



# **MONITORING REPORT**

1<sup>st</sup> of January – 30<sup>th</sup> of November 2012

**JI PROJECT**

**CO-GENERATION GAS POWER STATION BIOVET**

**ERU04/33**

**2006-2012**

**Revision 3**

**Peshtera, December 2012**

**Bulgaria**

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### **Abbreviations used**

ABEC	annual baseline electricity consumption in Biovet	MWhe/y
ABHEC	annual heat consumption in Biovet and OLD River	MWht/y
ABNG	annual baseline natural gas energy consumption	TJ/y
AECgr	annual consumption of electricity in Biovet from grid	MWhe/y
AECng	annual natural gas energy consumption by CHP	1000Nm <sup>3</sup> /y
AECHP	annual electricity produced by CHP	MWhe/y
AECHPgr	annual electricity produced by CHP and sold to grid	MWhe/y
BBEC	annual back up boilers natural gas consumption	TJ/y
BEFel	baseline CO <sub>2</sub> emissions factor for electricity from grid	tCO <sub>2</sub> /MWhe
BBH	back up boilers annual heat production	MWht/y
BEI	annual baseline CO <sub>2</sub> emissions from electricity supplied by grid	tCO <sub>2</sub> /y
BEth	baseline CO <sub>2</sub> emissions that would be offset by heat output	tCO <sub>2</sub> /y
BEtotal	total baseline emissions (CO <sub>2</sub> equivalent)	t CO <sub>2</sub> eq/y
CAHO	CHP annual heat output	MWht/y
CEO	annual CHP electricity output	MWhe/y
CGS	Co-Generation Gas Power Station	
CHOR	CHP heat output rate	GJ/y
CHP	combined heat power (co-generation)	
CPO	CHP net power output capacity	MW <sub>e</sub>
EFel gen	emission factor for electricity generation in Bulgaria	tCO <sub>2</sub> /MWhe
EFng	CO <sub>2</sub> emissions factor for natural gas combustion/Bulgarian Inventory 2002/	t CO <sub>2</sub> /TJ
ER	emission reduction from project activities	t CO <sub>2</sub> eq/y
EU	European Union	
e <sub>b</sub>	boiler efficiency, determined as a constant efficiency, according to CDM methodological tool “Tool to determine the baseline efficiency of thermal or electric energy generation systems” (version 01 EB 48, Annex 12, 17 July 2009	%
GE	General Electric	
GHG	green house gases	
HPP	hydro power plant	
HRSG	Heat Recovery Steam Generator	
PE <sub>CHP</sub>	annual project emissions from NG combustion in CHP	t CO <sub>2</sub> eq/y
(-) PE <sub>grid</sub>	annual project emissions avoided from replaced electricity to grid	t CO <sub>2</sub> eq/y
PE <sub>grid</sub>	annual project emissions from electricity coming by grid	t CO <sub>2</sub> eq/y
PE <sub>total</sub>	total project GHG emissions	t CO <sub>2</sub> eq/y
Q <sub>LHV</sub>	low heat value of natural gas	GJ/1000Nm <sup>3</sup>
RES	renewable energy sources	
BCEF	baseline carbon emission factor	

## 1. Introduction

The Monitoring report is prepared in accordance with the JI - Project Design Document and provides the measurements and calculations of the GHG emissions reduction in result of co-generation installation operation during 2012.

### 1.1 Project participants

Company name: **Biovet JSC**  
Position in the project: Owner of the project and Supplier of AAUs and ERUs  
Visiting address: 39, Petar Rakov Str  
Zip code + city: 4550, Peshtera  
Country: Bulgaria  
Contact person: Michev, Ivan  
Job title: Technical Director  
Telephone number: + 359 350 65635444, or + 359 889 302945  
Fax number: + 359 350 65636  
E-mail: [i\\_michev@biovet.com](mailto:i_michev@biovet.com)  
[http:// www.biovet.com](http://www.biovet.com)  
Company's core business: Pharmaceutical industry, Food additives for animal's health

Company name: **GE Packaged Power, Inc.**  
Position in the project: The main equipment supplier  
Visiting address: 2707 North Loop West, Houston  
Zip code + city: 77008, Houston, Texas  
Country: U.S.A.  
Contact person: Mrs. Tatyana Kossekova-Dimitrova  
Job title: Sales & Marketing, Central & Eastern Europe  
Telephone number: +359-2-944-0469  
Fax number: +90-212-216-1652  
E-mail: [Tatyana.Kossekova@ps.ge.com](mailto:Tatyana.Kossekova@ps.ge.com)  
[www.gepower.com](http://www.gepower.com)  
Company's core business: Gas turbines manufacturer

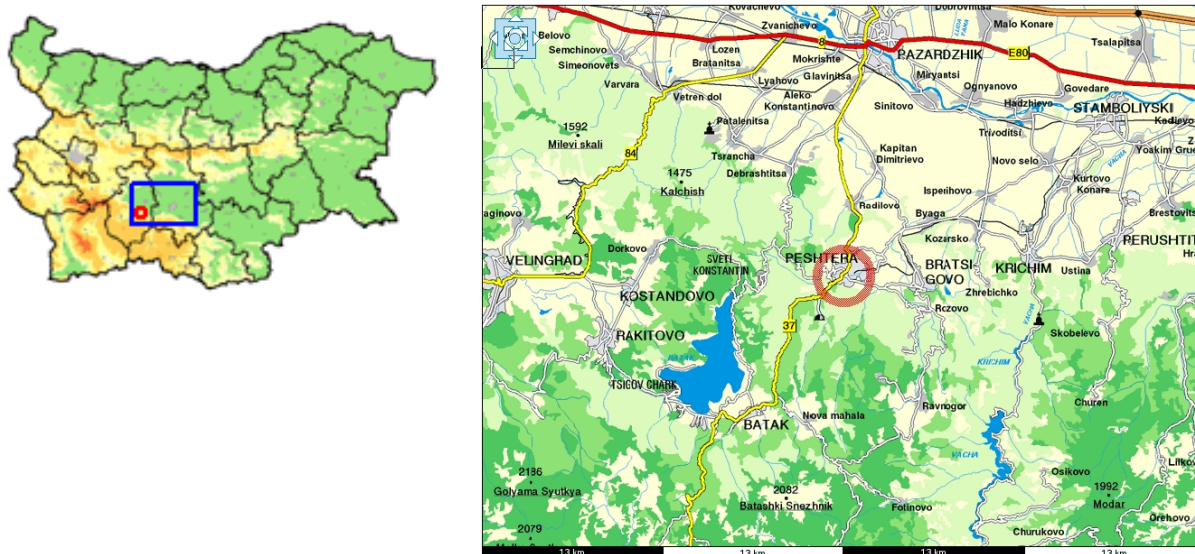
Company name: **CoGen Engineering LTD**  
Position in the project: PDD developer and consulting.  
Visiting address: 14, Stoian Zaimov Str.  
Zip code + city: 1421 Sofia  
Country: Bulgaria  
Contact person: Manev, Stefan  
Job title: Executive Director  
Telephone number: +359 2 9632223 or + 359 888 242728  
Fax number: +359 2 8660402  
E-mail: [cogen@cogeneng-bg.com](mailto:cogen@cogeneng-bg.com)  
[www.cogeneng-bg.com](http://www.cogeneng-bg.com)  
Company's core business: Co-generations and JI projects consulting

## 1.2 Project location

The project is executed in the town of Peshtera around the facilities of the pharmaceutical company Biovet Joint Stock Company.

The town location can be seen on the map below.

Peshtera is a historical town, established during the second half of the 4<sup>th</sup> century AD. Its population amounts to approximately 21 000 inhabitants, from which 56.3% is in the active employment age. It is situated at 450m altitude, at the foot of the West Phodope Mountains. Peshtera is located 20 km from the town of Pazardjik, 40 km from Plovdiv City and 125 km from Sofia City.



## 1.3 Background

Biovet is a leading European manufacturer and marketer of medicated and nutritional feed additives, enzymes, bulk active substances and pharmaceuticals for farm animal productivity and animal health. The company offers intermediates, active ingredients and medicines for the human pharmaceuticals industry. Biovet provides enzymes, enzyme complexes, and other ingredients for the baking, brewing, juice production, alcohol production, wine making, oil extraction, pharmaceuticals, paper, detergents, leather and textiles industries.

Biovet was established in 1961, more than 40 years ago. The first manufacturing plant was designed for the production of just one major animal health antibiotic. Throughout the decades, Biovet has been manufacturing a range of veterinary and human products in response to the changing market demands. Today, the product portfolio includes over 80 products for animal health, human health and enzymes.

