

Gold standard for the global goals
Monitoring report



June 2017, version 1

Title of the project	"Methane Gas Capture and Electricity Production at Kubratovo Wastewater Treatment Plant, Sofia, Bulgaria"
Gold Standard project id	GS4238
Version number of the monitoring report	04
Completion date of the monitoring report	04/03/2020
Date of project design certification	01/04/2016
Start date of crediting period	01/04/2014
Duration of this monitoring period	01/06/2016 to 31/08/2018
Duration of previous monitoring period	01/04/2014 to 31/05/2016
Project representative(s)	Sofiyska voda AD (Project owner)
Host Country	Bulgaria
Certification pathway (activity certification/impact certification)	Impact certification
SDG Contributions targeted (as per approved PDD)	1 – SDG 6: Clean water and sanitation 2 – SDG 11: Sustainable cities and communities 3 –SDG 13: Take urgent action to combat climate change and its impacts
Gold Standard statement/product certification sought (GSVER/ADALYs/RECs etc.)	GSVER
Selected methodology(ies)	AMS-III.H/Version 17: Methane recovery in wastewater treatment, dated 28 Nov 2014; AMS-I.D/Version 18 "Grid connected renewable electricity generation",dated 28/11/2014; AMS-I.C./Version 20: Thermal energy production with or without electricity, dated 01 June 2014;
Estimated amount of annual average certified SDG impact (as per approved PDD)	70,276
Total amount of certified SDG impact (as per approved methodology) achieved in this monitoring period	176,841

SECTION A. Description of project

A.1. Purpose and general description of project

The project is both a methane emissions reduction and energy production project.

Methane produced in Kubratovo wastewater treatment plant is captured in common methane tanks serving as a buffer and then supplied to the newly installed CHP gas engines for electricity and heat production, which in turn will substitute both the plant's electricity purchases from the grid and diesel fuel usage. Excess electricity is supplied to the grid.

The main purpose of the project is to transform the existing low tech sludge treatment process at Kubratovo that existed before implementation of the project into a modern advanced treatment process matching the best sludge treatment practice available in Western Europe. This transformation has a major effect on the environment through dramatically reducing the existing methane gas emissions at the plant while also reducing the volume of sludge that needs to be transported, hence reducing GHG emissions from transportation as well (not included in GHG abatement calculations).

The overall objective of the project is to provide an environmentally friendly sludge treatment process reducing methane and carbon dioxide emissions that – under a business-as-usual scenario – would have continued.

A.2. Location of project

A.2. Location of project activity

The project activity is situated at the site of Sofia central waste-water treatment plant near the village of Kubratovo, located some 20 km outside the centre of Sofia, the capital of Bulgaria, near the Iskar river.

The geographic coordinates of the project site are as follows:

Table 1: Geographic coordinates of the project.

Latitude	Longitude
42°45'10.70"N	23°22'11.56"E

Fig.1: Location of the project site.



The site is clearly visible in GOOGLE Earth as shown on Fig.1.

Fig.2: Location of the town of Sofia in Bulgaria



A.3. Reference of applied methodology

For determination of the baseline, the methodology AMS-III.H: Methane recovery in wastewater treatment (Version 17) and AMS-I.C, "Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories – I.C. Thermal energy production with or without electricity", Version 20, approved by the CDM Executive Board, are applied, using conservative options and data as presented in the following section.

To prove additionality, the official methodologies: "Guidelines on the Demonstration of Additionality of Small-scale Project Activities", Ver.09.0 (previously known as "Attachment A to Appendix B of the simplified modalities and procedures for small-scale CDM project activities version 08") is used.

In addition, the following methodological tools are applied in this PDD:

- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" Version 01;
- "Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion" Version 02;
- "Emissions from solid waste disposal site", Version 7.0.1;
- "Project emissions from flaring", Version 2.0.0;
- "Tool to calculate the emission factor for an electricity system", Version 04.0.0;
- "Tool to determine the remaining lifetime of equipment", Version 1;
- "Project and leakage emissions from anaerobic digesters", Version 1;

The project does not use a standardized baseline.

A.4. Crediting period of project

As per GS TAC decision from September 2014 the crediting period is a renewable 3*7 year period with a maximum of 21 years overall. The starting date of the first crediting period under JI and under a Green Investment Scheme is 1 January 2007. The baseline will get renewed retroactively 2 years prior to the date of registration of the project under Gold Standard.

The 6-week review by the Gold Standard expired on 31/03/2016 and the project is considered registered on 01/04/2016. According to the GS regulations the start date of the GS crediting period is 01/04/2014 (2 years prior GS registration).

The length of the 1st GS crediting period is 7 years 0 months (renewable).

As per the above GS TAC decision dated September 2014 the total crediting period of the project activity is 21 years for the period 01/01/2007 - 31/12/2028.

