FIFTH MONITORING REPORT, COVERING THE PERIOD FROM 01.01.2012 TO 30.11.2012.

"New cogeneration power station for combined production of heat and electricity in District Heating Bourgas, Bulgaria"

Dated December 2012

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Annexes

Background and Objectives of Monitoring Report

According to paragraph 36 of the JI guidelines project participants "shall submit to an accredited independent entity a report in accordance with the monitoring plan on reductions in anthropogenic emissions by sources or enhancements of anthropogenic removals by sinks that have already occurred. The report shall be made publicly available."
The objective of the present monitoring report is to provide the complete, consistent, clear, and accurate calculation of the emissions reductions, within the boundaries of the project:
"New cogeneration power station for combined production of heat and electricity in District Heating Bourgas, Bulgaria", for the period from 01.01.2012 to 30.11.2012.

SECTION A. General Project activity information

A.1 Title of the project
New cogeneration power station for combined production of heat and electricity in District Heating Bourgas, Bulgaria

A.2 Short description of the project activity

The project comprises the design, construction and operation for new cogeneration power station for combined production of heat and electricity in District Heating Bourgas including 6 gas engines with a total power capacity of 17,82 MWel (CHP: combined heat and power).
Three of the gas engines have single output of 3.125 MWel / 3.19 MWth and the other three – 2.814 MWel/ 2.394 MWth.
The cogeneration installation is used for producing of heat and electrical energy. The produced energy is sold to the residences, municipal and industrial customers of city of Bourgas.

The project includes 6 x 16V25SG "WARTSILA" gas engines coupled with AMG710Mm6 "ABB" generators. The cogeneration installation is situated at a separate territory within the DHC, north from the Administrative building.
The natural gas is supplied from the existing gas-distribution system located at 160 m from the cogeneration station. It is also constructed a new gas pipe diversion DN 100 mm starting from gas-distribution system with a nominal pressure 0.6 MPa, which ensure undependable supply of natural gas and measurement of the cogeneration system consumption. The heat energy received from the cooling systems and the exhaust gases of the gas engines, trough pipeline is supplied to the heat network.

The operating regime is year-round. The necessary thermal load in the heating season is added from the existing boilers. In the summer season the thermal load for hot water is covered with optimal chosen number of operating modules.
The produced electricity, without the auxiliary needs, is exported to the national electricity system.

Each separate cogeneration module includes engine, generator, turbo-compressor, silencer, and heat exchanger for cooling of the oil system, heat exchanger for cooling of the water "jacket", heat exchanger for the exhaust gases, gas regulating system, pumps, armatures, and control system.
The control and the regulation of the technological process of electricity production and heat production in the cogeneration system are automated.

The parties involved are stated in the next table:

Party involved	Legal entity project participant	Party involved considered as project participant (Yes/No)
Bulgaria (Host party)	DHC Burgas JSC	No
Denmark	Danish Energy Authority	No

A.3 Monitoring period:
- Monitoring period starting date: 01 January 2012
- Monitoring period closing date: 30 November 2012

A.4 Methodology applied to the project activity
A.4.1 Baseline methodology

For the baseline determination the CDM methodology ACM0002 has been chosen.

Key information and data used to establish the baseline is stated bellow in the tables:

Data/Parameter	CEO
Data unit	MWh
Description	Net electricity from new CHP
Time of determination/monitoring	Determined ex post
Source of data (to be) used	Measuring device of the DHC

Data/Parameter	CAHO
Data unit	MWh
Description	Heat output to covering the heat demand of the DHC
Time of determination/monitoring	Determined ex post
Source of data (to be) used	Measuring devices of the DHC

Data/Parameter	EFel
Data unit	tCO_2/MWh
Description	Emission factor for Bulgarian power grid, forecast Maximum demand, Dispatch data adjusted_OM_EF, fossil fuels
Time of determination/monitoring	Determined ex ante

Source of data (to be) used	"Baseline Study of Joint Implementation projects in the Bulgarian Energy Sector[1]"
Value of data applied (for ex ante calculations/determinations)	2007 – 1.156 2008 – 1.059 2009 – 0.947 2010 – 0.908 2011 – 0.884 2012 – 0.833

A.4.2 Monitoring methodology

The monitoring is in compliance with the approved baseline monitoring methodology AM0014 ("Natural gas-based package cogeneration") with the following deviation:

- The project emissions correspond not only to natural gas combustion at the DHC, but include also the emissions from the combustion of the backup fuel (HFO) and biomass.

