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Opinion on
POST DETERMINATION
(Statement)

Changes made to the portfolio the cogeneration power stations for combined production of heat and electricity in District Heat Company in Pleven and District Heating Company Veliko Tarnovo, Bulgaria

REPORT NO. 21212063

REVISION NO. 1.1

Date: 16.06.2010	Project No.: 21212063
Client *Toplofikatsia Pleven EAD* *128 East Industrial Zone* *5800 Pleven; Bulgaria*	Organisational unit: *TÜV Rheinland Immissionschutz und Energiesysteme GmbH* *TÜV Rheinland Group* *Am Grauen Stein; 51105 Köln; Germany*

Project Name: Changes made to the portfolio of the cogeneration power stations for combined production of heat and electricity in District Heat Company in Pleven and District Heating Company Veliko Tarnovo

Country: Bulgaria

GHG reducing Measure/Technology: Cogeneration of heat and electricity from natural gas replacing heavy fuel oil for heating and, fossil fuels of higher carbon content for electricity

Size: Large Scale

Post - Determination Phases: Amendment to the Determination

Determination Status: Amendment Determination

TÜV Rheinland Immissioinsschutz und Energiesysteme GmbH (TIE), hereafter the verifier, was contracted by Toplofikatsia Pleven EAD to express the post determination opinion on the changes made to the project design of the project *"Portfolio of the cogeneration power stations for combined production of heat and electricity in District Heat Company in Pleven and District Heating Company Veliko Tarnovo" (determined by TÜV SÜD in October 2006, Report No: 854386, 20.10.2006)*. This Determination opinion was expressed based on the following documentation: Project Design Document Version 04 of October 2006, the determination of TÜV SÜD (Report no: 854386, 20.10.2006), and on the basis of the on-site assessment of the project activity from 3.11.2009 until 7.11.2009 performed by the verifier.

In summary, it is TÜV Rheinland´s opinion that the Changes made to the portfolio of the cogeneration power stations for combined production of heat and electricity in District Heat Company in Pleven and District Heating Company Veliko Tarnovo in Bulgaria, were made in accordance with the presented documentations, and that the project meets all relevant requirements for the JI Track 1 and all relevant host country criteria.

Report No.: 21212063	Date of this revision: 27/05/2010	Rev. No. 1.1
Report title: Changes made to the portfolio of the cogeneration power stations for combined production of heat and electricity in District Heat Company in Pleven and District Heating Company Veliko Tarnovo in Bulgaria		
Work carried out by: Dr. Dorle Nörenberg		
Work verified by: Norbert Heidelmann		

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Summary - Opinion

"DHC Toplofikatsia Pleven" and "DHC Toplofikatsia Velico Tarnovo" ordered "TÜV Rheinland Immissionsschutz und Energiesysteme GmbH" as part of the "TÜV Rheinland Group" to express a post determination opinion of the project "Changes made to the portfolio of the cogeneration power stations for combined production of heat and electricity in District Heat Company in Pleven and District Heating Company Veliko Tarnovo" in Bulgaria. The initial determination was performed by TÜV SÜD in 2006 (Report no: 854386, 20.10.2006). This post determination only focuses on the amendments made to the project design after the initial determination by TÜV SÜD (Report no: 854386, 20.10.2006), which shall be kept valid. The post determination opinion solely based on the review of the Project Design Document Version 04 (Oct. 2006 "Portfolio of new cogeneration power stations for combined production of heat and electricity in District Heating Company Pleven and District Heating Company Veliko Tarnovo, Bulgaria" *), the Determination Report 2006 (Report no: 854386, 20.10.2006), and on the technical expertise of the on-site assessment performed from 3.11.2009 until 7.11.2009 by TÜV Rheinland in frame of this post determination and other associated documentations.*

The host country is Bulgaria and the guest country is Denmark. Both countries fulfil the participation criteria and have approved the project and authorized the project participants, accordingly to the TÜV SÜD Report no. 854386, 20.10.2006 . The project deems to generate emission reductions.

In the determined PDD "Portfolio of new cogeneration power stations for combined production of heat and electricity in District Heating Company Pleven and District Heating Company Veliko Tarnovo, Bulgaria" *dated in October 2006 it is demonstrated that the project is not a likely baseline scenario so that emission reductions attributable to the project operation are additional to any that would occur in the absence of the project activity.*

The amendments which have been presented to TÜV Rheinland are the following:

1) Technical changes:

The changes in emission are due to a changing plant configuration. In Veliko Tarnovo one gas motor burning NG (installed power: 2,8 MW) instead of two NG driven gas motors (Installed power: 2,8MW + 2,0MW) is installed. Further there are four NG boilers (installed power: 58 MW + 18 MW + 8,7 MW + 8,7 MW = 93,4 MW) and one boiler burning biomass (installed capacity 58 MW) installed instead of fife gas boilers with the installed power of 58 MW+ 58 MW + 18 MW + 8,7 MW + 8,7 MW = 151,4 MW.

2) Changes in Monitoring plan:

As described in PDD (10.2006, D1.1 Table D1.1.1) supplier of NG – Bulgargas – should provide the LCV of natural gas (NG) and heavy fuels oil (HFO). These measurement values of LCV of NG and HFO provided by Bulgargas are replaced by the parameters provided by the National GHG inventory – last version available reported to the Secretariat of UNFCCC. Furthermore, the amount of burned biomass will be monitored.

It is TÜV Rheinlands opinion that the technical and organisational changes (described before) take place in accordance to present documents which has been audited while the onsite assessment and in the presented documents. The amendments to the project design don't yield to changes which induces conflicts to relevant UNFCCC requirements for the JI and all relevant host country criteria.

Report title: Changes made in the JI project "Portfolio of new cogeneration power stations for combined production of heat and electricity in District Heating Company Pleven and District Heating Company Veliko Tarnovo, Bulgaria"	
Work carried out by: Mr. Boris Metodiev – Eko Analiz, Senior consultant	
Work approved by: Mr. Valentin Terziyski – DHC Pleven, CEO	
Dated 20 May 2010	

Summary

0. Introduction
1. Technical changes.
2. Changes in the baseline.
3. Changes in the monitoring.
4. Recalculations of baseline emissions, project emissions and emission reductions.

0. <u>Introduction</u>

The JI project “Portfolio of new cogeneration power stations for combined production of heat and electricity in District Heating Company Pleven and District Heating Company Veliko Tarnovo, Bulgaria” Version 04 was determined from TÜV SÜD Industrie Service GmbH with protocol 854386 from 20 October 2006.

The present post-determination is imposed by the fact, that some changes are occurred during the realization of the project. Technical changes are occurred in DHC Veliko Tarnovo and changes on the baseline and monitoring methodologies are occurred in both DHCs.

1. <u>Technical changes – only for DHC Veliko Tarnovo.</u>

<u>1.1 In the PDD Version 04, determined in 20 October 2006</u> are foreseen to be in exploitation during the crediting period the following equipment:

- Two gas motors burning NG: 2.8 + 2.2 = 5 MW_{el}

- Five Gas Boilers burning NG: 58+58+18+8.7+8.7 =151.4 MW

The production data in DHC V. Tarnovo according PDD Version 04 are shown in the next tables:

The calculations in PDD Version 04 are performed from the technical staff of the DHC and are based on:

- Electrical and heat output of the equipment;
- **6,500 working hours per year;**
- **Load factor – 0.821.**

Parameter	Unit	Produced	For auxiliary needs	To the grid
Electricity by the new CHP	MWh/y	**26,700**	1,350	24,000
Electricity by the existing facilities	MWh/y	0	1,350	0
Total electricity	MWh/y	26,700	2,700	24,000

Project activity in DHC V. Tarnovo – production of electricity.