Since its founding, the company has grown significantly. The Company increased its workforce and expanded its production facilities several times, established a Research and Development department and built a wastewater treatment plant. Over the recent years, Biovet has made significant investments in plant upgrades, equipment automation, and construction of new production facilities, laboratories and warehouses. At present, the administrative and production complex extends over an area of approximately 150 000 m<sup>2</sup>.

Biovet is the main supplier of reduced emissions and is the main organizer and executor of the project. Biovet provided the financing of the project by means of a credit obtained from Bulbank, Bulgaria.

The motives for the realization of this CHP project are based on the analysis of the situation in the country and the reforms in the energy sector with reference to the accession of our country into the EU.

Biovet is very sensitive to the fluctuations of the electricity prices due to the high relative share of its energy costs in the final product price. The unavoidable reforms in the energy sector are related to a future growth of the electric energy prices and their equalization with the average prices for the EU.

Biovet is supplied with electricity from two independent sources and, notwithstanding the above, incidents have occurred, in which the company has been left without electric power supply for over an hour. This has caused serious production losses due to the eradication of the fermentation bacteria and the discontinuation of the fermentation processes. The improvement of the electric power supply reliability is an important factor for the normal operation of Biovet.

It is a fact, that the decommissioned 3<sup>rd</sup> and 4<sup>th</sup> blocks of the Kozloduy NPS are expected to be substituted mainly by the new or overhauled facilities of the coal-fueled stations of Maritsa Iztok 1 TPS, Maritsa Iztok 2 TPS. Since the coal powered stations are one of the main sources of the greenhouse gases, this will not lead to a reduction of the greenhouse gases emissions (GHG) in the country and, respectively, of the obligations of Bulgaria with reference to the Kyoto Protocol.

With reference to the above, the Government of Bulgaria accepted new Energy Act (published in State Gazette No. 107 dated December 2003). The new Law is built upon the 2002 Energy Strategy of Bulgaria in accordance with the requirements of the European Union Directives on electricity and natural gas<sup>1</sup>. It is structured in a manner consistent with the modern energy laws- clearly identifies the law general purpose. Its general purpose is to create conditions for the establishment of a competitive energy market, lower the costs of energy supplied to the public, to promote the sustainable development of renewable energy sources (RES) and the co-generations for efficiency combined cycle generation of electricity and heat. The Chapter 11 / Articles 157-163/ of the Energy Act especially promotes the electricity produced from RES and high efficiency CHP.

The main promotion is that the public suppliers and distributors of energy are obligated to buy all produced from RES and CHP quantity of energy on preferential and regulated prices to come in force of the green certificates. The law was reformed in September 2006.

Significant document with reference to the reduction of the hazardous air emissions is also the approved in February 2004 Energy Efficiency Act.

The issue with reference to the construction of an own co-generation plant within the facilities of Biovet AD has been under discussion for a number of years. Various alternatives were studied for its construction on. In the end of 2003, the final decision was made for building the Plant on the basis of gas-turbine engines with electric and steam cycles, as technically the most efficient alternative.

The construction of this highly efficient plant for the production of electrical and thermal power should resolve the following issues of Biovet AD:

- High reliability of the electric power supply of the facilities will be guaranteed. In this case, the fact that even a ten-minute power supply disruption leads to high production losses, was taken into consideration;
- As a result of the comparatively low and stable in the time prices of the electricity and steam produced from the CHP, shall ensure the prognostic development of the factory and an improving the compatibility of the company on the international markets.

#### 1.4 Description of the Project activities

A common view of the realized co-generation project is shown on the picture below:



The main equipment of the Co-generation Gas Power Station is:

At the heart of Biovet's cogeneration plant is GE AERO ENERGY's LM2000 aeroderivative gas turbine genset. The LM2000 gas turbine, which is actually a re-rated LM2500 gas turbine, has a rating of 18MW at 36.4% thermal efficiency.

The main technical parameters of the gas turbine genset are shown in the table No.1 below:

Parameters	Dime	Co-gen Set
Gas Turbine Type		LM 2000
Year of production		2005
Producer		GE Packaged Power, Inc., USA
Electrical power	[MWe]	18
Fuel – Natural gas LHV	[kJ/kg]	49548
Fuel consumption	[kg/h]	4000
Exhaust gases temperature	°C	460
Exhaust gases flow	[kg/s]	61.2
NOx control –Steam	[kg/h]	4508 (340°C, 40 barg)
Generator Type		Synchronous
Year of production		2005
Producer		MEIDENSHA, USA
Rated Voltage	[kV]	6.3
Rated Power	[KVA]	21250
Rated current	[A]	2045
Efficiency	[%]	97.9

Table No.1 Genset main technical data

This gas turbine is a single shaft gas turbine with a free power turbine.

The axial compressor is made up of sixteen (16) stages, at a pressure ratio of 16.4:1. A two stage axial turbine drives the sixteen stage axial compressor. Both the compressor and turbine are on one shaft.

The free power turbine is a two-stage design, which is directly coupled to the generator, and is generating electricity at 3,000 RPM (or 50Hz).

The combustion system, chosen for this project, is GE AERO ENERGY's Single Annular Combustor (SAC). This combustor design shares a lot of similarity / commonality with the aircraft engine combustor, except that this combustor is also designed to burn natural gas, as well as liquid fuel (eg: Diesel, Kerosene, etc...).

NOx requirement for Biovet's project is 25vppm at 15% O<sub>2</sub> (or 51mg/Nm<sup>3</sup> at 15% O<sub>2</sub>). To meet the NOx requirement, the SAC combustor requires Steam Injection (SI), to reduce the unabated emissions to the required level. For Biovet's project, SI is used. The SI flow is directly injected into the combustor, and will reduce the unabated NOx emissions to the required 25vppm at 15% O<sub>2</sub>.

The steam for NOx control shall be provided by the Heat Recovery Steam Generator (HRSG). The HRSG is designed to provide the required amount of steam, at the required pressure and temperature, and quality levels, as stated by GE AERO ENERGY.

The main technical parameters of the boiler are shown in the table No.2 below:

Parameters	Dimer	Heat Recovery Steam Generator
Type		HRSG/one pass boiler/
Year of production		2005
Producer		Marcegaglia, Italy
Rated steam production		
Steam high pressure (steam injection)	[t /h]	5
- Temperature	[°C]	340
- Pressure	[barg]	40
Steam low pressure (technological steam)	[t /h]	25.5
- Temperature	[°C]	179
- Pressure	[barg]	9
Inlet water temperature		20
Blowings	[%]	0.7
Inlet exhaust gases pressure	[mmH <sub>2</sub> O]	210
Outlet exhaust gases temperature	[°C]	193

Table No. 2 – Heat Recovery Steam generator main technical data

The Gas turbine module is disposed in separate building for additional noise attenuation. The electrical and control equipment are in separate building around. The switch gears 6 kV and 0.4 kV, the accumulator batteries, transformers own needs etc. are on the first floor, the control room is on the second floor. The high level automation system is a DeltaV, Emerson system.

The water treatment plant for the boiler water is with capacity to 90 m<sup>3</sup>/h. The technology is based of mechanical treatment on the first stage, a reverse osmosis on the second stage and electrodialysis with ion exchange for deep demineralization of the water on the third stage.

Performance figures like this for one “typical” month are used in the design of the cycle and the heat balance analyses for each month of the year. The basic data for each month are shown below.



## 1.5 Implementation of the project

The project implementation is shown in the table No.3 below:

No.	Name of activity	Terms of execution
1	Start of the project	April 2004
2	Project detail design	July 2004- December 2004
3	Construction on site	February 2005- September 2005
4	Equipment delivery	June 2004 – June 2005
5	Equipment installing	May 2005 –September 2005
6	Operation tests	September 2005-October 2005
7	Commissioning	October 2005 – November 2005
8	Start of operation	26.11.2005

Table No.3 – Implementation of the project

## 1.6 Expected capacity

The production capacity of the co-generation station has been selected mainly on the bases of the steam needs of the factory. The expected annual availability was estimated of 8200 hours per year.

## 2. Methodology

The methodology used for the baseline and monitoring setting in the PDD is on the base of “Operational Guidelines for Project Design Documents of Joint Implementation Projects” of the Ministry of Economic Affairs of the Netherlands 2004 – “Operational Guidelines for PDD’s of JI projects-Specific project categories-CHP”.

### 2.1 Flowchart of the situation before the implementation of the project – separate generation of heat and electricity.

