)} / Q_{Fuel,\ marginal} * 100\%$

where:
$\eta_{h,m\ (actual)}$ marginal heat production efficiency (actual)

$Q_{Heat, co\text{-}gen\ (act)}$: Annual heat supplied to the DH network from co-generation, actual [GJ/year]
$Q_{Fuel, marginal}$: the marginal fuel consumption at the power plant [GJ/year]

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

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The new monitoring methodology requires that the emission reduction factors (equation (32 a) or (32 b)) as described in Section B.5. above are subject to verifications for each specific year (based on monitored data).

The emission reduction factor (for each specific project) is a factor which shall be agreed for each year of the monitoring period, however, subject to adjustments during the project activity according to actually obtained heat production efficiency in the project activity. The factor represents the conclusion in respect of all parameters in the baseline and project scenarios (e.g. time development (out phasing of exiting boilers), annual efficiencies, and emission factors for applied fuels, etc.).

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.
E 1	*Low*	*The energy meters shall be recalibrated according to procedures and at a frequency in compliance with national regulations for meter equipment used for billing. This will typically mean that an energy meter is recalibrated with intervals of 7 years. Check and recalibration of a meter can be requested if a party is questioning the accuracy of the metered data. In case the accuracy is proven to be within the accuracy stipulated in the relevant norms, the party requesting the recalibration will bear the cost for the check. In case the accuracy is found to exceed the accuracy stipulated within the relevant norms, the owner of the meter will bear the cost for the check and recalibration.* *The agreement on how to monitor the energy supplied is recommended also to include procedures on how to estimate the energy supplied in case of (temporary) failure of a meter.* *It is also recommended that the system operator shall keep accurate records of actual fuel consumption (e.g. tons of coal used, volume of natural gas), calorific value of combusted coal, data on calorific value of natural gas, replenishment water consumption and internal energy consumption at the boiler houses / power plant. The above mentioned data shall be available so that the monitored energy supply to the district heating network can be compared and evaluated in respect of actual fuel consumption.*
F1 (coal)	*Medium*	*The basis for the calculation of fuel used is the weight of the coal delivered to the coal yard. The weight is calculated in compliance with procedures agreed between the supplier (the seller) of coal and the purchaser. The quality of data (accuracy of measurement) shall comply with the stipulations agreed between the purchaser and the seller. This includes stipulations in respect of accuracy of measurement of weight of supplied coal and parameters for the supplied coal (e.g. calorific value).*

Cal 1	*Low*	*The calorific value of the coal shall be measured according to recognises standards.*
F2 (natural gas)	*Low*	*The natural gas meters shall be recalibrated according to procedures and at a frequency in compliance with national regulations for meter equipment used for billing. This will typically mean that a meter is recalibrated at intervals of 7 years. Check and recalibration of a meter can be requested if a party is questioning the accuracy of the metered data. In case the accuracy is proven to be within the accuracy stipulated in the relevant norms, the party requesting the recalibration will bear the cost for the check. In case the accuracy is found to exceed the accuracy stipulated within the relevant norms, the owner of the meter will bear the cost for the check and recalibration.* *The agreement on how to monitor the volume of natural gas supplied is recommended also to include procedures on how to estimate the energy (and volume of natural gas) supplied in case of (temporary) failure of a meter.*
Cal 2	*Low*	*The calorific value of the natural gas shall be s measured according to recognises standards.*
P 1	*Low*	*The power supply to the electrical grid shall be made by a recognised technology for metering of high voltage power supply. The meters shall be re-calibrated at intervals and to an accuracy in compliance with the practices applied by the utilities operating the high voltage power grid.*

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

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At the present stage, the Consultants preparing the proposed new monitoring methodology are not aware of any other project applying the proposed monitoring methodology.

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