Parameter	Unit	Produced	For auxiliary needs	To the grid
Heat by the new CHP	MWh/y	29,370	0	29,370
Heat by the SWB	MWh/y	56,015	3,500	52,515
Total heat	MWh/y	85,385	3,500	81,885

Project activity in DHC V. Tarnovo – production of heat.

1.2 <u>Real situation after the starting date of the project – February 2007</u>.

The construction works in DHC Veliko Tarnovo include civil works, electrical installations, gas pipelines and water pipelines for two gas modules, but only one of them was installed for the reasons of lack of sufficient heat load during the summer period. In the summer on gas module is sufficient to cover the heat demand of the DHC Veliko Tarnovo. The decision for the none installing the second module was taken by the owner of DHC Veliko Tarnovo on January 2007. In the same time decision was taken to reconstruct one of the old water boilers to burn biomass. The biomass used in the new configuration comes from forestry works in the region of Veliko Tarnovo and is composed from wood chips – please see attached invoice from supplier and protocol from accredited laboratory – analysis of the burned biomass.

<u>On the premise of DHC Veliko Tarnovo really are installed:</u>

- One gas module burning NG - 2.8MW_{el}
- Four Gas Boilers burning NG: 58+18+8.7+8.7 = 93.4 MW
- One Boiler burning Biomass instead of NG – 58 MW

<u>The real monitored data for 2007, 2008 and 2009 are shown in the next tables and they are based on the real working hours and load factor:</u>

- **7,600 working hours per year;**
- **Load factor – 1.**

This is a real load factor based on the monitoring (2.8 MW * 7,600 hours * 1 = 21,280 MWh)

Parameter	Unit	Produced	For auxiliary needs	To the grid
Electricity by the new CHP	MWh/y	**21,280**	1,350	18,580
Electricity by the existing facilities	MWh/y	0	1,350	0
Total electricity	MWh/y	21,280	2,700	18,580

Real activity in DHC V. Tarnovo – production of electricity.

Parameter	Unit	Produced	For auxiliary needs	To the grid
Heat by the new CHP	MWh/y	23,560	0	23,560
Heat by the SWB	MWh/y	28,440	3,500	24,940
Total heat	MWh/y	52,000	3,500	48,500

Real activity in DHC V. Tarnovo – production of heat

<u>The impact regarding the baseline is 25 % less electricity from DHC V. Tarnovo to the grid compared with the determined PDD Version 4.</u>

The lead parameter “payback time” applied in the PDD version 4 (Oct 2006) is 6.87 years - longer that the benchmark of 6 years determined in the PDD Version 4. Please see attached excel file <Payback period DHC Veliko Tarnovo>

2. Changes in the baseline – for the both DHCs Pleven and Veliko Tarnovo.

2.1 In the PDD Version 04, determined in 20 October 2006

The first version of the approved methodology AM0014 “Natural gas-based package cogeneration” has been applied to this project. This methodology has the following conditions for applicability:

• The cogeneration system is a third party cogeneration systems, i.e. not own or operated by the consuming facility that receives the project heat and electricity;

• The cogeneration system provides all or a part of the electricity and or heat demand of the consuming facility;

• No excess electricity is supplied to the power grid and no excess heat from the cogeneration system is provided to another user.

The AM0014 methodology has been applied to the project activity with the following deviations:

• The cogeneration system is owned by the project owner, but most of the electricity and heat from the system is provided to the grid and to consumers that are connected to the heat distribution network.

• The cogeneration system provides all or a part of the electricity and or heat demand to the grid and to end consumers for the heat;

• Excess electricity is supplied to the power grid and heat from the cogeneration system is provided to a distribution network.

2.2 Proposed for post determination changes in the baseline

The last version of AM0014 was proposed for post determination based on decision of the board of directors of the DHC.

The approved methodology AM0014/Version04 “Natural gas-based package cogeneration” has been applied to this project:

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

This methodology has the following conditions for applicability:

- The electricity and heat requirement of the consuming facility is generated in separate systems (I.e. electricity and heat in the baseline cannot be generated in another cogeneration facility) in the absence of the project activity;

- The cogeneration system is either third party cogeneration systems, i.e. not owned or operated by the consuming facility that receives the heat and electricity from project cogeneration systems or the cogeneration system is owned by the industrial user (henceforth referred to as self-owned) that consumes the heat and electricity from project cogeneration systems;
- The cogeneration syste provides all or a part of the electricity and or heat demand of the consuming facility;
- No excess electricity is supplied to the power grid and no excess heat from the cogeneration system is provided to another user;
- In the case project activity displaces electricity from fossil fuel based, dedicated power plant(s), methodology can only claim reductions from only that fraction of displaced electricity from the baseline dedicated power plant(s), for which it can be demonstrated that project activity led to reduction in generation of baseline dedicated power plant (s).

The AM0014 baseline methodology "Natural gas-based package cogeneration" has been applied to the project activity with the following deviations:

• The cogeneration system is owned by the project owner (the DHC), but most of the electricity and heat from the system is provided to the national electrical grid and to consumers that are connected to the heat distribution network. The deviation is in altered consuming facility. In the absence of the project activity, electricity and heat requirements of the consuming facility is generated in separate systems. The consuming facility of the heat is the heat distribution networks of the towns of Pleven and V. Tarnovo and the consuming facility of the electricity is the national grid. The heat distribution networks are owned by the project owner – there is not deviation regarding the original context. The national electrical grid is state owned;

• Excess electricity is supplied to the power grid and heat from the cogeneration system is provided to distribution networks of the towns of Pleven and V. Tarnovo.

The deviations affect the alternative baseline scenarios in a way that the industrial plant will be replaced trough the city consumers of heat and national consumers of electricity – the scenarios itself remain untouched.

The assumptions, formulae, parameters, data sources and key factors used in the methodology, are taken into account and conservativeness is safeguarded.

The additionality proof as stated in AM0014 will not be affected.

The consequences for the deviations described above to the application of AM0014 to the described project activity have been resolved by taking the following measures in the elaboration of the PDD:

Additionality

The additionality approach of AM0014 includes seven alternative baseline scenarios:

1. Industrial plant continues to operate with equipment replacement as needed with no change in equipment efficiency (The frozen-efficiency scenario).
2. Industrial plant continues to operate with improved efficiency new equipment at the time of equipment replacement using a less carbon intensive fuel.
   The consuming facility consists of the internal heat installations in the buildings (water radiators with distribution pipelines). The citizens of the town – many thousends of proprietors, own the apartments. The citizens are very limited to improve efficiency of the internal heating systems. In practice, they use natural gas like input baseline fuel in the DHC.

   This scenario is not a probable baseline scenario.

3. Industrial plant upgrades the thermal energy generating equipment and therefore increases the efficiency of boiler(s) immediately.
   This scenario is not a probable baseline scenario, because the consumers are not in possession of other thermal generating equipment.

4. The heat and or electricity demand of the industrial plant is reduced through improvements in end-use efficiency.
   It is possible to the proprietors of the apartments to reduce their heat and or electricity demand by implementing energy saving measures – insulation of the walls and implementation of new windows with less heat losses. This process takes several time, it is not an organized campaign, because of the reasons in (2). That because this scenario is not a probable baseline scenario.