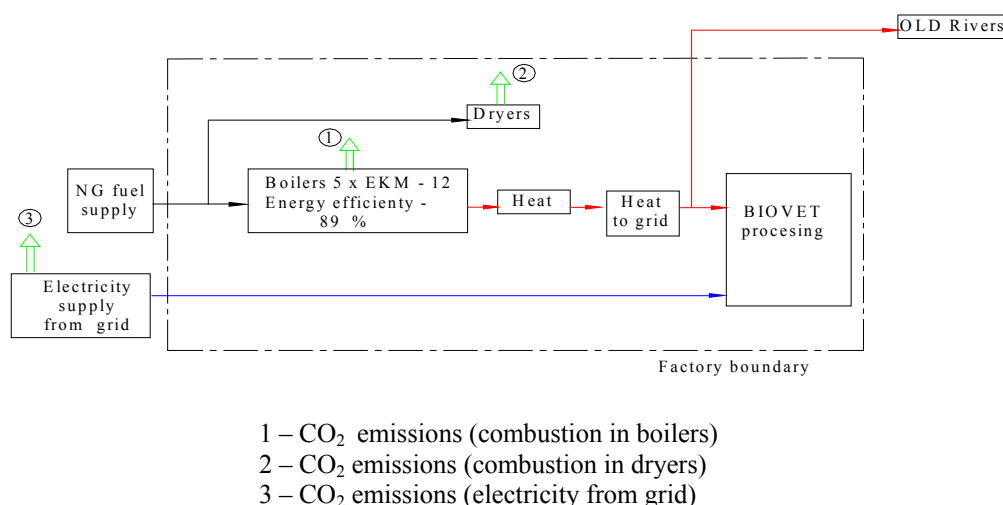
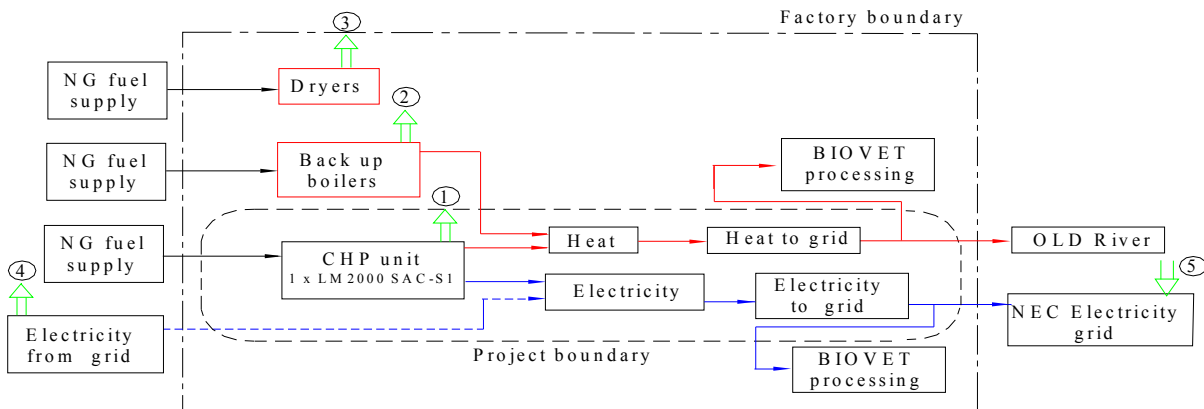


Fig.1- Flowchart of current delivery system with it's the main components and their connections.

## 2.2 Flowchart of the situation after the implementation of the project



1 – Direct on-site CO<sub>2</sub> emissions (comb in CHP)  
 2 – Direct off-site CO<sub>2</sub> emissions (comb in back up boilers)  
 3 – Off-site CO<sub>2</sub> emissions (comb in dryers)  
 4 – Direct off-site CO<sub>2</sub> emissions (electricity from grid)  
 5 – Direct off-site CO<sub>2</sub> avoided emissions (electricity to grid)  
 Fig 2 - Flowchart of the situation after the implementation of the project

## 2.3 Direct and indirect emissions

On-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO <sub>2</sub> emissions from NG combustion in CHP	CO <sub>2</sub> emissions from NG combustion in boilers	Direct	Include
	CO <sub>2</sub> emissions from NG combustion in dryers	Direct	Exclude, do not influence by the project
Off-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO <sub>2</sub> emissions from NG combustion in back - up boilers		Direct	Include
CO <sub>2</sub> emissions from NG combustion in dryers		No influence	Exclude, do not influence by the project
CO <sub>2</sub> emissions from electricity grid	CO <sub>2</sub> emissions from electricity grid	Direct	Include
CO <sub>2</sub> avoided emissions to electricity grid		Direct	Include

Table No. 4 - Direct and indirect emissions

## 2.4 Estimation of the baseline emissions

Annual NG consumption in boilers – ABNG in order to cover the heat demand ABHEC is given by:

$$ABNG = (100 * ABHEC / e_b) * 3.6/1000, \text{ TJ/y}$$

where:  $e_b$  – boiler efficiency, determined as a constant efficiency, according to Table 1 from CDM methodological tool “Tool to determine the baseline efficiency of thermal or electric energy generation systems” (version 01 EB 48, Annex 12, 17 July 2009).  
ABHEC - is total annual heat consumption in Biovet and OLD River equal of the produced heat from CHP and back up boilers.

$e_b = 87 \%$ , Old natural gas boiler (w/o condenser)

$$ABHEC = BBH + CAHO, \text{ MWht/y}$$

here, BBH – back up boilers annual heat production, MWht/y, measured by the steam flow meters (Boiler №1 and Boiler №2) and water inlet flowmeter (Boiler №3) and filled monthly in the tables of the Monitoring model;

CAHO - annual heat energy output from CHP measured from the steam flow meter and filled monthly in the tables of the Monitoring model.

The estimations of annual baseline CO<sub>2</sub> emissions – BE<sub>th</sub> from boilers are given by:

$$BE_{th} = ABNG * EF_{ng}, \text{ t CO}_2/\text{y}$$

where: EF<sub>ng</sub>– emission factor for NG combustion in boilers - t CO<sub>2</sub>/TJ /look in point 2.7 below/.

$$BE_l = ABEC * BEF_{el}, \text{ t CO}_2/\text{y}$$

where: ABEC, MWhe/y– annual baseline electricity consumption in Biovet .

$$ABEC = AEC_{gr} + (AECHP - AECHP_{gr})$$

here, AEC<sub>gr</sub>, MWhe/y – electricity consumed in Biovet by grid.

AECHP, MWhe/y – annual electricity produced from CHP, measured at the outlet of CHP (side 6.3 kV).

AECHP<sub>gr</sub>, MWhe/y – annual electricity produced from CHP and sold to the electrical distribution company, measured at the main power transformers (side 110 kV).

BEF<sub>el</sub> [tCO<sub>2</sub>/MWh] – annual baseline emission factor for electricity from grid /look in point 2.7 below/

Total baseline emissions are:

$$BE_{total} = BE_{th} + BE_l, \text{ t CO}_2/\text{y}$$

### Remark:

The formulas presented above, in principle are the same as in PDD format, but they are considered to the detail monitoring process realization.

## 2.5 Estimation of the project emissions

### Direct on-site CO<sub>2</sub> emission from NG combustion in CHP - PE<sub>CHP</sub>

$$PE_{CHP} = AEC_{ng} * Q_{LHV} * EF_{ng} / 1000, t CO_2/y$$

Where : AEC<sub>ng</sub>, 1000Nm<sup>3</sup>/y - annual NG consumption from CHP, measured by gas flow meter. The measurements monthly are filled in the tables of the Monitoring model.

Q<sub>LHV</sub> – low heat value of NG –GJ/1000 Nm<sup>3</sup>/y. LHVs of NG are extracted by gas quality certificates presented from Bulgargas monthly. Look in Annex No.1 to the Monitoring Report.

EF<sub>ng</sub> – emission factor for NG combustion in boilers - t CO<sub>2</sub>/TJ /look in point 2.7 below/.

### Direct off-site CO<sub>2</sub> emission from NG combustion in back up boilers - PE<sub>bb</sub>

$$PE_{bb} = BBEC * EF_{ng}, t CO_2/y$$

Where: BBEC, TJ/y - annual back up boilers NG energy consumption is calculated:

$$BBEC = (100 * BBH / e_b) * 3.6 / 1000, TJ/y;$$

here, BBH – back up boilers annual heat production, MWh/y;

e<sub>b</sub> – boiler efficiency, determined as a constant,

e<sub>b</sub> = 87 %, Old natural gas boiler (w/o condenser)

EF<sub>ng</sub>– emission factor for NG combustion in boilers - t CO<sub>2</sub>/TJ /look in point 2.7 below.

### Direct off-site CO<sub>2</sub> emission from additional electricity from grid - PE<sub>grid</sub>

CO<sub>2</sub> emissions caused by additional electricity from grid, in order to cover the electricity consumption of Biovet.

$$PE_{grid} = AEC_{gr} * BEF_{el}, t CO_2/y$$

Where: AEC<sub>gr</sub>, MWh/y - electricity coming from grid to cover the needs of Biovet.