Project emissions correspond to fuel combustion by the DHC, and include the same four components as in the baseline (CO_2, CH_4 and N_2O emissions from combustion) and CH_4 emissions from natural gas production and leaks in the transport and distribution pipeline supplying the plant and leaks in the gas distribution piping within the plant, associated with the natural gas consumption.

The project emissions are:

- Emissions of GHG (CO_2 + CH_4 + N_2O) from the burning process in the co-generation installations and in the existing steam/water boilers and;
- Emissions of CH_4 during the production, transportation and distribution of the natural gas.

Each of these is proportional to the fuel consumption on the DHC system, which is monitored.

A.5 Status of implementation including time table for major project parts

The project is implemented; the starting date of the project activities is 01 December 2006.

A.6 Revisions to the registered PDD, in compliance with the post determination dated June 2010.

A6.1 CEF of the national electrical grid

Dispatch Data Adjusted_OM_EF, Forecast Maximum demand, fossil fuels is applied instead of

Dispatch Data Adjusted OM EF, Forecast Maximum demand, HPP (Hydro Power Plants) included.

A.6.2 LCV of the used fuels

[1] http://www.moew.government.bg/recent_doc/international/climate/carbon_emission_joint.pdf

Data from the National GHG Inventory are implemented instead of results from local laboratories.

A.6.3 EF of the used fuels

Data from the National GHG Inventory are implemented instead of data from IPCC.

A.7 Revisions to the registered monitoring plan, in compliance with the post determination dated June 2010.

The project emissions are calculated by the equation:

PEtotal =PENG + PEHFO +PEB, [tCO2e/y], where:

PENG – project emissions from natural gas use, [tCO2e/y];
PEHFO - project emissions from heavy fuel oil burning, [tCO2e/y];
PEB - project emissions from biomass burning, [tCO2e/y].

PENG - project emissions from natural gas use, [tCO2e/y], are calculated as the sum of follows:

a) CO_2 emissions from natural gas combustion in DHC

Carbon dioxide emissions from natural gas combustion in the DHC, E_{cs} (tonnesCO_2/year):

E_{cs} = tonne CO_2 / year) $\frac{AEC_{NG}.\ EF_{NG}}{10^3}$

Where AEC_{NG} = annual energy consumption of natural gas in DHC (GJ/year), and

EF_{NG} = CO_2 emission factor of natural gas (kg CO_2/GJ, lower heating value basis)

b) Methane emissions from natural gas combustion in DHC

A certain amount of methane is generated in the combustion of natural gas. These are generally expressed in terms of natural gas energy consumption. Emissions are estimated using formulae described below:

Methane emissions from natural gas combustion in DHC, E met comb

$E_{met\ comb}$= tonne CO_2 / year) $\frac{AEC_{NG}.\ MEF_{NG}}{10^3}$

Where AEC_{NG} = annual energy consumption of natural gas in DHC (GJ/year), and

MEF_{NG} = methane emission factor for natural gas combustion (kg CH_4/TJ, lower heating value basis)

In units of carbon dioxide equivalent emission, $E_{equiv\ met\ comb}$ **(tonne CO_2 equiv/year)**

$E_{equiv\ met\ comb}$ (tonne CO_2 – equiv / year) = $E_{met\ comb}$ GWP (CH_4) (4.3)

Where GWP (CH_4) = global warming potential of methane = 21

c) Nitrous oxide emissions from natural gas combustion in DHC

A certain amount of nitrous oxide is generated in the combustion of natural gas. These are generally expressed in terms of natural gas energy consumption. Emissions are estimated using formulae similar to those for methane emissions in combustion, and are described below:

Nitrous oxide emissions from natural gas combustion in the cogeneration system, $E_{N2O\ comb}$ **(tonne N_2O / year),** are given by:

$$E_{N2O\ comb}\ (\text{tonne } N_2O\ /\ \text{year}) = \frac{AEC_{NG}\ NEF_{NG}}{10^3} \quad (4.4)$$

Where AEC_{NG} = annual energy consumption of natural gas in the DHC (GJ/Year), and

NEF_{NG} = nitrous oxide emission factor for natural gas combustion (kg N_2O/TJ, *lower heating value basis*)

In units of carbon dioxide equivalent emission, $E_{equiv\ N2O\ comb}$ **(tonne CO_2 equiv/year)**

$E_{equiv\ N2O\ comb}$ (tonne CO2 – equiv / year) = $E_{N2O\ comb}$ GWP (N_2O)

Where GWP (N_2O) = global warming potential of nitrous oxide = 310

d) Methane emissions from natural gas production and pipeline leaks in the transport and distribution of natural gas, including leakage within the industrial plant