5. Installation of a cogeneration system owned by the industrial plant.
   It is not probable that the citizens, the municipality or third party invest in new heat generating facility when the DHC already exist, own the heat distribution network and supply the town with energy. The energy is generated using fuel with low emission factor – natural gas. That because this scenario is not a probable baseline scenario.

6. Installation of a package cogeneration system owned by a company other than the industrial plant.
   The proposed project partially fulfill this scenario – the new CHP is owned by the DHC, but the electricity from the new CHP is exported to the national grid ant not to the consumers in the town. That because and also for the reasons stated in (5), this is not a probable baseline scenario.

7. Installation of a cogeneration system by a third party.
   This is not a probable baseline scenario, because of reasons stated in (5).

However, the most probable alternative is a continuation of the current situation without any project activity or alternatives undertaken – the frozen efficiency scenario. In this alternative DHC Pleven will not sell electricity to the national grid and DHC V. Tarnovo would continue to purchase electricity from the regional grid and both would continue to generate thermal electricity from the existing sources. The costs that would occur if the plants keep this situation would be only maintenance cost to keep the equipment operational in the future.

In the case of the implemented two subprojects, the consuming facility (DHCs Pleven and Veliko Tarnovo) own the cogeneration system after which they transfer the electricity to the grid and the heat to the heat distribution network. The heat distribution network is owned from the project owner and there is not deviation from the original context of AM0014.

The electricity exported from the new facilities to the national grid is consumed inside in the country and the concept of the Additionality proof as stated in AM0014 isn't affected. The deviation consists of the replacement of the consuming industrial plant with the consuming national grid. The BCEF (Baseline Carbon Emission Factor) of the national grid is published on the web site of MOEW. He is elaborated using the IRP-Manager model.

The IRP-Manager (Integrated Resource Planning) model provides comprehensive management of demand; supply, financial and rate data needed for long-term integrated resource planning of the power sector. It coordinates an expansive "Tool Box" of capabilities including: chronological simulation of demand and resources, automated resource strategy development, decision analysis and complete forecasts of impacts from all perspectives.

The forecast power balances obtained by merit order dispatching are used to develop the Baseline study. The basis study itself was developed using the ACM0002 Methodology, "Consolidated Baseline Methodology for Grid-Connected Electricity Generation from Renewable Sources" of UNFCCC CDM – Executive Board.

In order that the study can be as complete as possible and applied to the widest possible range of JI projects in the Bulgarian power sector, all methods offered in the power plant operation margin determination methodology are applied. The relation between operation margin and build margin is assumed everywhere as 50/50 % for BCEF determination.

3. Changes in the monitoring - for the both DHCs Pleven and Veliko Tarnovo

3.1 The monitoring plan in the determined PDD Version 4 is in *italic*:

In the determined PDD Version 4 is foreseen to estimate only the emissions of CO_2 from burning processes in the project and baseline case.

SECTION D. Monitoring Plan – Determined PDD Version 4

The Monitoring Plan (MP) provides a practical framework for the collection and management of project performance data, which will be used for the verification of the actual emissions reduction generated. The process of verification is the annual auditing of monitoring results by a third party, which makes the assessment of the achieved emission reductions. This MP does not contain specific guidelines on emissions reduction auditing and verification, but it provides sufficient *detail on the project structure, the proposed data that needs to be monitored and relevant operational issues, and thus giving the opportunity to an independent verifier to develop suitable auditing and verification procedures for the CHP portfolio of the JI project activity.*

D.1. Description of monitoring plan chosen

***The project emissions** are mainly emissions of CO_2 from the burning process of natural gas in the co-generation installations and in the existing steam water boilers. There is an insignificant quantity of methane emissions (assessed as insignificant and excluded from supervision) and emissions from nitrous oxide released during the natural gas burning process. These quantities are insignificant, because:*

- *the technology employed for the burning process is state-of-art one and there is not unburned quantity of natural gas in the flue gases;*
- *the quantity of nitrous oxide in the flue gases released during the burning process will be lower than in the existing situation.*

Additionally, to the natural gas quantity feed for burning in the co-generation installation, there is a quantity of emissions from methane, from natural gas leakages during its delivery through the gas pipeline. These indirect greenhouse emissions are assessed by the delivered natural gas parameters through the incorporate gas pipelines and their length, using standard assessments for the specific leakages and emissions factors. These indirect greenhouse emissions are not evaluated, because of their insignificant quantity and they are the same as in the existing situation.

Considering the project scope, to install a co-generation installation in DHC Pleven and DHC V.Tarnovo, the following data/parameters need to be monitored:

- *Natural gas consumed by the co-generation installation, in thousand Nm3;*
- *Natural gas consumed by the water heated and steam boilers, in thousand Nm3;*
- *Natural gas consumed by the DHC;*
- *Consumed "back up" fuel (HFO), in tons;*
- *LCV of the NG, in MWh/m3;*
- *LCV of the HFO, in MWh/t;*
- *Net electricity provided by the new CHP to the national electricity network, in MWh;*
- *Net thermal energy provided by the DHC to the heat supply network, in MWh;*
- *CAHO – heat output to covering heat demand, in MWh;*
- *Efficiency of the existing SWB;*
- *Emission factor of the national electricity network, in tCO2/MWh.*

There is a monitoring model, expressing the specific requirements, during the assessments in this PDD. Such model is prepared under MS-Excel and is presented below in the annexes. The model requirements are to enter the monitored parameters as an input data, so it will automatically calculates simultaneously the project and the baseline emissions, for each year after the project commissioning. The electronic worksheets should be filled with information by *the project manager and also the inspecting personnel, through the whole operational lifetime of the project related to the crediting period.*

The baseline emissions *depend on the thermal energy and electricity production of the existing co-generation system and they are determined by the input data in the model, which also determines the emissions reduction which are obtained as a result of the project activity. The personnel responsible for the monitoring should fill up the electronic worksheets on a monthly basis. The model automatically calculates the annual sum and respectively the emissions reductions of greenhouse gases obtained as a result of the project operation of the new co-generation systems. The model contains different electronic worksheets series with various functions:*

Electronic worksheet – Input data:

- *Natural gas consumed by the co-generation installation, in thousand Nm3;*
- *Natural gas consumed by the water heated and steam boilers, in thousand Nm3;*
- *Natural gas consumed by the DHC;*
- *Consumed "back up" fuel (HFO), in tons;*
- *LCV of the NG, in MWh/m3;*
- *LCV of the HFO, in MWh/t;*
- *Net electricity provided by the new CHP to the national electricity network, in MWh;*
- *Net thermal energy provided by the DHC to the heat supply network, in MWh;*
- *CAHO – heat output to covering heat demand, in MWh;*
- *Efficiency of the existing SWB;*
- *Emission factor of the national electricity network, in tCO2/MWh.*

Electronic worksheet - calculations:

- *Project emissions;*
- *Baseline emissions*

Electronic worksheet - Results:

- *Emissions reduction of CO_2.*

D.1.1. Option 1 - Monitoring of the emissions in the project scenario and the baseline scenario:

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how this data will be archived:

ID number (Please use numbers to ease cross-referencing to D.3)	***Data variable***	***Source of data***	***Data unit***	***Measured (m), calculated (c) or estimated (e)***	***Recording frequency***	***Proportion of data to be monitored***	***How will the data be archived? (electronic/ paper)***	***Comment***
1	*Quantity of NG used by the new CHP*	*Measuring devices of the power plant*	*1,000 nm3/y*	*m*	*monthly*	*100%*	*Electronic and paper*	
2	*Quantity of NG used by the existing SWB*	*Measuring devices of the power plant*	*1,000 nm3/y*	*m*	*monthly*	*100%*	*Electronic and paper*	
3	*Quantity of NG used by the DHC*	*Measuring devices of the supplier (Bulgargas)*	*1,000 nm3/y*	*m*	*monthly*	*100%*	*Electronic and paper*	
4	*Quantity of HFO used by the*	*Measuring devices of the power*	*tones/y*	*m*	*monthly*	*100%*	*Electronic and paper*	

	DHC	*plant*						
5	*LCV of used NG*	*Data by the supplier (Bulgargas)*	*MWh/1,000 nm3*	*c*	*monthly*	*100%*	*Electronic and paper*	
6	*LCV of used HFO*	*Data by the supplier*	*MWh/tone*	*c*	*monthly*	*100%*	*Electronic and paper*	

D.1.1.2 Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

The project emissions will be calculated by the equation:

*APE = AECng*EFng +AEChfo*EFhfo = Qng*LCVng*EFng + Qhfo*LCVhfo*EFhfo [tCO2/y], where:*

APE – annual project emissions [tCO2/y];
AECng - annual energy consumption of natural gas [MWh/y];
AEChfo - annual energy consumption of heavy fuel oil [MWh/y];
Qng - annual quantity of NG used by the DHC [1000nm3/y];
LCVng - low calorific value of NG, average for the year [MWh/1000nm3];
Efng - emission factor for NG burning – 0.202 tCO2/MWh(0.0561 Kton/TJ)– emission factor for combustion of natural gas, estimated from IPCC- www.ipcc-nggip.iges.or.jp/public/gl/invsl.htm, published by Ministry of Economic Affairs of the Netherlands;
Qhfo - annual quantity of HFO used by the DHC [tones/y];
LCVhfo - low calorific value of HFO, average for the year [MWh/tone];
EFhfo - emission factor for HFO burning – 0.279 tCO2/MWh.

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary, and how such data will be collected and archived:

ID number (Please use numbers to ease cross-referencing to table D.3)	***Data variable***	***Source of data***	***Data unit***	***Measured (m), calculated (c), estimated (e),***	***Recording frequency***	***Proportion of data to be monitored***	***How will the data be archived? (electronic/ paper)***
7	*Wel,s electricity from new CHP to the grid*	*Measuring device of the power plant*	*MWh/y*	*M*	*monthly*	*100%*	*Electronic and paper*
8	*Heat from DHC to the grid*	*Measuring device of the power plant*	*MWh/y*	*M*	*monthly*	*100%*	*Electronic and paper*
9	*CAHO - annual heat output to covering the heat deman*	*Measuring device of the power plant*	*MWh/y*	*M*	*monthly*	*100%*	*Electronic and paper*

	d of the DHC						
10	*Eb-Efficiency of the existing SWB*	*DHC*	*-*	*E*	*once*	*100%*	*Electronic and paper*
11	*EFel – emission factor for Bulgarian power grid*	*MoEW of Bulgaria*	*tCO2/MWh*	*C*	*yearly*	*100%*	*Electronic and paper*

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO2 equ.):

Annual baseline GHG emissions – ABE1 = BEth - *from natural gas combustion in boilers for production of heat, covering annual heat demand of the DHC is calculated as follows:*

*BEth = ABE1 = ABECng *EFng, tCO2/y*

where:

ABECng is the heat input with natural gas fuel for covering heat demand annually, [MWh/y]

*ABECng = CAHO/Eb = Bng*LCVng, MWh/y;*

CAHO is annual heat output to covering heat demand of DHC, MWh/y;

Eb is efficiency of existing SWB(yearly monitored);

Bng is quantity of natural gas used for combustion in boilers, [Tnm3/y]

LCVng is low calorific value of natural gas – 9.30 [MWh/Tnm3]-data from Bulgargas

EFng = 0.202 tCO2/MWh (0,0561 Kton/TJ)– emission factor for combustion of natural gas, estimated from IPCC.

Annual baseline GHG emissions – ABE2 = BEel - *from electricity generated by the new CHP and going to grid is calculated as follows:*

BEel = ABE2 = Wel,s EFel, tCO2/y*

where:

W el,s - electricity production from CHP, which will substitute generation of electricity elsewhere in the power grid, [MWh/y];

Wel,s = Wel – Wel aux, [MWh/y];

Wel – electricity production of new CHP, [MWh/y];

Wel aux – electricity for auxilary needs of CHP himself, [MWh/y].

EFel – calculated emission factor for Bulgarian Power grid [tCO2/MWh]. Description and calculation of emission factor for Bulgarian power grid are presented in paragraph B.

Total annual baseline GHG emissions, ABE*, are given by:*

ABE = ABE1 + ABE2 , tCO2 /y

D. 1.2. Option 2 - Direct monitoring of emission reductions from the project (values should be consistent with those in section E):

Not applicable

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source, formulae/algorithm, emissions units of CO2 equ.):

Not applicable.

D.1.3. Treatment of leakage in the monitoring plan:

Not applicable.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:

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

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO2 equiv.):

Not applicable

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source, formulae/algorithm, emissions units of CO2 equiv.):

The estimated emission reductions are calculated as follows:

AER = ABE – APE [tCO2/y];
Where:
AER – annual emission reductions;
ABE – annual baseline emissions, calculated in respect of D.1.1.4;
APE – annual project emissions, calculated in respect of D.1.1.2.

D.1.5. Information to be collected in order to monitor environmental impacts of the project, and how this information will be archived:

Not applicable. There is no information related to the environmental impacts of this project which *will especially be collected.*

D.2 Quality control (QC) and quality assurance (QA) procedure to be performed for the data monitored:

The table below describes the procedure for the quality control and the quality assurance – (QA/QC) for every data which is changing, together with the relevant information for every variable.

. Data	***Uncertainty level of data (High/Medium/Low)***	***Are QA/QC procedures planned for these data?***	***Justification why QA/QC procedures are or aren't being planned?***
1	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
2	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
3	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
4	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
5	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
6	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
7	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
8	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
9	*Low*	*Yes*	*These data will be directly used for calculation of emissions reductions*
10	*Low*	*Low*	*These data will be directly used for calculation of emissions reductions*
11	*Low*	*Low*	*These data will be directly used for calculation of emissions reductions*

D.3.Please describe the operational and management structure that the project operator will implement regarding the monitoring plan:

For monitoring, collection, registration, visualization, archiving, reporting of the monitored dates and periodical checking of the measurement devices are responsible the measurement team. The authorises are not divided separately between the people. Every one from the team is authorized and responsible for all actions connected with the servicing of the monitoring system.

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 memory and can be recorded in every time.

The existing measurement devices which are not equipped with communication ports will be reading and their results will be recorded in the tables of the Central monitoring system 1 time of day from the measurement team people.
The measurement team will record the measurement dates from all measurement devices and will compare with the dates recorded in the Central monitoring system 1 time monthly like internal audit of the monitoring system.

The measurement team carry out all maintenances of the measurement devices from the Monitoring system / cleaning the probes etc./ 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 authorized laboratory. The plan and the report data for the periodical checking are record and automatically generated in the Central monitoring system.