BEF<sub>el</sub> – emission factor for electricity from grid, /look in point 2.7 below/.

### Direct off-site avoided CO<sub>2</sub> emission - replaced electricity to grid – PE<sub>rgrid</sub>

$$(-) PE_{rgrid} = AECHP_{gr} * EF_{el,gen}$$

Where: AECHP<sub>gr</sub>, MWh/y – annual electricity produced from CHP and sold to the electrical distribution company,;

EF<sub>el,gen</sub>, tCO<sub>2</sub>/MWh - is emission factor for generated electricity /look in point 2.7 below/.

### Total CO<sub>2</sub> emissions from the project implementation are:

$$PE_{total} = PE_{CHP} + PE_{bb} + PE_{grid} + (-) PE_{rgrid}, t CO_2/y$$

## 2.6 Estimation of CO<sub>2</sub> emission reductions

The difference between total baseline emissions and total project emissions represent the emission reduction from the project activity:

$$ER = BE_{total} - PE_{total}, t CO_2 - eq/y$$

Remark: The leakages of emissions from the producing and transportation of the Natural gas are neglected because of its insignificant.

## 2.7 Baseline and project emission factors estimation

The emissions reduction in the Monitoring Report are calculated with the using of Bulgarian emission factors:

### 2.7.1 Baseline and project emission factors for electricity

*EF<sub>el,gen</sub>* emission factor is used for calculation of the emission reduction from CHP generated and sold to the grid (NEC) electricity and *BEF<sub>el</sub>* emission factor for electricity consummated from grid in Biovet.

The calculations of the emissions reduction for 2012 shown in point 4 below is prepared with emission factors for generated electricity in Bulgaria (*EF<sub>el,gen</sub>*) evaluated in accordance with really operation of the electrical system of Bulgaria. The emission factors are developed on the base of “Consolidated Baseline Metodology for Grid Connected Electricity Generation from Renewable Sources” of UNFCCC CDM Executive Board – ACM 0002. In order that the study can be as complete as possible and applied to the widest possible range of JP 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. It is choosen the most conservative approach – Maximum demand – HPP Included – Dispatch Data Adjusted\_OM\_EF. The values of the emission factors /forecast/ are shown in the table below. The table can be seen in Annex No.4 to the Monitoring report (ref.: [http://www3.moew.government.bg/files/file/Climate/Climate\\_Change\\_Policy\\_Directorate/IETM/Joint\\_Implementation/JI\\_documents/Baseline\\_CEF\\_Summary.pdf](http://www3.moew.government.bg/files/file/Climate/Climate_Change_Policy_Directorate/IETM/Joint_Implementation/JI_documents/Baseline_CEF_Summary.pdf)).

	Year	2005	2006	2007	2008	2009	2010	2011	2012
<i>EF<sub>el,gen</sub></i>	[tCO <sub>2</sub> /MWh]	1.105	1.091	1.095	1.006	0.888	0.850	0.834	0.791
<i>BEF<sub>el</sub></i>	[tCO <sub>2</sub> /MWh]	1.224	1.204	1.206	1.108	0.978	0.934	0.912	0.865

Table No5 – Bulgarian baseline emission factors for electricity

The emission factor for the electricity from grid *BEF<sub>el</sub>* is calculated on the base *EF<sub>el,gen</sub>* increased with the average percent of losses in the grid /Source-NSI Bulgaria Statistical Journals - National Material Balance - Electro energy table – (transportation and distribution losses)\* 100 / (consumption-total)/.

The values are:

	2005	2006	2007	2008	2009	2010
Average percent of losses, %	10,8	10,4	10,12	9,7	9,89	9,37

The tables are attached in Annex No. 5 to the Monitoring report.

## 2.7.2 Baseline and project emission factor for Natural gas

The calculations of the emissions reduction for 2012 shown in point 4 below are prepared with emission factor  $EF_{ng} = 55,2413 \text{ t CO}_2/\text{TJ}$ . The value is from Table 38 **Country-specific emission factors for CO<sub>2</sub> for gaseous fuels** of Inventory 2012 Bulgaria “List of emission factors – Table Energy Industries”. The list of EF is attached in Annex No. 4 to the Monitoring report (ref.: <http://eea.government.bg/bg/output/unfccc/NIR-12-eng.pdf>.)

## 3. Monitoring

This project comprises the installation of a natural gas-fired cogeneration system at an industrial plant, where electricity and heat are provided separately, prior to project implementation. The Monitoring is based on recording natural gas used by the cogeneration plant, and electricity and heat supplied by cogeneration plant to the factory, as well as heat production from back up boilers and exchanged electricity with the power grid.

### 3.1 Data monitored

Considering the project boundary, the following data need to be monitored in order to estimate project and baseline emissions, and emissions reductions:

- Natural gas used by the cogeneration plant,  $\text{Nm}^3$ .
- Net electricity produced by cogeneration plant,  $\text{MWhe}$
- Exchanged electricity with the power grid,  $\text{MWhe}$
- Net heat supplied by cogeneration plant to factory,  $\text{MWht}$
- Heat supplied by back up boilers,  $\text{MWht}$
- Heat efficiency of back boilers station providing heat to the factory, %

Data are collected on a monthly basis for the duration of the project lifetime and crediting period (7 years).  $\text{CO}_2$  emissions following project implementation are determined from the parameters monitored, as described above.

The monitoring plan describes the procedures for data collection, and auditing required for the project, in order to determine and verify emissions reductions achieved by the project. Biovet JSC is certificated by ISO 9001 and all procedures above and all procedures for quality control (QC) and quality assurance (QA) are described inside.

No	Data type	Data variable	Data unit	Measure (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data archived? (electronic/paper)	For How long is archived data to be kept?
1	Volume of natural gas consumed from CHP;	$V_{NG}$	$\text{Nm}^3$	m	Mont	100%	Paper (field record) Electronics (spreadsheet)	Paper 1 years Electronics 7 years
2	Co-generation electricity production	$E_{CHP}$	$\text{MWhe}$	m	Mont	100%	Paper (field record) Electronics (spreadsheet)	Electronics 7 years

3	CHP steam generation to industrial plant	$G_{\text{STEAM}}$ $Q_{\text{steam}}$	Tons MWht	m	Mont	100%	Paper (field record) Electronics (spreadsheet)	Paper 1 years Electronics 7 years
4	Efficiency of existed boilers	$e_b$	-	c	Year	100%	Paper (field record) Electronics (spreadsheet)	Paper 1 years Electronics 7 years
5	Low heating value of NG	LHV	Kcal/N $m^3$	m	Month	100%	Paper (Protocols Bulgargas)	Paper 1 years
6.	Back up boilers steam generated	$G_{\text{STEAM}}$ $Q_{\text{steam}}$	Tons MWht	m	Month	100%	Paper (field record) Electronics (spreadsheet)	Paper 1 years Electronics 7 years
7.1	Electricity imported from the grid	Econs	MWhe	m	Month	100%	Paper (field record) Electronics (spreadsheet)	Paper 1 years Electronics 7 years
7.2	Electricity exported to the grid	Eg	MWhe	m	Month	100%	Paper (field record) Electronics (spreadsheet)	Paper 1 years Electronics 7 years

Table No.6 - Data collecting in order to monitor the project and baseline emissions

### 3.2 Measurement scheme and measurement devices

The measurement scheme realized (measurement devices and the measurement points) for the data collecting in order to monitor the project emission, baseline emissions and estimation of the emissions reduction are given on Fig. No. 3 below in outline.

Shortly descriptions of the used measurement devices in accordance with Table No. 6 and Fig. No. 3 positions are shown in Table No. 7 below.