These baseline emissions are associated with natural gas consumption in the DHC. The procedure for estimating these emissions is described below:

Methane emissions from natural gas production and leakage in transport and distribution, corresponding to fuel used in DHC, Efug (tonne CH_4 / years), are given by:

$$E_{fug}\ (\text{tonne } CH_4 / \text{year})\ \frac{AEC_{NG}\ MLR}{10^3}$$

Where AEC_{NG} = is defined as before, and

MLR = methane leakage rate in natural gas production, transport and distribution leakage, including leaks at the industrial site (kg CH_4/GJ natural gas energy consumption, lower heating value basis)

Convert methane emissions to carbon dioxide equivalent emissions, $E_{equiv\ fug}$ **(tonne CO_2 equiv / year)**

$$E_{equiv\ fug}\ (\text{tonne } CO_2 - \text{equiv / year}) = E_{fug}\ GWP\ (CH_4)$$

Where $GWP\ (CH_4)$ = is defined as before = 21.

PEHFO - project emissions from heavy fuel oil burning, [tCO2e/y] are calculated as the sum of follows:

a) CO_2 emissions from HFO combustion in DHC

Carbon dioxide emissions from HFO combustion in the DHC, E_{cs} (tonnesCO_2/year):

$$E_{cs} = \text{tonne } CO_2 / \text{year})\ \frac{AEC_{HFO}.\ EF_{HFO}}{10^3}$$

Where AEC_{HFO}= annual energy consumption of HFO in DHC (GJ/year), and

EF_{HFO} = CO_2 emission factor of HFO (kg CO_2/GJ, lower heating value basis)

b) Methane emissions from HFO combustion in DHC

A certain amount of methane is generated in the combustion of HFO. These are generally expressed in terms of HFO energy consumption. Emissions are estimated using formulae described below:

Methane emissions from HFO combustion in the DHC, E met comb

$E_{met\ comb}$= tonne CO_2 / year) $\frac{AEC_{HFO} \cdot MEF_{HFO}}{10^3}$

Where AEC_{HFO}= annual energy consumption of HFO in cogeneration system (GJ/year), and

MEF_{HFO} = methane emission factor for HFO combustion (kg CH_4/TJ, lower heating value basis)

In units of carbon dioxide equivalent emission, $E_{equiv\ met\ comb}$ **(tonne CO_2 equiv/year)**

$E_{equiv\ met\ comb}$ (tonne CO_2 – equiv / year) = $E_{met\ comb}$ GWP (CH_4)

Where GWP (CH_4) = global warming potential of methane = 21

c) Nitrous oxide emissions from HFO combustion in DHC

A certain amount of nitrous oxide is generated in the combustion of HFO. These are generally expressed in terms of HFO energy consumption. Emissions are estimated using formulae similar to those for methane emissions in combustion, and are described below:

Nitrous oxide emissions from HFO combustion in the cogeneration system,

$E_{N2O\ comb}$ **(tonne N_2O / year),** are given by:

$E_{N2O\ comb}$ (tonne N_2O / year) = $\frac{AEC_{HFO}\ NEF_{HFO}}{10^3}$

Where AEC_{HFO} = annual energy consumption of HFO in the DHC (GJ/Year), and

NEF_{HFO} = nitrous oxide emission factor for HFO combustion

(kg N_2O/TJ, *lower heating value basis*)

In units of carbon dioxide equivalent emission, $E_{equiv\ N2O\ comb}$ **(tonne CO_2 equiv/year)**

$E_{equiv\ N2O\ comb}\ (tonne\ CO2 - equiv\ /\ year) = E_{N2O\ comb}\ GWP\ (N_2O)$

Where GWP (N_2O) = global warming potential of nitrous oxide = 310

PEB - project emissions from biomass burning, [tCO2e/y] are proportional to the biomass energy consumption, but for the purpose regarding the PDD determination and periodic verifications are cosidered equals a zero. The source of these emissions is GHG neutral biomass.

Baseline emissions are those emissions that those associated with the production of heat and electricity that are offset by the output of the cogeneration system. Baseline emissions comprise two components:

- **ABE1** – annual GHG baseline emissions from combustion of baseline fuel NG, that have been used to cover the annual heat output (CAHO), and
- **ABE2** - annual CO_2 emissions associated with the electricity that would have to be generated through dedicated fossil fuel power plants.