In accordance with the procedures for checking the recorded monitoring dates, emergency preparedness and replacing missing data shall be marked:

- *All measurement devices are registered in the State Register like trade devices;*
- *All suppliers of the measurement devices have services in the country and are obligated to respond in 48 hours;*
- *DHC keep in its storage spare parts in accordance with the recommendations of the suppliers, which the monitoring team is ready to change;*
- *All measurement devices are with fiscal memory;*
- *The Central monitoring system archives all measurement data for very long period inside. The missing data for the period of damage will be replaced with enough precision with archived dates for similar period.*

DHC Pleven

For monitoring, collection, registration, visualization, archiving, reporting of the monitored dates and periodical checking of the measurement devices is responsible the measurement team from 4 people and its manager Mr Erdinai Muratov. The responsibilities are not divided separately between the people. Every one from the team is authorized and responsible for all activities.

The team is formed by:

1. *Mr.Erdinai Muratov – Eng., Chief of department „Production and Technology";*
2. *Mr.Andrian Andreev – Eng., Chief of department „Measurements";*
3. *Mr. Aleksander Nikolov – Eng., department „Measurements";*
4. *Mrs. Desislava Toteva – department „Production and Technology"*

DHC Veliko Tarnovo

For monitoring, collection, registration, visualization, archiving, reporting of the monitored dates and periodical checking of the measurement devices are responsible the measurement team from 3 people and its manager Mr Dimitar Georgiev. The responsibilities are not divided separately between the people. Every one from the team is authorized and responsible for all activities.

The team is formed by:

1. *Mr. Dimitar Georgiev – Eng., Chief of department „Measurements";*
2. *Mr. Toncho Penev - department „Measurements";*
3. *Mr. Borislav Mihailov - department „Measurements".*

3.2 The new monitoring plan proposed for post determination is based on AM0014 Approved monitoring methodology:

The new monitoring plan is more consistant because include emissions of CO_2, CH_4, N_2O from combustion and leakages during production and distribution of baseline fuel.

SECTION D. Monitoring plan proposed for post determination

D.1. Description of monitoring plan chosen:

The monitoring is in conjunction 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 back up 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 + NH_4 + N_2O) from the burning process in the co-generation installations and in the existing steam/water boilers and;
- Emissions of NH_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.

Considering the project scope, to install a co-generation installation in DHC Pleven and DHC V.Tarnovo, the following data/parameters need to be monitored throughout the crediting period:

- Natural gas consumed by the DHC, in thousand Nm3;
- Consumed “back up” fuel (HFO), in tons;
- Consumed biomass by the DHC, in tons;

The following parameters, needed for the calculations, are given from the National GHG inventory – the last version available reported to the Secretariat of UNFCCC:

- LCV of the NG, in GJ/1000Nm3;
- LCV of the HFO, in GJ/t;
- LCV of the biomass, in GJ/t;
- EF for NG burning in g-$CO_{2eq.}$/MJ, including CO_2, N_2O and CH_4 emissions;
- EF for HFO burning in g-$CO_{2eq.}$/MJ, including CO_2, N_2O and CH_4 emissions;
- EF for biomass burning in g-$CO_{2eq.}$/MJ;
- MLR for NG production, transportation and distribution in kgCH_4/PJ.

The baseline emissions depend on the thermal energy from sources on the premise to covering the heat demand (CAHO) and net electricity production of the co-generation system and they are determined by the input data in the model, which also determines the emissions reduction which are obtained as a result of the project activity.

The following parameters/data need to be monitored throughout the crediting period in order to calculate the baseline emissions:

- Net electricity provided by the new CHP, in MWh;
- CAHO – heat output to covering heat demand of the plant, in MWh.

The following parameters/data are not monitored throughout the crediting period, bur are determined only once and are available at the stage of determination regarding the PDD:

- Emission factor of the national electricity network, in tCO2/MWh.

There is a monitoring model, expressing the specific requirements, during the assessments in this PDD. Such model is prepared under MS-Excel and is presented below in the annexes. The model requirements are to enter the monitored parameters as an input data, so it will automatically calculates simultaneously the project and the baseline emissions, for each year after the project commissioning. The electronic worksheets should be filled with information by the project manager and also the inspecting personnel, through the whole operational lifetime of the project related to the crediting period.

The personnel responsible for the monitoring should fill up the electronic worksheets on a monthly basis. The model automatically calculates the annual sum and respectively the emissions reductions of greenhouse gases obtained as a result of the project operation of the new co-generation systems. The model contains different electronic worksheets series with various functions:

Electronic worksheet – Input data:

- Natural gas consumed by the DHC in thousand Nm3;
- Consumed “back up” fuel (HFO) by the DHC, in tons;
- Consumed biomass by the DHC, in tons;
- Net electricity provided by the new CHP, in MWh;
- CAHO – heat output to covering heat demand of the DHC, in MW

Electronic worksheet - lookups:

- LCV of the used fuels, in GJ/t;
- Efficiency of the existing SWB;
- Emission Factors of the used fuels, in $kgCO2_{eq.}$ /GJ;
- Emission factor of the national electricity network, in tCO2/MWh.

Electronic worksheet - calculations:

- Project emissions in tCO_{2equiv};
- Baseline emissions in $tCO_{2equiv.}$

Electronic worksheet - Results:

- Emissions reduction in $tCO_{2equiv.}$

D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	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
1	Quantity of NG used by the DHC	Measuring devices of the supplier	1,000 nm3	m	monthly	100%	Electronic and paper	The supplier provides monthly protocols.
2	Quantity of HFO used by the DHC	Measuring devices of the power plant	tones	m	monthly	100%	Electronic and paper	The operator elaborates monthly protocols.
3	Quantity of biomass used by the DHC	Measuring devices of the power plant	tones	m	monthly	100%	Electronic and paper	The operator elaborates monthly protocols.

Biomass is used like fuel only at the premise of DHC Veliko Tarnovo. The composition of the biomass includes:

- Wood chips – residues from the wood manufacturing industries in the region of Veliko Tarnovo.

D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

The project emissions will be 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) $\frac{AEC_{NG} \cdot EF_{NG}}{10^3}$ (4.1)

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) $\dfrac{AEC_{NG}.\ MEF_{NG}}{10^3}$ (4.2)

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:

$E_{N2O\ comb}$ (tonne N_2O / year) = $\dfrac{AEC_{NG}\ NEF_{NG}}{10^3}$ (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) (4.5)

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:

$$E_{fug} \text{ (tonne } CH_4 \text{ / year) } \frac{AEC_{NG}\ MLR}{10^3} \qquad (4.6)$$

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)**

$$E_{equiv\ fug} \text{ (tonne } CO_2 \text{ – equiv / year) } = E_{fug}\ GWP\ (CH_4) \qquad (4.7)$$

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

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

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:

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

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.

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	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
4	CEO-net electricity output of the new CHP	Measuring device of the DHC	MWh	M	monthly	100%	Electronic and paper	In CEO is not included the electricity for auxiliary needs of the new cogeneration itself.

5	CAHO - Heat output to covering the heat demand of the DHC	Measuring devices of the DHC	MWh	M	monthly	100%	Electronic and paper	In CAHO are included the amounts of heat energy with hot water and steam that are supplied to consumers and measurable on borders of the DHC.

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

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.