This period includes the following schemes:

01/01/2007 – 31/12/2007 – Green Investment Scheme

01/01/2008 – 31/12/2012 – Joint Implementation Scheme

01/04/2014 – 31/03/2021 – 1st 7-years GS crediting period

01/04/2021 – 31/03/2028 – 2nd 7-years GS crediting period (subject to GS approval)

SECTION B. Implementation of project

B.1. Description of implemented project

The project supplies Kubratovo waste-water treatment plant with thermal and electrical energy.

The following overall measures have been implemented by the project in order to achieve its goals:

- Digesters for anaerobic sludge treatment

The project activity aimed the erection of a new digester system consisting of 4 digesters, 7,000 m³ each, designed, supplied and erected by PASSAVANT ROEDIGER Anlagenbau.

The anaerobic sludge treatment plant stabilises the sludge anaerobically. With this procedure the organic part of the sludge is reduced which also effects a reduction on the dry solid mass of the total sludge. This process has a positive influence on the sizing of the sludge treatment units following digestion and also on the properties of sludge regarding the ability to dewater and elimination of odour nuisance. The goal of anaerobic digestion is the stabilization of the sewage sludge in order to prevent odour nuisance and improve dewatering.

After the process of digestion the sludge is dewatered and afterwards transported to the temporary pits and then transported for land use as fertiliser.

The maximal biogas generating capacity of the digesters is 1,816 Nm³/h.

Fig.4: Digesters and raw sludge pumping house



- Raw Sludge Pumping Station

As part of the project 5 new raw sludge pumps have been installed in the existing raw sludge pumping station.

- Sludge Circulation System

For heating up the raw sludge and maintaining the process temperature at mesophilic conditions (35°C), a new combined heating and sludge circulation system is provided within the basement of the new service building. 6 volute-casing pumps for dry-well installation have been installed, whereas 4 pumps are in operation and 2 are standby for emergency cases.

Fig.5: Dewatering house



- Heat Exchanger

The anaerobic digestion process takes place under mesophilic conditions, which means within a temperature range of about 33 to 37°C. The fresh incoming raw sludge has to be heated up to the required

temperature conditions. Also the heat loss of the digester has to be compensated. For this purposes a double tube heat exchanger is installed for each digester.

The mixture of raw sludge and seeding sludge is transported from the seeding mixer via the heat exchanger where the sludge is indirectly heated in the counter-current flow with hot water. The heated sludge mixture is transported via the feeding line back into the digester.