ABE1 are calculated as the sum of follows:

a) **CO_2 from combustion.** CO_2 emissions corresponding to the combustion of a baseline fuel NG that would have been used to cover the heat demand CAHO;

b) **CH_4 from combustion.** CH_4 emission corresponding to the combustion of a baseline fuel NG that would have been used to cover the heat demand CAHO;

c) **N_2O from combustion.** N_2O emissions corresponding to the combustion of a baseline fuel NG that would have been used to cover the heat demand CAHO;

d) **CH_4 leaks during production of the baseline fuel.** CH_4 emissions from natural gas production and leaks in the transport and distribution pipeline supplying the DHC and leaks in the gas distribution piping within the DHC, associated with the natural gas consumption identified to cover the annual heat demand CAHO.

The consumption of the baseline fuel for the supply of heat is determined as follows:

Annual energy consumption for heat supply at baseline plant, $ABEC_{BF}$ (MWh/year):

$$ABEC_{BF} = \frac{CAHO}{e_b}$$

Where CAHO = annual heat output from DHC (MWh/year), and

e_b = industrial boiler efficiency (fraction, lower heating value basis).

The annual heat output from the DHC (CAHO in MWh), (3.2) is monitored on monthly basis like sum of heat output from the premise of the DHC to heat consumers and represent monthly sum of heat with hot water and with steam.

Once the boiler energy consumption $ABEC_{BF}$ has been quantified, the four GHG emissions components (a to d, above) can be determined, as indicated below.

a) **Baseline CO_2 emissions from combustion of baseline fuel for heat supply**

Baseline CO_2 emissions from combustion of baseline fuel for heat supply, BE_{th} (tonnesCO_2/year):

$$BEth = ABEC_{BF}.\ EF_{BF}$$

Where:

$ABEC_{BF}$ = annual energy consumption for heat supply at baseline plant (MWh/year), and

EF_{BF} = CO_2 emission factor of the fuel used to generate heat (t CO_2/MWh)

A value of EF_{BF} is estimated from National GHG inventory.

b) Baseline methane emissions from combustion of baseline fuel for heat supply

Baseline methane emissions from combustion of baseline fuel for heat supply, BEmet comb (tonne CH_4/year): **$BE_{met\ comb}$ (tonneCH_4/year)** = $ABEC_{BF}$ x MEF Where: $ABEC_{BF}$ = annual baseline energy consumption for heat supply (MWh/year), and MEF = methane emission factor for baseline fuel combustion (t CH_4/MWh), lower heating value basis) **In units of carbon dioxide equivalent, BE** equity met comb **(tonne CO_2 eq/year)** BE equiv met comb (tonne CO_2 equiv / year) = $BE_{met\ comb}$ x GWP (CH_4) Where GWP (CH4) = global warming potential of methane = 21

A value of **MEF_{BF}** is estimated from National GHG inventory.

c) Baseline nitrous oxide emissions from combustion of baseline fuel for heat supply

Baseline nitrous oxide emissions from combustion of baseline fuel for heat supply, BEN_2O comb **(tonne N_2O/year):**

$BE_{N2O\ comb}$ (tonne N_2O/year) =$ABEC_{BF}$. NEF

Where:

$ABEC_{BF}$ = annual baseline energy consumption for heat supply (MWh/year), and

NEF = nitrous emission factor for fuel combustion (t N_2O/MWh), lower heating value basis)

In units of carbon dioxide equivalent, BE equity met comb **(tonne CO_2 eq/year)**

BE equiv N_2Ocomb (tonne CO_2 equiv / year) = BE $_{N2O\ comb}$ x WP (CH_4) (3.7)

GWP (N_2O) = global warming potential of nitrous oxide = 310

The value of NEF is estimated from National GHG inventory.

d) Baseline methane emissions from natural gas production and pipeline leaks in the transport and distribution

The value of MLR is estimated from National GHG inventory.

Baseline methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, BE $_{th\ fug}$ tonne CH_4/year):

BE $_{th\ fug}$ (tonneCH_4/year) = $ABEC_{BF}$ x MEF

Where:

MLR = Methane Leakage Rate in natural gas production, transport and distribution leakage, including leaks at the industrial site (t CH_4/MWh natural gas energy consumption, lower heating value basis).

$ABEC_{NG}$ = annual baseline natural gas energy consumption for heat supply (MWh/year)

In units of carbon dioxide equivalent, $BE_{th\ equiv\ fug}$ (tonne CO_2 equiv/year):

$BE_{th\ equiv\ fug}$ (tonne CO_2 - equiv / year) = $BE_{th\ fug}$ GWP (CH_4)

Where GWP (CH_4) = is defined as before = 21

- **ABE2** - annual CO_2 emissions associated with the electricity that would have to be generated through dedicated fossil fuel power plants.