<u>**ABE1** are calculated as the sum of follows:</u>

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):

$$ABEC_{BF} = \frac{CAHO}{e_b} \qquad (3.1)$$

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):

$$BEth = ABEC_{BF} . EF_{BF} \qquad (3.3)$$

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 $\mathbf{EF_{BF}}$ 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):

$\mathbf{BE_{met\ comb}}$ **(tonneCH_4/year)** = $ABEC_{BF}$ x MEF (3.4)

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) (3.5)

Where GWP (CH4) = global warming potential of methane = 21

A value of $\mathbf{MEF_{BF}}$ 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 (3.6)

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 (3.8)

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) (3.9)

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. $BEF_{elec\ fossil\ fuel}$ (3.11)

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[1]", ex ante determined. Please refer to section B and to Annex 2.

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

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

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

D. 1.2. Option 2 – Direct monitoring of emission reductions from the project (values should be consistent with those in section E.):

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

Not applicable.

D.1.3. Treatment of leakage in the monitoring plan:

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	Comment

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

The emissions from leakages of methane during the production, transport and distribution of the natural gas outside/inside of the project boundaries are included in both baseline and project scenarios. For other types of fuel, the emissions associated with production and transportation are assumed zero for simplification and conservatism.

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

The estimated emission reductions are calculated as follows:

AER = BEtotal – PEtotal [tCO2e/y], where:
AER – annual emission reductions;
BEtotal – annual baseline emissions, calculated in respect of D.1.1.4;
PEtotal – annual project emissions, calculated in respect of D.1.1.2.

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

Not applicable. There is no information related to the environmental impacts of this project which will especially be collected.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1	Low	QA/QC procedures are planned - these data will be directly used for calculation of emissions reductions. The gas measuring devices are owned by the state company – supplier of natural gas. The metering devices are calibrated by an independent entity which has a state licence. The reading of the metering devices happens once per month in the presence of the chief of the Production/Technical Department.The data are transffered into protocols, signed by two parties – supplier and client (DHC). The data from meters are regularly transferred to the computer system and archived. Supervision of data archiving is performed by the Production/Technical Department.

2	Low	QA/QC procedures are planned - these data will be directly used for calculation of emissions reductions. Calibration of the metering devices is made in accordance with the calibration schedule which approved by the Chief Engineer for one year. Supervision of calibration is performed by the Department of heat automatic and measurement. The metering devices are calibrated by an independent entity which has a state licence. The data from meters are automatically and regularly transferred to the computer system and archived. Supervision of data archiving is performed by the Production/Technical Department.
3	Low	QA/QC procedures are planned - these data will be directly used for calculation of emissions reductions. Calibration of the metering devices is made in accordance with the calibration schedule which approved by the Chief Engineer for one year. Supervision of calibration is performed by the Department of heat automatic and measurement. The metering devices are calibrated by an independent entity which has a state licence. The data from meters are automatically and regularly transferred to the computer system and archived. Supervision of data archiving is performed by the Production/Technical Department.

4	Low	The data of the electricity generated and the internal needs electricity consumption at the DHC are determined by standardized electricity meters. These meters will be a part of the commercial automatic system of energy accounting and will be provide to fulfil the accuracy requirements of the system. Calibration of the electricity meters is made in accordance with the calibration schedule which is approved by the Chief Engineer for one year. Supervision of calibration is performed by the Electrotechnical laboratory of the electrical department. The metering devices are calibrated by an independent entity which has a state licence. The data from meters are automatically and regularly transferred to the computer system and archived. Supervision of data archiving is performed by the Production/Technical Department.
5	Low	QA/QC procedures are planned - these data will be directly used for calculation of emissions reductions. Calibration of the metering devices is made in accordance with the calibration schedule which approved by the Chief Engineer for one year. Supervision of calibration is performed by the Department of heat automatic and measurement. The metering devices are calibrated by an independent entity which has a state licence. The data from meters are automatically and regularly transferred to the computer system and archived. Supervision of data archiving is performed by the Production/Technical Department.

D.3. Please describe the operational and management structure that the project operator will apply in i plan:

For monitoring, collection, registration, visualization, archiving, reporting of the monitored dates and periodical checking of the measurement devices are responsible the measurement team. The authorities are not divided separately between the people. Every one from the team is authorized and responsible for all actions connected with the servicing of the monitoring system.

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.

The existing measurement devices which are not equipped with communication ports will be reading and their results will be recorded in the tables of the Central monitoring system 1 time of day from the measurement team people.

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

The Central monitoring system archives all measurement data for very long period inside. The missing data for the period of damage or onerous measurements will be replaced with enough precision with archived data for period with same activity level.

The data will be stored for ten years after the end of the crediting period electronically and in hard copy.

Every single monitoring device is subject of checking procedure for accuracy. The procedure depends of technical specifications of the device and is in conjunction with the requirements of the State agency of metrology.

Calibration of the metering devices is made in accordance with the calibration schedule which approved by the Chief Engineer for one year. The Department of heat automatic and measurement perform supervision of calibration. The metering devices are calibrated by an independent entity, which has a state licence.

In accordance with the procedures for checking the recorded monitoring dates, emergency preparedness and replacing missing data shall be marked:

- All measurement devices are registered in the State Register like trade devices;
- All suppliers of the measurement devices have services in the country and are obligated to respond in 48 hours;
- DHC keep in its storage spare parts in accordance with the recommendations of the suppliers, which the monitoring team is ready to change ;
- All measurement devices are with memory;

- The Central monitoring system archives all measurement data for very long period inside. The missing data or onerous measurements will be replaced with enough precision with archived data for period with same activity level.

DHC Pleven

For monitoring, collection, registration, visualization, archiving, reporting of the monitored data and periodical checking of the measurement devices is responsible the measurement team from four people and its manager Mr Erdinai Muratov. The responsibilities are not divided separately between the people. Every one from the team is authorized and responsible for all activities.

The team is formed by:

5. Mr.Erdinai Muratov – Eng., Chief of department „Production and Technology";
6. Mr.Andrian Andreev – Eng., Chief of department „Measurements";
7. Mr. Aleksander Nikolov – Eng., department „Measurements";
8. Mrs. Desislava Toteva – department „Production and Technology"

DHC Veliko Tarnovo

For monitoring, collection, registration, visualization, archiving, reporting of the monitored data and periodical checking of the measurement devices are responsible the measurement team from 3 people and its manager Mr Dimitar Georgiev. The responsibilities are not divided separately between the people. Every one from the team is authorized and responsible for all activities.

The team is formed by:

4. Mr. Dimitar Georgiev – Eng., Chief of department „Measurements";
5. Mr. Toncho Penev - department „Measurements";
6. Mr. Borislav Mihailov - department „Measurements".

The technical staff, which will participate in the installation, commissioning and which will be responsible for the operation and monitoring of the new co-generations installations shall be trained in the phase of commissioning and operation, please see in Annex No. 15: Training Program Project Toplofikatsia Bourgas for more details.

D.4. Name of person(s)/entity(ies) establishing the monitoring plan:

Name of person/entity establishing the monitoring plan: Eko Analiz Ltd.

Contact information:

Contact person: Boris Metodiev

Address: Bulgaria, 1303 Sofia, 34, 3020 street, floor 4, office 418.

Tel./Fax: +359 2 8904 258, e-mail: eko_analiz@abv.bg

Eko Analiz is not a project participant.