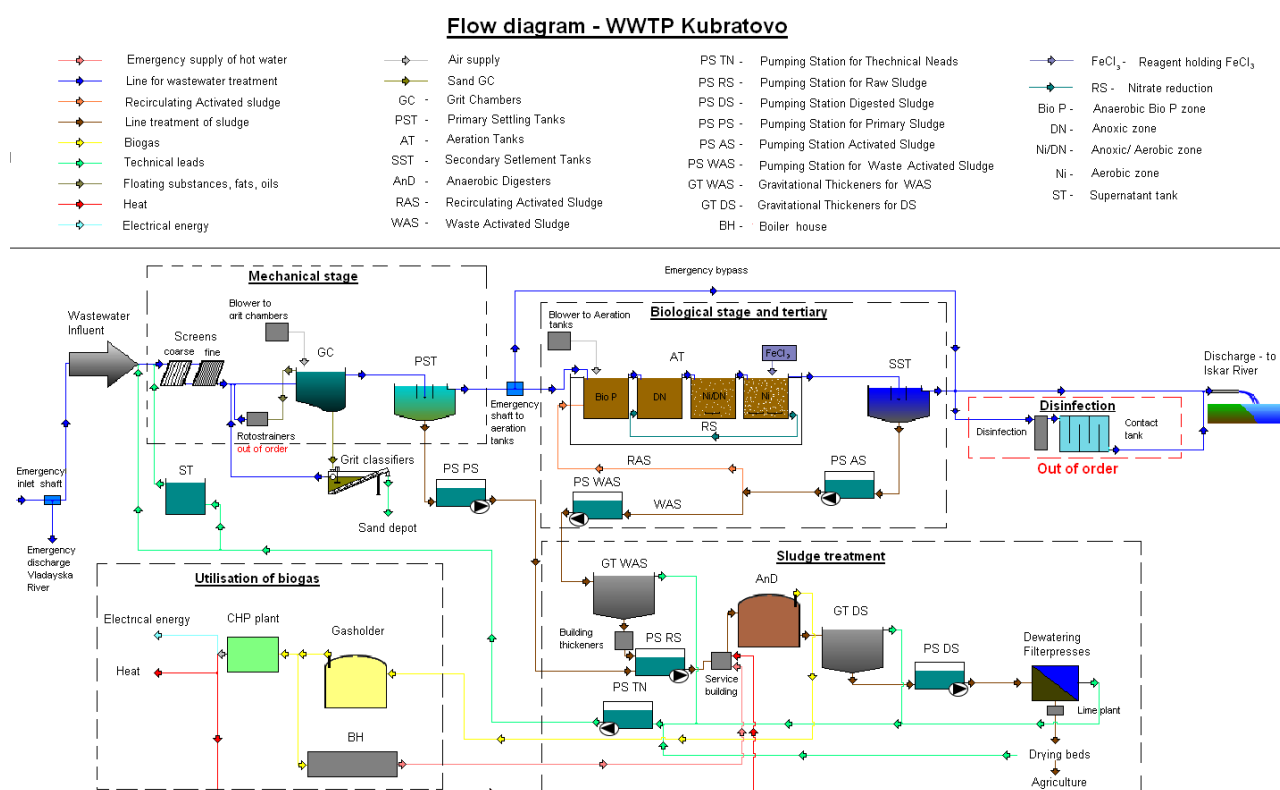
- Combined Heat and Power Plant

The CHP comprises of 3 new co-generation sets GE JMS 320 GS-B.LC with 1,063 kW electric capacity and 1,088 kW thermal capacity each, for generation of electric and thermal energy by combusting biogas from digesters. The electric energy generated is used to cover the plant's need of electricity and replaces the energy supplied from the grid in the baseline. The thermal energy generated by the CHP is also used for internal needs and replaces the thermal energy that would have been generated by the on-site fossil-fuelled hot water boilers.

- Emergency flare system

An emergency flaring system have been implemented, consisting of 2 x DN150 flares, type Passavant-Roediger FAVAE.

The full up-to-date flow diagramme of the WwTP is listed below:



The present Monitoring Report has been produced after the new regulations concerning the Gold Standard had come into force after 01/03/2018.

Parallel with the verification of the 2nd Monitoring report, the PP applied for re-registration under GS4GG following the requirements for that process provided by GS Secretariat.

An Annex 1 form has been issued for that purpose to the Secretariat and the process for re-registration has been started. The PP expects the final decision for the re-registration in short term.

B.2. Post-registration changes

B.2.1. Temporary deviations from Certified Key Project Information, Project Design Document, Monitoring & Reporting Plan, applied methodology or applied standardized baseline

No deviations from the registered monitoring plan and applied methodology have been registered.

B.2.2. Corrections

No corrections are necessary.

B.2.3. Changes to start date of crediting period

There are no changes to the start date of the crediting period.

B.2.4. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

No permanent changes have been registered.

B.2.5. Changes to project design of approved project

No changes to the project activity are regarded.

SECTION C. Description of monitoring system applied by the project

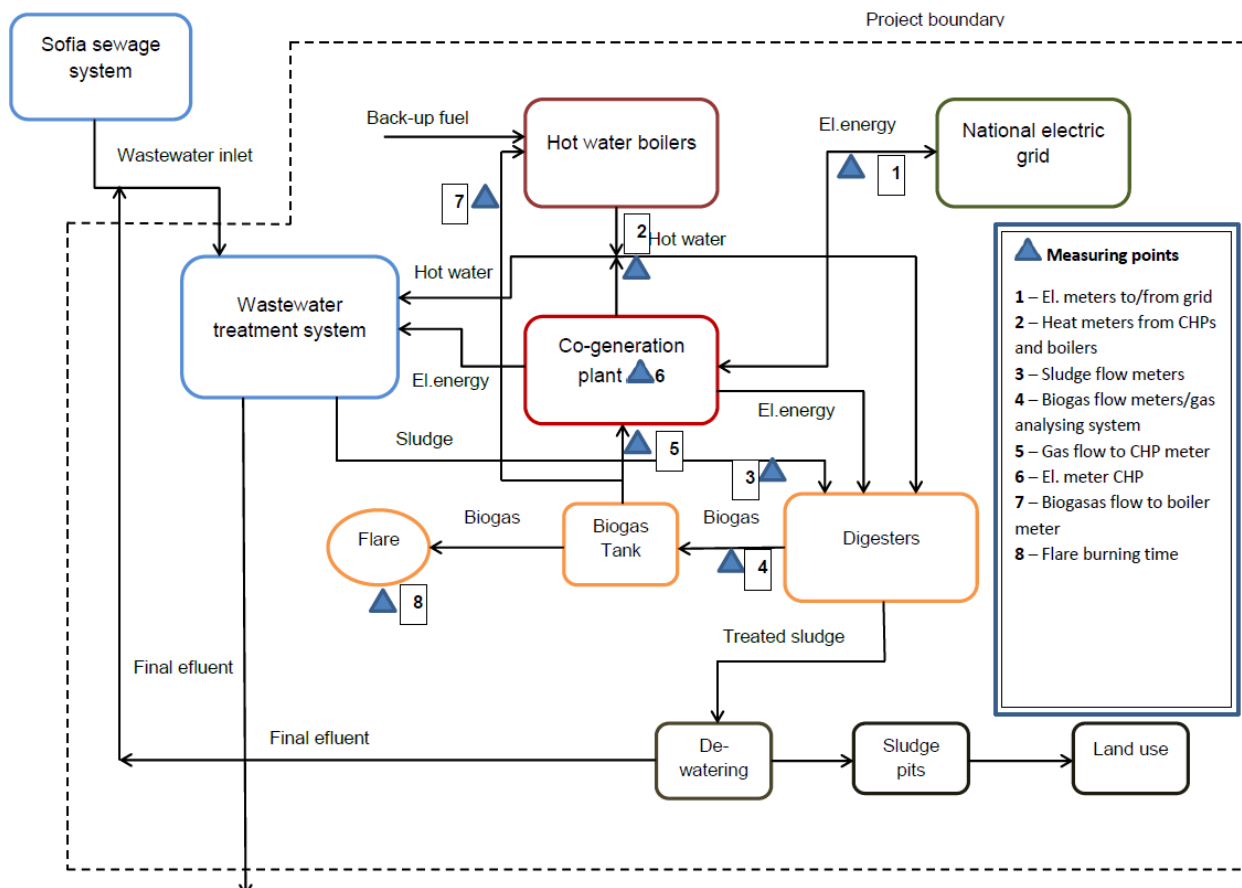
The Kubratovo WwTP is certified under ISO 14001:2015 by Tuev Nord and has certificate No 44 104 087290, valid until 07.03.2019. The WwTP is also certified under OHSAS 18001:2007 with certificate No 44 116087290, valid until 15.01.2021 and ISO 45001:2018.