Position No. (acc. Table No.6 and Fig. No3)	Quantity measured and device installing place	Technical parameters	Dimensions	Technical parameters values	Period of calibration	Calibration and Conformity certificates	Remark
1	2	3	4	5	6	7	8
1	<b>Gas flow meter – Co generation gas consumption</b>						
1.1	Volume ( $V_{\text{NG}}$ ) of natural gas	Model		FLIXI/TZ G250	Every two years /Ordinance No.A-412 16.08.2004	Official Calibr. Cert. M16019/ 16.12.2009	

1	2	3	4	5	6	7	8
		Type		Turbine meter		Calibr.Cert. CT1459/11 15.11.2011	
		Producer/ Year		Actaris /2009			
		Serial Number		3400245383			
		Flow range	[m³/h]	20 ÷ 400			
		Pressure max	[bar]	40			
		Accuracy ( 0.2 Q <sub>max</sub> ÷ Q <sub>max</sub> )	[%]	± 1.0			
1.2	Electronic correction device	Model		Explorer FT		Calibr. Cert. NV 07 / 24.02. 2011 NV 10 / 10.02. 2012	
		Producer/ Year		Pietro Fiorentini / 2005			
		Serial Number		05N0905			
		Range - temperature	[°C]	- 20 ÷ + 50			
		Range - pressure	[bar]	7 ÷ 35			
		Accuracy ( permissible deviation)			Every two years /Ordinance No.A-412 16.08.2004		
		- for temperature	[°C]	± 0.15			
		- for pressure	[%]	± 0.10			
2	<b>Electro meter – Co generation electricity production</b>						
2.1	Current transformers – three pieces	Model		ARJA1N2		Test Protocols of Merlin Gerin from 04.04.2005	
		Producer/ Year		Merlin Gerin/2005			
		Serial Number		0518191, 0518192, 0518193,	NOTE 1		
		Range- I side/II side	[A]	2500/5			
		Voltage side	[kV]	6.3			
		Accuracy class		0.5			
2.2	Voltage transformers – three pieces	Model		VRQ3NS2		Test Protocols of Merlin Gerin from 15.04.2005	
		Producer/ Year		Merlin Gerin/2005			
		Serial Number		0519369, 0519370, 0519371,	NOTE 1		
		Range- I side/II side	[V]	6300/100			
		Voltage (max)	[kV]	7.2			
		Accuracy class		0.5			
2.3	Electrical two way meter	Model		AINRTL 3 phases, 3 tariffs		Test Protocol №106 /20.11.2009 Test Protocol №98 /24.11.2011	
		Energy		Active + Reactive			
		Producer/ Year		ABB			
		Serial Number		02210367			
		Range U <sub>R</sub> / I <sub>R</sub>	[V/A]	3x58..277/100..480V 3 x 1 (10) A	Every two years /Ordinance No.A-412 16.08.2004		
		Constant		30000			
		Voltage side	[kV]	6			
		Accuracy class		0.2S			
		Permissible deviation	[%]	0.2			
		Last check					
3	<b>Steam flow meter – Co generation generated steam ( Biovet technological needs )</b>						
3.1.1	Transmitter for pressure measurement	Model		3051TG3A2B21 BB4S5Q4		Cal.Certific. No.NV 05/23.02.2011 No.NV 07/09.02.2012	
		Producer/year		Rosemount/2005			
		Serial No.		7984427			
		Range	[bar]	-1 ÷ 55.2	Every two years /Ordinance No.A-412 16.08.2004		
		Lower range value	[bar]	0			
		Calibration value	[bar]	20			
		Output	[mA]	4 ÷ 20 linear			
		Permissible deviation	[%]	0.1 from scale			



1	2	3	4	5	6	7	8
3.1.2	Input current loop for pressure measurement	Serial No.		L044604994	Every two years /Ordinance No.A-412 16.08.2004	Calibr. Cert. No.NV 12/26.08.2011 No.NV 13/01.08.2012	
		Producer/year		Rosemount/2005			
		Range	[mA]	4 ÷ 20 linear			
		Permissible deviation	[%]	0.1 from scale			
		Calibration values	[mA]	4, 12, 20			
3.2.1	Transmitter for temperature measurement	Model		644HAI1XAQ4	Every two years /Ordinance No.A-412 16.08.2004	Calibr. Cert. No.NV 04 /23.02.2011 No.NV 09/10.02.2012	
		Sensor type		PT100_385 4 wire			
		Producer/year		Rosemount/2005			
		Serial No.		1957228			
		Range	[°C]	0 ÷ 200			
		Lower range value	[°C]	0			
		Calibration values	[°C]	0, 50, 100			
		Output	[mA]	4 ÷ 20 linear			
		Permissible deviation	[%]	0.2 from scale			
3.2.2	Input current loop for temperature measurement	Serial No.		L044604982	Every two years /Ordinance No.A-412 16.08.2004	Calibr. Cert. No.NV 11 /26.08.2011 No.NV 15 /01.08.2012	
		Producer/year		Rosemount/2005			
		Range	[mA]	4 ÷ 20 linear			
		Permissible deviation	[%]	0.1 from scale			
		Calibration values	[mA]	4, 12, 20			
3.3.1	Flow element (Diaphragm)	Element type		Orifice plate Stand.	Every two years /Ordinance No.A-412 16.08.2004	1. Steam flow compens. calc. 2. Conform. declaration – 04/02/2005 3. Inspection report - 78204 – TVD-1 /04.02.2005	
		Pressure type -Upstream	[barg]	9			
		Serial No.		C-782/04 /			
		Element bore	[mm]	186,628			
		Thickness	[mm]	6			
		Flow rate	[kg/h]	45000			
		Difference pressure	[mm H2O]	3924.231			
		Pressure loss	[mm H2O]	2403.280			
3.3.2	Differential pressure transmitter for steam flow measurement	Temperature	[°C]	183	Every two years /Ordinance No.A-412 16.08.2004	Calibr. Cert. No.NV 06 /23.02.2011 No.NV 08 /09.02.2012	
		Model		3051CD3A02A1 BS5Q4			
		Producer/year		Rosemount/2005			
		Serial No.		7984424			
		Range	[mm H2O]	0 ÷ 5000			
		Lower range value	[mm H2O]	0			
		Calibration values	[mm H2O]	0, 2500, 5000			
		Output	[mA]	4 ÷ 20 linear			
3.3.3	Input current loop for differential pressure measurement	Permissible deviation	[%]	0.2 from scale	Every two years /Ordinance No.A-412 16.08.2004	Calibr. Cert. No.NV 13 /26.08.2011 No.NV 14 /01.08.2012	
		Serial No.		L044604994			
		Producer/year		Rosemount/2005			
		Range	[mA]	4 ÷ 20 linear			
		Calibration values	[mA]	4, 12, 20			
3.4	Flow computer steam measurements integrator - electronic device to the co-generation control system	Module tag		B-FI-002		1. Module structure	The measurement device is integrated part from the central control system of the co-generation plant
		Path		Boiler/ B-FI-002			
		Execution period	[s]	1			
		History recorders	number	6			
		Value recorded		A11/OUT.CV LP_ST_TOTAL_MONT.CV LP_STEAM_MASS_FL.CV LP_STEAM_TOTAL.CV STEAM_TOT_RESET.CV STEAM_TOTM_RESET.CV			
		Deviation		0.01			

1	2	3	4	5	6	7	8
6	<b>Steam flow meter – Steam Power Station generated steam (to Biovet and Old River)</b>						
6.1	Annubar Flowmeter – two positions after Boiler No.1 and after Boiler No.2	Serial No. - Boiler No. 1 - Boiler No. 2 Type: - Primary element - Annubar - Meter tube sizing /diam./ Producer/year Sensor size Range - pressure - temperature - minimum flow - normal flow - maximum flow Calculated data: -Diff. press. /norm. flow/ -Structural limit flow -Resonant frequency -Flow coefficient -Permanent press. Loss -Velocity at max. flow	           [mm]           [barg] [°C] [Ton(M)/h] [Ton(M)/h] [Ton(M)/h] [mbar] [Ton(M)/h] [Hz] [mbar] [m/s]	3095MFAS060C CHPS1T100T32 BA1BQ4 OB-FT-001 OB-FT-002 485 Annubar 3095MFA 154 at 20°C Rosemount/2005 T1 direct mounting 15 200 4.0 10.0 12.0 70.720 41.120039 629.20 0.5784 8.759 38.201		1. Annubar Calculation Data Sheet/ 10.03.2005 2. Primary Element Report /14.03.2005	
6.2	Annubar differential pressure transmitter for steam flow measurement- two positions after Boiler No.1 and after Boiler No.2	Model Producer/year Serial No. - Boiler No. 1 - Boiler No. 2 Range: - Diff. pressure sensor - Steam pressure sensor - Temperature sensor Operating conditions: - Pressure - Temperature Output System mass flow accuracy Repeatability	           [mbar] [bar] [°C] [kPa] [°C] [mA] [%] [%]	3095MV Rosemount/2005 SN8008296WO1 209187 OB-FT-001 SN8008297WO1 209187 OB-FT-002 - 622 ÷ + 622 0.0 ÷ 55 -183 ÷ +821 260 ÷ 1300 140 ÷ 196 4 ÷ 20 linear 1 of mass flow rate 0.1	Every two years /Ordinance No.A-412 16.08.2004	Calibr. Cert. No.NV 14 /06.10.2011 No.NV 16 /31.10.2012 No.NV 15 /06.10.2011 No.NV 17 /31.10.2012	
6.3	Flow computer steam measurements integrators for Boiler No.1 and for Boiler No.2	Model Producer/year Serial No. - Boiler No. 1 - Boiler No. 2 Analog Inputs : - voltage - current Digit Outputs Analog Outputs re-transmitters - voltage - current Calibration values Permissible deviation	           [V] [mA]           [V] [mA] [mA] [LSB]	MS8202AI/Kb Microsyst /2006 SN-35528 SN-35603 0 ÷ 5(10) 0(4) ÷ 20 Relays K1÷K3 0 ÷ 5(10) 0(4) ÷ 20 4, 8, 12, 16, 20 ± 1	Every two years /Ordinance No.A-412 16.08.2004	Calibr. Cert. No.NV 19 /02.11.2010 No.NV 18 /08.11.2011 No.NV 20 /03.11.2010 No.NV 19 /09.11.2011	