  ABE2 = $BE_{elec\ fossil\ fuel}$ (tonne CO_2/year)

Baseline carbon dioxide emissions for electricity supplied, $BE_{elec\ fossil\ fuel}$ (tonne CO_2/year):

$BE_{elec\ fossil\ fuel}$ (tonne CO_2/year) = CEO. $BEF_{elec\ fossil\ fuel}$

Where:

CEO = New Cogeneration Net Electricity Output (MWh/year), and

$BEF_{elec\ fossil\ fuel}$ = Baseline CO_2 emissions factor for electricity from the dedicated fossil fuel power plants (t CO_2/MWh)

CEO, New Cogeneration Electricity Output (MWh) is monthly monitored.

$BEF_{elec\ fossil\ fuels}$ is the value of <Dispatch data adjusted_OM_EF> emission factor of Bulgarian power grid, source "Baseline Study of Joint Implementation projects in the Bulgarian Energy Sector[2]", ex ante determined.

[2] http://www.moew.government.bg/recent_doc/international/climate/carbon_emission_joint.pdf

Total baseline emissions are given by the sum of the components analyzed above:

$BE_{total} = ABE1 + ABE2 = BE_{th} + BE_{equiv\ met\ comb} + BE_{equiv\ N2O\ comb} + BE_{th\ equiv\ fug} + BE_{elec\ fossil\ fuel}$

SECTION B. Key monitoring activities according to the monitoring plan for the monitoring period.

B.1. Monitoring equipment

The monitoring system is built with modern measurement devices, equipped with specialized computers for collecting of probes information and calculation of the measurement results. The communication ports of the devices permit the dates to be collected automatically in the Central monitoring system of DHC.
All measurement devices are equipped with fiscal storage and can be recorded in every time.

B.2. Data collection (accumulated data for the whole monitoring period):

The measurement team will record the measurement dates from all measurement devices and compare with the dates recorded in the Central monitoring system 1 time monthly like internal audit of the monitoring system.

B.3. Data processing and archiving

The measurement team carries out all maintenances of the measurement devices from the Monitoring system - described in maintenance documentation of the suppliers.
The manager of the team is authorized for preparing of the annuals report for the verification company with the results from the measurement and evidence of authenticity.
The manager of the team is authorized to organize periodical checking of the measurement devices from the accredited laboratory. The plan and the report data for the periodical checking are record and automatically generated in the Central monitoring system

SECTION C. Quality assurance and quality control measures

C.1. Roles and responsibilities

The personnel involved in the Monitoring process and their responsibilities are the following:
• Shift operator: he is responsible to control the correct operation of the System and ensure the proper operation of the measurement instruments;
• Auditor: he is responsible to perform internal audit (he is not the same person who is charge of monitoring process);
• Engineer in charge of monitoring process: he is responsible to assess and validate the reliability and accuracy of the data recorded. Furthermore, he is responsible to calculate the total annual Emission Reductions, update the monthly document and generate the "Monitoring Annual Report" on status of the yearly Monitoring plan progress. He has also to liaise with the Chief operation & maintenance about any non - conformities.
• Chief operation & maintenance: responsible of the monitoring plan.

C.2 Trainings

The internal auditors have been trained in order to elaborate and plan the annual internal audit plan, execute the audits according to the approved plans, elaborate, submit and distribute pertinent reports, and supervise the implementation and fitting of amendment and preventive actions, if any.

C.3 Internal audits and control measures

This procedure has the purpose to describe the established system for the programming and execution of internal audits of the Monitoring Plan.
The Internal Auditor complies with the following requirements:
- He is trained by an Independent Company with proven expertise in developing PDD projects;
- He is participated to at least one audit as observer;
- He is not the same person involved in the monitoring process.

SECTION D. Calculation of GHG emission reductions

D.3.1 Project emissions

TABLE 8 - ANNUAL PROJECT EMISSIONS DHC Burgas					
	2008	2009	2010	2011	01.01.2012 30.11.2012
tCO2e/y	**80 567**	**81 992**	**81 638**	**84 404**	**65 532**

D.3.2 Baseline emissions

TABLE 7 - ANNUAL BASELINE EMISSIONS DHC Burgas					
	2008	2009	2010	2011	01.01.2012 30.11.2012
tCO2e/y	**187 754**	**169 032**	**160 334**	**160 060**	**122 911**

D.3.3 Summary of the emissions reductions during the monitoring period

TABLE 9 - ANNUAL EMISSION REDUCTIONS DHC Burgas					
	2008	2009	2010	2011	01.01.2012 30.11.2012
tCO2e/y	**107 187**	**87 040**	**78 696**	**75 656**	**57 379**