The scope of services is:

"Management and maintenance of water supply and sewerage systems on the territory of Sofia Municipality. Water supply, sewerage and treatment of waste waters services on the territory of Sofia Municipality."

The operator of the Waste water Treatment Plant is required to comply with the data collection, testing and analysis, and data management obligations of this MP. The operator must integrate the following data collection requirements into the company's data basis and information collection policies.

The diagramme below shows the main measuring points related to the project:



1. Data on CHP plant and boilers performance:

- Total electricity generation (MWh/yr)
- Total net heat production (MWh/yr)

The data will be collected and processed on yearly basis

2. Data on biogas generation and sludge:

- Quantity and quality of biogas generated (m³/year)
- Quantity of CH₄ flared (kg/year)
- Quantity of sludge entering digesters (m³/y)
- Quantity of dry substance in the sludge entering digesters (t/y)

The data will be collected continuously and recorded and processed monthly and yearly.

The operator has the responsibility to input the required data feeds on a monthly and annual basis as required in the monitoring methodology and input data templates in the electronic workbook. The workbook should be saved after each update. Back-up copies of the workbook should be saved and stored on a secure system on a monthly basis to avoid loss of information.

The following measuring equipment will be used for monitoring of the project activity:

Table 2: List of measuring equipment

No	Measuring equipment	Measured parameter, variable	Equipment producer and type	Serial number	Installation date	Date of latest calibration	Periodicity of calibration	Measurement error data	Comments
1	Automatic gas analyser, flow-meter system	Methane concentration in the biogas $w_{CH_4,y}$ Methane – 0-100 Vol% Oxygen – 0-25 Vol% Carbon dioxide – 0-100 Vol% H ₂ S – 0-500 ppm Absolute pressure 0-1600 mbar	Draeger, Awite Awiflex	564_09	01 July 2009	October 2018	6 months	+/- 1 % for Methane and Carbon Dioxide +/- 0.015 % for temperature	Analysis the content of the biogas (normalised)
2	Automatic gas analyser, flow-meter system	Biogas flow $B_{G_{burnt,y}}$	FCI International LLC ST51 MASS FLOW METER	MODEL 022218-0620J1 S/N 642404	January 2018	N/A	N/A	+/- 2%	The flow-meter is integral part of the AWITE automatic gas analyzer, flow-meter system.
3	Digital electric meter	Electricity generated by the CHP $E_{G_{grid,y}}$	Schneider Electric PM 5560	Ser. No 600 008 706 annunciator module LSB6RGB	January 2016	New	4 years	+/- 0.5%	
4	Digital electric	Electricity exported to the	ZMQ 202C.8; L+G	Ser. No 95591478	April 2017	0 April 2017	4 years according to	+/- 0.5%	The commercial electric meter is