1	2	3	4	5	6	7	8
6.4	Electromagnetic flowmeter for water measurement for Boiler No.3	Model		OPTIFLUX 2000	Every two years /Ordinance No.A-412 16.08.2004	Calibr. Cert. DIN 55 350-18-4.2.2/07.03.2012	
		Producer/year		Krohne/2012			
		Serial No.		A12001913			
		Size	[mm]	DN50			
		Uncertainty	[%]	0.02			
6.5	Signal converter for electromagnetic flowmeter for Boiler No.3	Model		IFC 100			
		Producer/year		Krohne/2012			
		Serial No.		10613639			
		Range	[m³/h]	0 ÷ 15			
7	Electro meters – Electricity exchange with the national electricity grid ( to Biovet and Co-gener. to grid)						
7.1	Current transformers – 2 x 3 pieces at transformers 110/6.3 kV – el. leading line- “Dipel” and “Isperihovo”	Model		TMO-126	NOTE 1		NEC is owner of the transformers
		Producer/ Year		Bulgarian/1982			
		Range- I side/II side	[A]	200/5			
		Voltage side	[kV]	110			
		Accuracy class		0.5			
		Rated power	[VA]	30			
		Last check		07.2005/11.2005			
7.2	Voltage transformers – 2 x 3 pieces at transformers 110/6.3 kV – el. leading line- “Dipel” and “Isperihovo”	Model		HMO-126	NOTE 1		NEC is owner of the transformers
		Producer/ Year		Bulgarian/1981			
		Range- I side/II side	[V]	110000/100			
		Voltage	[kV]	110			
		Accuracy class		0.5			
		Last check		07.2005/11.2005			
7.3	Electrical two way meters- 2 pieces at transformers 110/6.3 kV – el. leading line- “Dipel” –Trans form. No.1 and “Isperihovo”- Transf. No..2	Model		ANTRAL-X 3 phases, 3 tariffs	Every two years /Ordinance No.A-412 16.08.2004	Term of calibration validity September 2007 – Letter 134/26.02.2007 of Reg. Dep. of Bulgarian Metrology Institute Calibration proofs. Next test 12.2013	NEC is owner of the electrical meters
		Energy		Active + Reactive			
		Channels		4x3 tariffs independent 1- in active 2-in reactive 3- out active 4- out reactive			
		Producer/ Year		ABB Power T/1999			
		Serial Number		G002364808-Tr.1 G002365120-Tr.2			
		Range U <sub>R</sub> / I <sub>R</sub>	[V/A]	3x58..277/100..480V 3 x 1 (10) A			
		Constant		44000			
		Voltage side	[kV]	110			
		Accuracy class		0.2 S			
		Permissible deviation	[%]	0.2			
		Last check		08.2007			

**NOTE 1:** § 15 of the Government Decree No. 126 from 2<sup>nd</sup> of June 2007 regarding changes and amendments in the Regulation for measurement devices which are subjected to metrological control revokes the requirement for subsequent testing of current and voltage transformers.

Short technical description, test and calibration protocols for the measurement devices are shown in Annex No. 3 to the Monitoring Report.

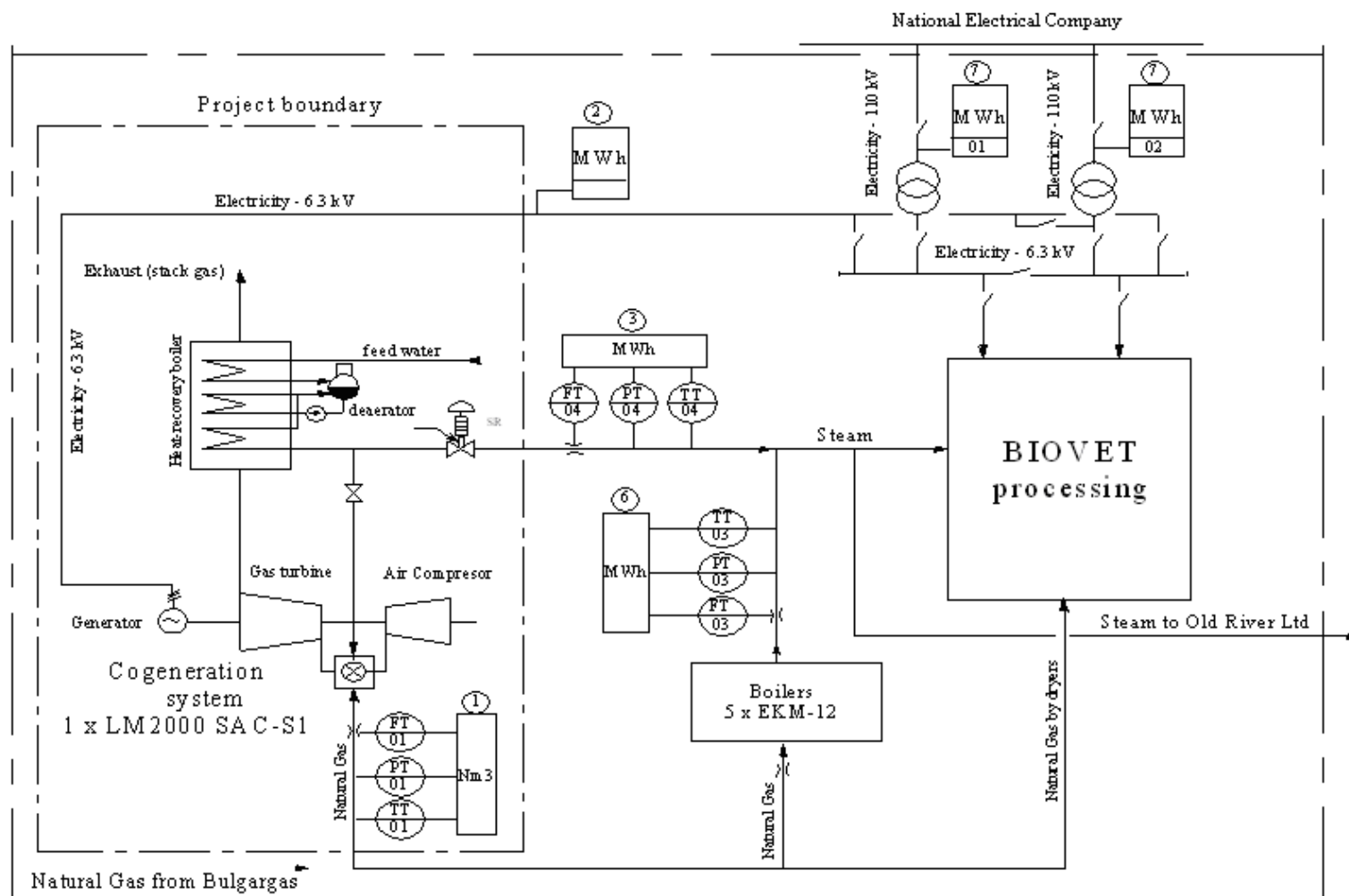


Fig. No. 3 Biovet project measurement scheme

#### 4. Measurement data 2012 collection

The measurement data are collected from the measurement devices outlined above in accordance with the Monitoring plan, monthly for the period from January to the end of November 2012. The data are filled in the tables of the Monitoring model in Excel format and are the base for automatically calculations of the baseline, project line emissions and the emissions reduction.