3.3 The changes on the monitoring and formulae results consist of:

- Implementation of data for LCV of fuels from the National GHG Inventory instead of laboratories of suppliers – the reason of these changes is that the laboratory of the Supplier of NG – Bulgargas is not accredited and the data from the National GHG Inventory are more reliable. In the time of the determination of the PDD the GHG inventory was not in place.

- Implementation of data for EF from the National GHG Inventory instead of data from IPCC – the reason of these changes is that when the national GHG Inventory is in place, the data from the inventory are with priority in comparison with the data from IPCC. In the proposed for post determination monitoring plan are included also emissions of N2O, CH4 and methane leaks during exploration, transportation and distribution of the NG.

  The methane leaks are included after the recommendation of Determinators Norbert Heidelmann and Dorle Noerenberg.

- Implementation of default value of 0.9 for the Eb (efficiency of boilers) is in consistence with AM0014 and conservative regarding the baseline.

The impact of the changes is shown in the next table:

Parameter	Value in the determined PDD Ver.4	Value proposed for post determination – Data from National GHG Inventory for 2007
LCV of NG	Average from suppliers – 33.49 GJ/1000Nm^3	33.5 GJ/1000Nm^3
LCV of HFO	Average from suppliers – 39.77 GJ/t	39.8 GJ/t
EF of NG burning	IPCC – **56.1 kg CO_2/GJ**	55.82kgCO2/GJwithGWP1 0.1gN2O/GJwith GWP310 2.5gCH4/GJwith GWP 21

		MLR=279500kgCH4/PJwithGWP21 Total EF for NG = **55.90937 kgCO2$_{equv.}$/GJ**

All formulae results of the AM0014, except the measured value CAHO:

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

$$ABEC_{BF} = \frac{CAHO}{e_b} \quad (3.1)$$

Where:

- CAHO in the proposed post determination is **annual heat output from DHC**, and not
- **Annual heat output from cogeneration system** like in the original context of AM0014**.**

  Which is in consistence with the deviations stated in 2.2.

4. Recalculations of baseline emissions, project emissions and emission reductions.

The recalculations are in compliance with the new monitoring plan and formulae.

SECTION E. Estimation of greenhouse gas emission reductions proposed for post determination

E.1. Estimated project emissions

These emissions comprise emissions of CO2, NH4 and N2O from the combustion process of the fuel in project scenario, including NH_4 leakages during the production, transportation and distribution of NG.

DHC Pleven

The emissions of GHG from the project activities are formed by:

- Combustion of natural gas (NG) in the new GTI;
- Combustion of NG in the back up Steam and Water Boilers (SWB);
- Combustion of heavy fuel oil (HFO) in SWB.

The project activity includes:

- Gross electricity production by new GTI , GEPGTI = 257,280 MWh/y;
- Gross thermal production by new GTI , GTPGTI = 361,800 MWh/y;
- Gross efficiency of the new GTI , GEGTI = 0.90;
- Gross thermal production by old SWB , GTPSWB = 184,200 MWh/y;
- Gross thermal efficiency of the old SWB , e_b = 0.90.

AEC_{NG} - annual energy consumption of natural gas in DHC (input energy with NG) to cover the project activities is determined by:

(GEPGTI + GTPGTI)/ GEGTI + GTPSWB/ e_b = 892,533MWh/y.

EF_{NG} - The emission factor for NG combustion - 55.90937 kg$CO_{2\ eq.}$/GJ (201.274 kg $CO_{2eq.}$/MWh), applying the data from National GHG inventory, including CO_2, CH_4, N_2O from combustion and CH_4 leakages during production, transport and distribution.

The emission factor for HFO combustion is 74.656 kg$CO_{2\ eq.}$/GJ (268.762 kg $CO_{2eq.}$/MWh), applying the data from National GHG inventory, including CO_2, CH_4, N_2O from combustion.

The calculated project emissions from October 2007 to December 2012 are shown in the next table E.1.1:

Parameter	Unit	2007	2008	2009	2010	2011	2012
Input energy with NG to DHC	MWh	223,133	892,533	892,533	892,533	892,533	892,533
EF for NG combustion	tCO2e/MWh	0.2013	0.2013	0.2013	0.2013	0.2013	0.2013
Em.of CO2e by NG comb	tCO2e	44,917	179,667	179,667	179,667	179,667	179,667
Input energy with HFO	MWh	0	0	0	0	0	0
EF for HFO comb.	tCO2e/MWh	0.2688	0.2688	0.2688	0.2688	0.2688	0.2688

Project em. by HFO comb.	tCO2e	0	0	0	0	0	0
Project emissions Pleven	tCO2e	44,917	179,667	179,667	179,667	179,667	179,667

Table E.1.1: Estimated project GHG emissions in DHC Pleven

<u>DHC Veliko Tarnovo</u>

The of GHG emissions from the project activities are formed by:

- Combustion of natural gas in the new CHP;
- Combustion of natural gas in the old facilities;
- Combustion of HFO in the old facilities;
- Combustion of biomass in the old facilities.

The project activity includes (please refer to section A):

- Gross electricity production by new CHP , GEPCHP = 21,280 MWh/y;
- Gross thermal production by new CHP, GTPCHP = 23,560 MWh/y;
- Gross efficiency of the new CHP, GECHP = 0.82;
- Gross thermal production by old SWB, GTPSWB = 28,440 MWh/y
- Gross thermal efficiency of the old SWB, e_b = 0.90.

AEC_{NG} - annual energy consumption of natural gas in DHC (input energy with NG) to cover the project activities is determined by:

(GEPCHP + GTPCHP)/ GECHP + GTPSWB/ e_b = 86,283MWh/y.

EF_{NG} - The emission factor for NG combustion - 55.90937 kg$CO_{2\ eq.}$/GJ (201.274 kg $CO_{2eq.}$/MWh), applying the data from National GHG inventory, including CO_2, CH_4, N_2O from combustion and CH_4 leakages during production, transport and distribution.

The emission factor for HFO combustion is 74.656 kg$CO_{2\ eq.}$/GJ (268.762 kg $CO_{2eq.}$/MWh), applying the data from National GHG inventory, including CO_2, CH_4, N_2O from combustion.

The calculated project emissions from February 2007 to December 2012 are shown in the next table E.1.2:

Parameter	Unit	2007	2008	2009	2010	2011	2012
Input energy with NG to DHC	MWh	79,093	86,283	86,283	86,283	86,283	86,283

EF_{NG}	tCO2e/MWh	0.2013	0.2013	0.2013	0.2013	0.2013	0.2013
Em.of CO2e by NG comb	tCO2e	15,921	17,369	17,369	17,369	17,369	17,369
Input energy with HFO	MWh	0	0	0	0	0	0
EF for HFO comb.	tCO2e/MWh	0.2688	0.2688	0.2688	0.2688	0.2688	0.2688
Project em. by HFO comb.	tCO2e	0	0	0	0	0	0
Input biomass	t	0	110	4,000	4,000	4,000	4,000
Em. Coefficient for biomass combustion	tCO2e/t	0	0	0	0	0	0
Emissions of CO2e by biomass comb.	tCO2e	0	0	0	0	0	0
Total project emissions V.Tarnovo	tCO2e	15,921	17,369	17,369	17,369	17,369	17,369

Table E.1.2: Estimated project GHG emissions in DHC V.Tarnovo

The estimated project GHG emissions for the two DHCs are shown in the table E.1.3 bellow:

Parameter	Unit	2007	2008	2009	2010	2011	2012
Total project emissions of both DHCs	tCO2e	60,838	197,036	197,036	197,036	197,036	197,036

Table E.1.3: Estimated project GHG emissions in the two DHCs

E.2. Estimated leakage:

The emissions from leakages of methane during the production, transport and distribution of the natural gas outside/inside of the project boundaries are included in both baseline and project scenarios. For other types of fuel, the emissions associated with production and transportation are assumed zero for simplification and conservatism.