	meter	grid EG _{grid,y}					the regulation		property of the electric distribution company (NEC)
5	Digital electric meter	Electricity exported to the grid EG _{grid,y}	ZMQ 202C.8; L+G	Ser. No 95591477	April 2017	April 2017	4 years according to the regulation	+/- 0.5%	The commercial electric meter is property of the electric distribution company (NEC)
6	Inlet sludge flow to digester	Sludge Flow in m ³ /h Qmax:600m ³ /h Tmax:90°C Q_DGs_inlet	ABB Electromagnetic Flowmeter FXE4000 (COPA-XE/MAG-XE) DE41F	000015791/X001	2006	N/A	Not required if there are no range changes	Standard Calibration +-0.5% of rate	Sludge flow meter for Digester 1
7	Inlet sludge flow to digester	Sludge Flow in m ³ /h Qmax:600m ³ /h Tmax:90°C Q_DGs_inlet	ABB Electromagnetic Flowmeter FXE4000 (COPA-XE/MAG-XE) DE41F	000015791/X003	2006	N/A	Not required if there are no range changes	Standard Calibration +-0.5% of rate	Sludge flow meter for Digester 2
8	Inlet sludge flow to digester	Sludge Flow in m ³ /h Qmax:600m ³ /h Tmax:90°C Q_DGs_inlet	ABB Electromagnetic Flowmeter FXE4000 (COPA-XE/MAG-XE) DE41F	000015791/X004	2006	N/A	Not required if there are no range changes	Standard Calibration +-0.5% of rate	Sludge flow meter for Digester 3
9	Inlet sludge flow to digester	Sludge Flow in m ³ /h Qmax:600m ³ /h Tmax:90°C Q_DGs_inlet	ABB Electromagnetic Flowmeter FXE4000 (COPA-XE/MAG-XE) DE41F	000015791/X002	2006	N/A	Not required if there are no range changes	Standart Calibration +-0.5% of rate	Sludge flow meter for Digester 4

10	Automatic gas analyser, flow-meter system	Biogas flow 24 V DC ; max. 3 W; IP 65 by EN 60529 -20 oC to +60 °C BG_{burnt,y}	Binder , Combimass eco basic switch bio EEx de Messsystems	S.No.Co80650	01 July 2009	N/A	Not required if there are no range changes	+/-1%	Biogas flowmeter for Digester 1 (normalised)
11	Automatic gas analyser, flow-meter system	Biogas flow 24 V DC ; max. 3 W; IP 65 by EN 60529 -20 oC to +60 °C BG_{burnt,y}	Binder , Combimass eco basic switch bio EEx de Messsystems	S.No.Co80647	01 July 2009	N/A	Not required if there are no range changes	+/-1%	Biogas flowmeter for Digester 2 (normalised)
12	Automatic gas analyser, flow-meter system	Biogas flow 24 V DC ; max. 3 W; IP 65 by EN 60529 -20 oC to +60 °C BG_{burnt,y}	Binder , Combimass eco basic switch bio EEx de Messsystems	S.No.Co80649	01 July 2009	N/A	Not required if there are no range changes	+/-1%	Biogas flowmeter for Digester 3 (normalised)
13	Automatic gas analyser, flow-meter system	Biogas flow 24 V DC ; max. 3 W; IP 65 by EN 60529 -20 oC to +60 °C BG_{burnt,y}	Binder , Combimass eco basic switch bio EEx de Messsystems	S.No.Co80648	01 July 2009	N/A	Not required if there are no range changes	+/-1%	Biogas flowmeter for Digester 4 (normalised)
14	Automatic gas analyser, flow-meter system	Biogas flow to CHPs, Nm ³ /h	Binder , Combimass eco ver.2014-02	S.No.C120564	July 2014	N/A	Not required if there are no range changes	+/-0.25%+0.025% of max calibrated value(4245,24Nm ³ /h)	The flowmeter is measuring the gas used in the CHPs (normalised) For crosschecking purposes
15	Turbine gas meter	Biogas flow to boilers	Common Turbine gas meter	450345/2011	09.2014	N/A	Not required if there are	0.2Q _{max} -Q _{max} <+/-1%	The flowmeter is measuring the

		50-1000m ³ /h					no range changes	$Q_{min}-0.2Q_{max} < +2\%$	gas used in the boiler. 16For crosschecking purposes
16	Digital thermal energy meter	Thermal energy generated by the CHP units. $EG_{thermal,y}$	Kamstrup, Type 602C00070D1233	Ser.No: 69303430/2013	30.12.2013 (with factory calibration)	05.2017	2 years	$EC \pm (0.5 \Delta\Theta_{min}/\Delta\Theta) \%$ +	The heatmeter is installed at the delivery side of the CHP unit to measure the generated useful heat.
17	Digital thermal energy meter	Thermal energy generated by the CHP units. $EG_{thermal,y}$	Kamstrup, Type 602C00070D1233	Ser.No: 69303431/2013	30.12.2013 (with factory calibration)	05.2017	2 years	$EC \pm (0.5 \Delta\Theta_{min}/\Delta\Theta) \%$ +	The heatmeter is installed at the delivery side of the CHP unit to measure the generated useful heat.
18	Digital thermal energy meter	Thermal energy generated by the CHP units. $EG_{thermal,y}$	Kamstrup, Type 602C00070D1233	Ser.No: 69303432/2013	30.12.2013 (with factory calibration)	05.2017	2 years	$EC \pm (0.5 \Delta\Theta_{min}/\Delta\Theta) \%$ +	The heatmeter is installed at the delivery side of the CHP unit to measure the generated useful heat.
19	Digital thermal energy meter	Thermal energy generated by the boiler. $EG_{thermal,y}$	Kamstrup, Type 602C00020C1233	Ser.No: 69303436/2013	30.12.2013 (with factory calibration)	05.2017	2 years	$EC \pm (0.5 \Delta\Theta_{min}/\Delta\Theta) \%$ +	The heatmeter is installed at the delivery side of the boiler units to measure the generated useful heat.