The data collected are shown in the input tables below:

2012				
Net Heat production from CHP				
Month	Specific Enthalpy	Heat production		
	KJ/kg	t	MJ	MWht
Jan	2777.8	20,230	56,194,894	15,610
Feb	2777.8	20,861	57,947,686	16,097
Mar	2777.8	24,708	68,633,882	19,065
Apr	2777.8	21,613	60,036,591	16,677
May	2777.8	23,085	64,125,513	17,813
Jun	2777.8	21,159	58,775,470	16,327
Jul	2777.8	20,595	57,208,791	15,891
Aug	2777.8	22,976	63,822,733	17,729
Sep	2777.8	22,374	62,150,497	17,264
Oct	2777.8	22,993	63,869,955	17,742
Nov	2777.8	22,516	62,544,945	17,374
Dec	2777.8		0	0
Total [MWht]		243,110	675,310,958	187,586

Specific Enthalpy at 9bar gage pressure = 2777.8KJ/kg

Heat production from back up boilers				
Month	Specific Enthalpy	Heat production		
	KJ/kg	t	MJ	MWht
Jan	2773.72	784	2,174,596	604
Feb	2773.72	1,327	3,680,726	1,022
Mar	2773.72	139	385,547	107
Apr	2773.72	860	2,385,399	663
May	2773.72	153	424,379	118
Jun	2773.72	391	1,084,525	301
Jul	2773.72	633	1,755,765	488
Aug	2773.72	87	241,314	67
Sep	2773.72	234	649,050	180
Oct	2773.72	316	876,496	243
Nov	2773.72	157	435,474	121
Dec	2773.72		0	0
Total [MWht]		5,081	14,093,271	3,915

Specific Enthalpy at 8bar gage pressure = 2773.72KJ/kg

Those tables above are with raw data from Monthly reports.

Heat produced from CHP and back up boilers is equal:

$$H = m * h / 3600,$$

where  
H – heat (MWht)  
m – mass (t)  
h – specific enthalpy (KJ/kg)

Values of Specific Enthalpy is from steam tables in SpiraxSarco company internet site (ref.: <http://www.spiraxsarco.com/resources/steam-tables/saturated-steam.asp>)

**Natural gas for CHP x1000 Nm3**

Month	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan			1,773	4,264	4,426	1,866	4,233	4,278	4,059
Feb			1,438	4,012	3,435	3,436	3,960	1,010	3,692
Mar			1,929	4,465	3,507	3,554	4,484		4,331
Apr			2,330	2,963	3,263	3,134	3,802		3,726
May			1,511	3,759	3,590	3,222	3,978	3,181	3,900
Jun			3,456	3,569	2,929	3,350	3,737	1,166	3,549
Jul			3,499	3,877	3,949	3,464	3,688		3,547
Aug			3,081	3,639	3,891	3,378	3,753		3,907
Sep			0	4,011	4,166	4,341	3,238		3,882
Oct			2,841	4,097	3,683	4,324	4,210		3,997
Nov			3,683	4,299	3,899	4,131	4,078		4,005
Dec		541	3,745	4,488	4,014	4,485	4,280	875	
<b>Total (1000 Nm3)</b>	<b>0</b>	<b>541</b>	<b>29,284</b>	<b>47,441</b>	<b>44,751</b>	<b>42,685</b>	<b>47,441</b>	<b>10,509</b>	<b>42,596</b>

**Generated electricity from CHP :[MWhe]**

Month	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan			5,258	14,065	14,021	6,175	13,970	13,932	13,204
Feb			4,363	13,368	10,608	11,181	12,945	3,489	11,679
Mar			5,314	14,660	10,811	11,430	15,013		14,465
Apr			6,755	9,925	10,000	10,230	13,039		12,419
May			4,585	12,334	10,971	10,782	13,549	10,588	12,929
Jun			11,092	11,590	8,901	11,125	12,649	4,043	11,681
Jul			11,170	12,487	12,239	11,672	12,335		11,653
Aug			10,067	11,931	12,263	11,052	12,581		12,963
Sep			0	13,054	13,205	14,633	10,853		13,052
Oct			9,152	13,379	11,830	14,384	14,450		13,471
Nov			11,847	14,093	13,393	13,505	13,871		13,427
Dec		1,255	11,988	14,676	13,458	14,885	13,682	2,564	
<b>Total (MWh)</b>	<b>0</b>	<b>1,255</b>	<b>91,592</b>	<b>155,562</b>	<b>141,698</b>	<b>141,055</b>	<b>158,937</b>	<b>34,615</b>	<b>140,943</b>

**Exchange electricity from power grid (consumed from NEC,all); [MWhe]**

Month	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan	8,598	8,631	5,573	8,432	9,429	6,959	8,950	10,049	9,290
Feb	8,201	7,881	4,167	8,355	8,475	6,061	7,929	8,983	9,771
Mar	8,305	8,586	4,101	9,386	8,924	6,472	9,249	9,454	10,570
Apr	7,866	8,521	4,096	8,754	8,525	6,916	9,177	9,509	9,879
May	8,335	9,004	6,624	9,273	8,564	7,623	10,237	9,377	10,216
Jun	8,294	8,800	6,340	8,947	7,937	7,728	9,864	8,671	9,493
Jul	8,890	8,552	6,635	8,571	7,077	7,902	10,416	9,867	10,105
Aug	8,319	8,741	7,833	9,143	6,446	7,054	10,149	9,806	10,164
Sep	7,806	8,408	7,998	8,823	6,000	7,875	9,607	9,107	9,945
Oct	8,829	8,675	8,829	8,862	5,680	8,656	9,957	10,056	9,897
Nov	8,880	8,187	7,656	8,894	6,205	9,193	10,105	9,231	9,757
Dec	8,786	7,822	8,680	9,191	6,663	9,611	10,191	10,349	
<b>Total (MWh)</b>	<b>101,109</b>	<b>101,810</b>	<b>78,532</b>	<b>106,631</b>	<b>89,924</b>	<b>92,049</b>	<b>115,830</b>	<b>114,458</b>	<b>109,086</b>

Exchange electricity to power grid (Sold to NEC) ;[MWh]

Month	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan			1,994	13,811	13,721	6,045	13,642	13,617	12,864
Feb			2,708	13,121	10,382	10,943	12,633	3,405	11,515
Mar			3,212	14,394	10,685	11,210	14,647		14,079
Apr			4,073	9,789	9,686	10,029	12,716		12,110
May			3,657	12,114	10,746	10,555	13,262	10,172	12,587
Jun			10,812	11,382	8,728	10,845	12,344	3,941	11,416
Jul			10,971	11,597	11,923	11,491	12,050		11,374
Aug			9,985	11,564	11,989	10,628	12,197		12,635
Sep			0	12,815	12,880	14,255	10,579		12,723
Oct			8,824	13,127	11,574	14,027	14,090		13,131
Nov			10,839	13,879	13,076	13,216	13,568		13,108
Dec		548	11,771	14,355	13,153	14,527	13,328	2,503	
<b>Total (MWh)</b>	<b>0</b>	<b>548</b>	<b>78,846</b>	<b>151,947</b>	<b>138,544</b>	<b>137,771</b>	<b>155,056</b>	<b>33,638</b>	<b>137,543</b>

Net Energy content from CHP - to Biovet; [MWh]

Mont	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan			7,732	10,465	17,396	8,376	17,542	17,822	15,610
Feb			5,517	10,606	14,941	15,116	15,842	4,499	16,097
Mar			5,300	10,796	15,207	14,536	18,431		19,065
Apr			4,794	5,890	12,266	12,138	16,816		16,677
May			2,618	7,346	15,488	12,572	17,862	14,411	17,813
Jun			5,063	7,487	12,205	14,245	17,163	4,621	16,327
Jul			5,598	12,656	16,566	12,975	17,041		15,891
Aug			4,514	12,089	15,394	8,646	17,644		17,729
Sep				13,212	16,465	16,378	14,509		17,264
Oct			4,450	13,516	15,536	15,271	19,083		17,742
Nov			8,746	13,958	17,489	14,770	18,473		17,374
Dec		1,479	8,378	14,421	17,998	18,073	14,620	2,721	
<b>Total [MWh]</b>	<b>0</b>	<b>1,479</b>	<b>62,711</b>	<b>132,441</b>	<b>186,951</b>	<b>163,098</b>	<b>205,025</b>	<b>44,074</b>	<b>187,586</b>

Energy content from back up boilers; [MWh]

Mont	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan	16,849	15,412	6,524	767	1,233	5,426	448	307	604
Feb	15,340	14,887	5,223	283	858	44	126	6,773	1,022
Mar	15,040	14,453	2,689	228	455	105	123	11,276	107
Apr	12,508	12,294	1,896	2,960	772	313	794	9,498	663
May	12,071	12,038	4,313	1,484	180	99	292	1,920	118
Jun	10,970	10,822	493	1,707	1,548	96	122	5,514	301
Jul	11,239	9,312	663	715	394	776	222	8,015	488
Aug	11,101	10,566	2,184	1,640	573	291	149	8,753	67
Sep	10,776	10,170	7,493	540	142	109	1,099	7,896	180
Oct	12,667	10,384	2,432	907	516	415	312	9,659	243
Nov	13,378	10,874	1,365	333	166	617	119	10,407	121
Dec	15,293	11,145	2,975	261	312	267	149	8,877	
<b>Total [MWh]</b>	<b>157,231</b>	<b>142,357</b>	<b>38,248</b>	<b>11,824</b>	<b>7,148</b>	<b>8,556</b>	<b>3,956</b>	<b>88,894</b>	<b>3,915</b>