E.3. The sum of E.1. and E.2.:

Parameter	Unit	2007	2008	2009	2010	2011	2012
Total project emissions of both DHCs	tCO2e	60,838	197,036	197,036	197,036	197,036	197,036

E.4. Estimated baseline emissions:

Baseline emissions comprise the following components:

- **$CO_{2eq.}$ Combustion (ABE1)** corresponds to natural gas that would have been used for covering the whole heat demand during the investigated period for every year. These emissions comprise emissions of CO2, CH4 and N2O from the combustion process and methane leakages during the production, transport and distribution of the baseline fuel.
- **CO_2 electricity (ABE2)** – emissions associated with the electricity that would have been generated by the power grid if the new CHP did not provide electricity to the DHC Plant for auxiliary needs plus the rest of produced by CHP electricity, which substitutes the electricity produced elsewhere, distributed in the same grid.

The formulae used for the calculations are described in D.1.1.4. The baseline emissions of $CO_{2eq.}$ from combustion are determined as follows:

ABE1 = ABEC $_{BF}$ x EF_{BF} [$tCO_{2\ eq.}$/y], where:

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

$$ABEC_{BF} = \frac{CAHO}{e_b} \qquad (3.1)$$

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

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

CAHO – data from project activity;
EF_{NG} - The emission factor for NG combustion - 55.90937 $kgCO_{2\ eq.}$/GJ (201.274 kg $CO_{2eq.}$/MWh), applying the data from National GHG inventory, including CO_2, CH_4, N_2O from combustion and CH_4 leakages during production, transport and distribution.

ABE2 = $BE_{elec\ fossil\ fuel}$, [tCO_2/y], where:

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* (3.11) Where: *CEO* **=** New Cogeneration 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)

BEF elec fossil fuel - Emission factor for Bulgarian power grid, forecast Maximum demand, Dispatch data adjusted_OM_EF, please refer to section B and Annex 2;
CEO – data from project activity;

<u>DHC Pleven</u>

The estimated baseline emissions from October 2007 to December 2012 for DHC Pleven are given in the table E.4.1 bellow:

Parameter	Unit	2007	2008	2009	2010	2011	2012
CAHO	MWh	136,500	546,000	546,000	546,000	546,000	546,000
$ABEC_{BF}$	MWh	151,667	606,667	606,667	606,667	606,667	606,667
EF_{NG}	tCO2e/MWh	0.2013	0.2013	0.2013	0.2013	0.2013	0.2013
ABE 1	tCO2e	30,531	122,122	122,122	122,122	122,122	122,122
CEO	MWh	59,174	236,698	236,698	236,698	236,698	236,698
$BEF_{el.fossil\ fuels}$ - Dispatch Data Adj_OM_EF of Bulgarian Grid	tCO2/MWh	1.156	1.059	0.947	0.908	0.884	0.833
ABE 2	tCO2	68,405	250,663	224,153	214,922	209,241	197,169
Baseline emissions (ABE 1 + ABE 2) for DHC Pleven	tCO2e	98,936	372,785	346,275	337,044	331,363	319,291

Table E.4.1: Baseline emissions DHC Pleven

DHC V. Tarnovo

The estimated baseline emissions from February 2007 to December 2012 for DHC Veliko Tarnovo are given in the table E.4.2 bellow:

Parameter	Unit	2007	2008	2009	2010	2011	2012
CAHO	MWh	47,667	52,000	52,000	52,000	52,000	52,000
$ABEC_{BF}$	MWh	52,963	57,778	57,778	57,778	57,778	57,778
EF_{NG}	tCO2e/MWh	0.2013	0.2013	0.2013	0.2013	0.2013	0.2013
ABE 1	tCO2e	10,661	11,631	11,631	11,631	11,631	11,631
CEO	MWh	18,336	20,003	20,003	20,003	20,003	20,003
Dispatch Data Adj_OM_EF of Bulgarian Grid	tCO2/MWh	1.156	1.059	0.947	0.908	0.884	0.833
ABE 2	tCO2	21,196	21,183	18,943	18,163	17,683	16,662
Baseline emissions (ABE 1 + ABE 2) for DHC V. Tarnovo	tCO2e	31,857	32,814	30,574	29,794	29,314	28,293

Table E.4.2: Baseline emissions DHC V.Tarnovo

The total baseline emissions for the two DHCs are shown in the next table E.4.3:

Parameter	Unit	2007	2008	2009	2010	2011	2012
Total baseline emissions for both DHCs	tCO2e	130,793	405,599	376,849	366,838	360,677	347,584

Table E.4.3: Total baseline emissions.

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

DHC Pleven

The emission reductions of the project activities in DHC Pleven are shown in the table E.5.1 bellow:

Parameter	Unit	2007	2008	2009	2010	2011	2012
Baseline emissions Pleven	tCO2e	98,936	372,785	346,275	337,044	331,363	319,291
Project emissions Pleven	tCO2e	44,917	179,667	179,667	179,667	179,667	179,667
Emission reductions Pleven	tCO2e	54,019	193,118	166,608	157,377	151,696	139,624

Table E.5.1: Emission reductions DHC Pleven

DHC Veliko Tarnovo

The emission reductions of the project activities in DHC Veliko Tarnovo are shown in the table E.5.2 bellow:

Parameter	Unit	2007	2008	2009	2010	2011	2012
Baseline emissions V.Tarnovo	tCO2e	31,857	32,814	30,574	29,794	29,314	28,293
Project emissions Veliko Tarnovo	tCO2e	15,921	17,369	17,369	17,369	17,369	17,369
Emission reductions Veliko Tarnovo	tCO2e	15,936	15,445	13,205	12,425	11,945	10,924

Table E.5.2: Emission reductions DHC Veliko Tarnovo

Total emission reductions by the project activity are shown in table E.5.3 bellow:

Parameter	Unit	2007	2008	2009	2010	2011	2012
Emission reductions DHC Pleven	tCO2e	54,019	193,118	166,608	157,377	151,696	139,624
Emission reductions DHC V.Tarnovo	tCO2e	15,936	15,445	13,205	12,425	11,945	10,924
Total reductions both companies	tCO2e	69,955	208,563	179,813	169,802	163,641	150,548

Table E.5.3: Total emission reductions of the project activity.

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

YEAR	Estimated Project Emissions (tones CO2 Equivalent)	Estimated Leakage (tones CO2 Equivalent)	Estimated Baseline Emissions (tones CO2 Equivalent)	Estimated Emissions Reductions (tones CO2 Equivalent)
2007	60,838	0	130,793	69,955
2008	197,036	0	405,599	208,563
2009	197,036	0	376,849	179,813
2010	197,036	0	366,838	169,802
2011	197,036	0	360,677	163,641
2012	197,036	0	347,584	150,548
Total (tones CO2 Equivalent)	1,046,018	0	1,988,340	942,322

Please see the attached standard excel sheets, proposed for post determination:

<Monitoring_models_DHCs_Pleven_VT>

The formulae described in the monitoring plan are used for the makeup of the sheets and can be viewed in the cells.