The management and operation of the project is a responsibility of Sofiyska voda AD (the project operator). Ensuring the environmental credibility of the project through accurate and systematic monitoring of the project's implementation and operation, for the purpose of achieving trustworthy VERs is the key responsibility of the operator.

The project operator will have responsibility to procure and install all the necessary equipment and data acquisition systems to enable the collection and of the stipulated data at the required frequency, and to manage and present this data in the electronic workbook as part of a wider data management system that will be sufficient to meet the needs of the monitoring and the independent verifier.

The establishment of transparent, auditable systems for the collection and storage of data, including adequate record keeping and data monitoring systems is also a responsibility of the operator. The operator must develop and implement a protocol that provides for these critical functions and processes, which must be fit for independent auditing.

For electronic and paper based data entry and record keeping system, there must be clarity in terms of the procedures and protocols for collection and entry of data, use of workbooks and spreadsheets and any assumptions made, so that compliance with requirements can be assessed by a third party. Stand-by processes and systems, e.g. paper based systems, must be outlined to provide for the possibility of electronic system failures and used in the event of such failure. The record keeping system must provide for a paper trail that can be audited.

The operator will appoint a competent manager who will be in charge of and accountable for the generation of VERs including monitoring, record keeping, computation of VERs, audits and verification. The operator will officially sign off on all official paper versions of GHG emission worksheets.

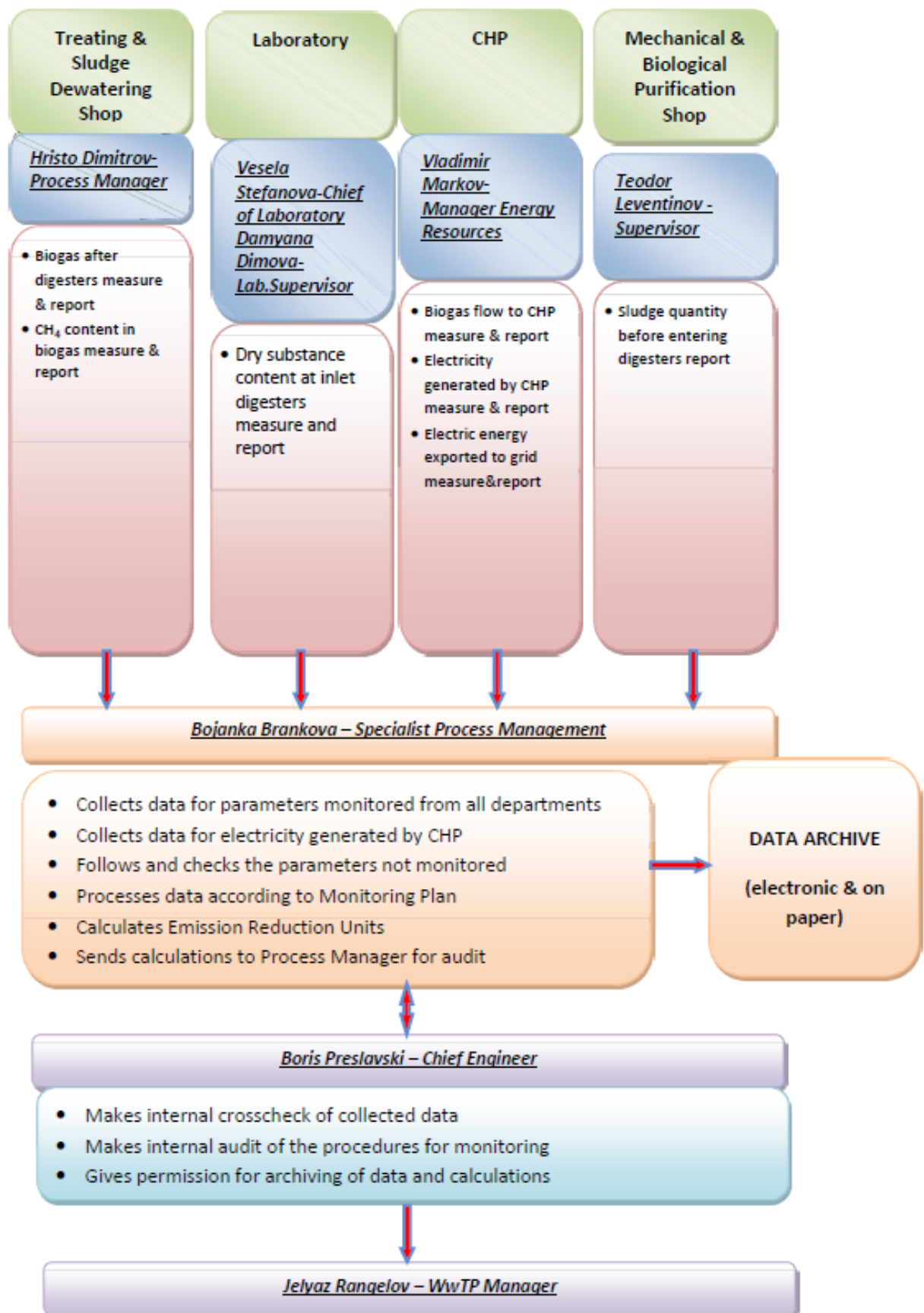
The general project management will be implemented by Mr. Jelyaz Rangelov – Manager of Kubratovo WwTP through supervising and coordinating activities of his subordinates, such as head of laboratory, head of Process Management dept., head of accounting department, head of planning unit. During the daytime a group of mechanics who will be responsible for maintenance of all technological and measuring equipment as well as automation tools will be present on-site.