**Efficiency of back up boilers (month mean value); [%]**

Mont	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan	88	88	71	88	91	87	87	87	87
Feb	88	88	80	88	88	87	87	87	87
Mar	88	88	89	88	88	87	87	87	87
Apr	88	88	88	88	88	87	87	87	87
May	88	88	82	89	88	87	87	87	87
Jun	88	88	88	88	88	87	87	87	87
Jul	88	88	88	88	88	87	87	87	87
Aug	88	88	88	88	88	87	87	87	87
Sep	88	88	88	88	88	87	87	87	87
Oct	88	88	88	88	88	87	87	87	87
Nov	88	88	88	88	88	87	87	87	87
Dec	88	88	88	88	88	87	87	87	87
Average ;%	88	88	86	88	88	87	87	87	87

**NG mean value from BULGARGAS**

**LHV<sub>NG</sub> Lower heating value kkal/Nm<sup>3</sup> -**

Mont	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan			8,010	8,015	8,020	8,050	8,042	8,024	8,042
Feb			8,008	8,013	8,013	8,049	8,048	8,010	8,043
Mar			8,010	8,012	8,021	8,064	8,051	7,978	8,028
Apr			8,010	8,014	8,021	8,083	8,090	8,014	8,044
May			8,013	8,022	8,019	8,090	8,065	8,027	8,059
Jun			8,018	8,021	8,019	8,089	8,095	8,012	8,074
Jul			8,017	8,052	8,021	8,083	8,089	8,033	8,050
Aug			8,011	8,028	8,044	8,071	8,096	8,047	8,039
Sep			8,004	8,019	8,031	8,077	8,084	8,022	8,043
Oct			8,009	8,018	8,031	8,049	8,059	8,032	8,052
Nov			8,012	8,013	8,035	8,044	8,012	8,036	8,047
Dec		8,000	8,015	8,030	8,079	8,042	8,007	8,037	
Average ;kkal/Nm <sup>3</sup>	0	8,000	8,011	8,021	8,030	8,066	8,062	8,023	8,047

The protocols with the filled data in the tables above are shown in Annex No.1 and Annex No. 2 to the Monitoring Report.



## 5. Calculations

The calculations of the emissions and the emissions reduction in the Monitoring model are performed automatically using the formulas outlined in point 2 of the Monitoring report and PDD.

### 5.1 Baseline emissions calculation

The calculations are based on formulas in point 2.4 and are executed with Bulgarian emissions factors in accordance with point 2.7 of the Monitoring report.

Baseline scenario

#### Base line calculations

LHV <sub>NG</sub>	Lower heating value	8,047 kkal/Nm <sup>3</sup> -	NG mean value from BULGARGAS for 2012
EF <sub>NG</sub>	CO <sub>2</sub> emissions factor (combustion)	55.2413	tCO <sub>2</sub> /TJ

Emissions from produced heat

Year	Year	CHP heat to Biovet MWh/year	Back up boilers energy content MWh/year	Total energy content MWh/year	Back-up boiler Efficiency %	Total heat NG input TJ/year	CO <sub>2</sub> emissions (combustion) t/year
1	2004	0	157,231	157,231	88.2	642	36003
2	2005	1,479	142,357	143,836	88.2	587	32936
3	2006	62,711	38,248	100,958	85.5	425	23847
4	2007	132,441	11,824	144,265	88.1	590	33077
5	2008	186,951	7,148	194,099	88.4	717	40197
6	2009	163,098	8,556	171,654	87.0	710	39649
7	2010	205,025	3,956	208,980	87.0	865	48270
8	2011	44,074	88,894	132,969	87.0	550	30369
9	2012	187,586	3,915	191,501	87.0	792	43774

Emissions from electricity

Year	Year	Electricity from CHP MWh	Electricity to grid MWh	Electricity from grid MWh	Total el. consumption in BIOVET MWh	EF tCO <sub>2</sub> /MWh	CO <sub>2</sub> emission (electricity grid) t/year
1	2004	0	0	101,109	101,109	0.979	98,986
2	2005	1,255	548	101,810	102,517	0.957	98,108
3	2006	91,592	78,846	78,532	91,278	0.934	85,253
4	2007	155,562	151,947	106,631	110,247	0.912	100,545
5	2008	141,698	138,544	89,924	93,079	0.890	82,840
6	2009	141,055	137,771	92,049	95,333	0.978	93,236
7	2010	158,937	155,056	115,830	119,711	0.934	111,810
8	2011	34,615	33,638	114,458	115,436	0.912	105,277
9	2012	140,943	137,543	109,086	112,486	0.865	97,300

## 5.2 Project emissions calculation

The calculations are based on formulas in point 2.5 and are executed with Bulgarian emissions factors in accordance with point 2.7 of the Monitoring report.

### Project emissions

CHP LM2000

<b>LHV<sub>ng</sub></b>	Lower heating value	8,047 kkal/Nm <sup>3</sup> -	NG value from BULGARGAS for 2012
<b>EF<sub>ng</sub></b>	CO <sub>2</sub> emissions factor (combustion)	55.2413	tCO <sub>2</sub> /TJ

#### Emissions from combustion

Year	Year	Natural gas for CHP x1000 Nm <sup>3</sup>	CHP(NG-LHV) consumption TJ/year	Back up boilers heat production MWh	Back -up boiler Efficiency %	NG-LHV cons. back up boilers TJ/year	Total NG heat input TJ/year	CO <sub>2</sub> emissions (combustion) t/year
1	2004	0	0	157,231	88.2	642	642	36003
2	2005	541	18	142,357	88.2	581	599	33613
3	2006	29,284	982	38,248	85.5	161	1143	64118
4	2007	47,441	1,589	11,824	88.1	48	1637	91838
5	2008	44,751	1,504	7,148	88.4	26	1531	85864
6	2009	42,685	1,441	8,556	87.0	35	1477	82424
7	2010	47,441	1,601	3,956	87.0	16	1617	90278
8	2011	10,509	353	88,894	87.0	368	721	39782
9	2012	42,596	1,435	3,915	87.0	16	1451	80160

#### Emissions from electricity

Emissions from electricity			Electricity	Avoided (-)				
Year	Year	Electricity from CHP	consumed from grid	EF	CO2 emission (el. from grid)	Electricity to grid	EF	CO2 emission (el. to grid)
		MWh	MWh	tCO2/MWh	t/year	MWh	tCO2/MWh	t/year
1	2004	0	101109	0.979	98986	0	0.832	0
2	2005	1255	101810	0.957	97432	548	0.814	446
3	2006	91592	78532	0.934	73349	78846	0.797	62,841
4	2007	155562	106631	0.912	97248	151947	0.779	118,367
5	2008	141698	89924	0.890	80033	138544	0.761	105,432
6	2009	141055	92049	0.978	90024	137771	0.888	122,341
7	2010	158937	115830	0.934	108186	155056	0.850	131,798
8	2011	34615	114458	0.912	104386	33638	0.834	28,054
9	2012	140943	109086	0.865	94359	137543	0.791	108,796

### 5.3 Emissions reduction calculations

The calculations are based on the formula in point 2.6 and are executed with Bulgarian emissions factors in accordance with point 2.7 of the Monitoring report.

#### **Reduction CO<sub>2</sub> emission**

Year	Year	Base Line		Project Line			Reduction
		CO2 emissions (combustion)	CO2 emission (electricity grid) consumption	CO2 emissions (combustion)	CO2 emission (el. from grid)	CO2 emission (el. to grid) (-)	Total CO2 emission reduction
		t/year	t/year	t/year	t/year	t/year	t/year
1	2004	36,003	98,986	36,003	98,986	0	0
2	2005	32,936	98,108	33,613	97,432	446	445
3	2006	23,847	85,253	64,118	73,349	62,841	34,475
4	2007	33,077	100,545	91,838	97,248	118,367	62,903
5	2008	40,197	82,840	85,864	80,033	105,432	62,573
6	2009	39,649	93,236	82,424	90,024	122,341	82,777
7	2010	48,270	111,810	90,278	108,186	131,798	93,414
8	2011	30,369	105,277	39,782	104,386	28,054	19,532
9	2012	43,774	97,300	80,160	94,359	108,796	75,351