On-line information will be transmitted to the Chief Engineer Mr. Boris Preslavski. His department will calculate finally emission reductions based on this data and will archive all data.

The personnel of Treating and Dewatering of the sludge process, listing 32 people and headed by the Process manager Mr. Hristo Dimitrov are authorized to take all measurements related to the generation of biogas.

The plant laboratory managed by Mrs. Vesela Stefanova and Mrs. Damyana Dimova measure the dry substance content in the sludge at inlet of anaerobic digesters. The data is transferred to the Process Management dept. for further processing.

Flow chart with procedures for monitoring reporting and data flow



D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/parameter:	EFEL,y
Unit	tCO ₂ /MWh
Description	Emission factor of the national power grid of Bulgaria
Source of data	Calculated value
Value(s) applied)	1.0190
Choice of data or measurement methods and procedures	The project activity involves displacement of grid electricity. As per the AMS-I.D, version 18 methodology, the EFCO ₂ of the grid is calculated based on a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the "Tool to calculate the Emission Factor for an electricity system"
Purpose of data	Calculation of baseline emissions
Additional comments	This parameter has been fixed ex-ante for the whole crediting period.

Data/parameter:	MCFs,BL,final
Unit	
Description	Methane correction factor of the disposal site that receives the final sludge in the baseline situation,
Source of data	IPCC 2006 Guidelines for national Greenhouse Gas Inventories
Value(s) applied)	0.4
Choice of data or measurement methods and procedures	CDM Tool "Emissions from solid waste disposal sites", Version 07
Purpose of data	Calculation of baseline emissions
Additional comments	

Data/parameter:	DOCs
Unit	
Description	Degradable organic content of the untreated sludge generated in the year y (fraction, dry basis)
Source of data	IPCC 2006 Guidelines for national Greenhouse Gas Inventories
Value(s) applied)	0.5
Choice of data or measurement methods and procedures	Default value from AMS-III.H
Purpose of data	Calculation of baseline emissions
Additional comments	

Data/parameter:	DOCF
Unit	
Description	Fraction of DOC dissimilated to biogas

Source of data	IPCC 2006 Guidelines for national Greenhouse Gas Inventories
Value(s) applied)	0.5
Choice of data or measurement methods and procedures	Default value from AMS-III.H
Purpose of data	Calculation of baseline emissions
Additional comments	

Data/parameter:	F
Unit	-
Description	Fraction of CH ₄ in biogas
Source of data	IPCC 2006 Guidelines for national Greenhouse Gas Inventories
Value(s) applied)	0.5
Choice of data or measurement methods and procedures	Default value from AMS-III.H
Purpose of data	Calculation of baseline emissions
Additional comments	

Data/parameter:	UFBL
Unit	
Description	Model correction factor to account for model uncertainties
Source of data	AMS-III.H
Value(s) applied)	0.89
Choice of data or measurement methods and procedures	Default value from AMS-III.H
Purpose of data	Calculation of baseline emissions
Additional comments	

Data/parameter:	GW _{PCH₄}
Unit	
Description	Global Warming Potential for methane
Source of data	IPCC
Value(s) applied)	25
Choice of data or measurement methods and procedures	Default value from 4th IPCC Assessment Report is used as per the applied methodology
Purpose of data	Baseline/project emissions calculation
Additional comments	

Data/parameter:	η _{flare}
Unit	%
Description	Flare efficiency
Source of data	"Project emissions from flaring", Version 02.0.0

Value(s) applied)	80%
Choice of data or measurement methods and procedures	Default value from "Project emissions from flaring" , Version 02.0.0. The flare efficiency for the minute m ($\eta_{\text{flare},m}$) is 80% when the following two conditions are met to demonstrate that the flare is operating: (1) The temperature of the flare (TEG,m) and the flow rate of the residual gas to the flare (FRG,m) is within the manufacturer's specification for the flare (SPECflare) in minute m; and (2) The flame is detected in minute m (Flamem). Otherwise $\eta_{\text{flare},m}$ is 0%.
Purpose of data	Project emissions calculation
Additional comments	The value is 10% less the default value for conservativeness.

Data/parameter:	$\eta_{\text{BL,thermal}}$
Unit	%
Description	Efficiency of the plant using fossil fuel that would have been used in the absence of the project activity determined as per paragraph 39 or 40
Source of data	Manufacturer's specifications ¹
Value(s) applied)	92%
Choice of data or measurement methods and procedures	The value is presented in the specifications provided by the manufacturer of the boilers. The baseline fuel is changed from light oil to natural gas.
Purpose of data	Baseline emissions calculation
Additional comments	The baseline fuel is changed from light oil to natural gas. The standard efficiency of newly built natural gas boilers is 92%.

Data/parameter:	EFF _F ,CO ₂
Unit	tCO ₂ /TJ
Description	CO ₂ emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available, alternatively, IPCC default emission factors can be used
Source of data	2006 IPCC Guidelines for national Greenhouse Gas Inventories, Volume 2.2 Stationary Combustion, Table 2.2
Value(s) applied)	54.30
Choice of data or measurement methods and procedures	Lower value at 95% confidence interval
Purpose of data	Baseline emissions calculation
Additional comments	The baseline fuel is changed from light oil (naphta) to natural gas

Data/parameter:	NCV _{i,y}
Unit	GJ/t
Description	Net calorific value of the light oil used for emergency cases in year y
Source of data	2006 IPCC Guidelines on National GHG Inventories
Value(s) applied)	46.50

¹ <http://www.kotlostroene.com/kotliKV>

Choice of data or measurement methods and procedures	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Purpose of data	Project emissions calculation
Additional comments	

Data/parameter:	EFCO _{2,i,y}
Unit	tCO ₂ /GJ
Description	CO ₂ emission factor of the light oil (naphta) used for emergency cases in year y
Source of data	2006 IPCC Guidelines on National GHG Inventories
Value(s) applied)	76.30
Choice of data or measurement methods and procedures	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Purpose of data	Project emissions calculation
Additional comments	

Data/parameter:	PE _{fugitive,s,y}
Unit	Nm ³ leaked/Nm ³ produced
Description	
Source of data	AMS-III.H, paragraph 42(b)
Value(s) applied)	0.05
Choice of data or measurement methods and procedures	Default value
Purpose of data	Project emissions calculation
Additional comments	

Data/parameter:	DCH ₄
Unit	Kg/m ³
Description	Density of methane
Source of data	AMS-III.D2
Value(s) applied)	0.670
Choice of data or measurement methods and procedures	0.670 kg/m ³ at 20 oC and 1 atm pressure
Purpose of data	Project emissions calculation including emissions from incomplete flaring.
Additional comments	

D.2. Data and parameters monitored

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	Sfinal,PJ,y
Unit	t
Description	Amount of dry matter in the sludge in the year y
Measured/calculated/default	Measured
Source of data	Plant records
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 7 01/06/2016 – 31/12/2016: 20,135.33 01/01/2017 - 31/12/2017: 38,658.60 01/01/2018 – 31/08/2018: 28,338.72
Monitoring equipment	See Table 2
Measuring/reading/recording frequency:	Measured continuously. Recorded monthly and yearly.
Calculation method (if applicable):	N/A
QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.
Purpose of data:	Calculation of baseline emissions
Additional comments:	The quantity of sludge delivered to the digesters is equal to the quantity of sludge delivered for dewatering in the baseline.

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	EGthermal,y
Unit	TJ
Description	The net quantity of heat supplied by the project activity
Measured/calculated/default	Measured
Source of data	Plant records
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 2 01/06/2016 – 31/12/2016: 46.88 01/01/2017 - 31/12/2017: 89.77 01/01/2018 – 31/08/2018: 59.01
Monitoring equipment	See Table 2.
Measuring/reading/recording frequency:	Measured continuously. Recorded monthly and yearly.
Calculation method (if applicable):	N/A

QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007, ISO 45001:2018 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.
Purpose of data:	Calculation of baseline emissions
Additional comments:	

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	EGgrid,y
Unit	MWh
Description	Electricity generated by the CHP
Measured/calculated/default	Measured
Source of data	Plant records
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 3 01/06/2016 – 31/12/2016: 12,432.49 01/01/2017 - 31/12/2017: 23,169.54 01/01/2018 – 31/08/2018: 15,754.11
Monitoring equipment	See Table 2
Measuring/reading/recording frequency:	Measured continuously. Recorded monthly and yearly.
Calculation method (if applicable):	N/A
QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007, ISO 45001:2018 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.
Purpose of data:	Calculation of baseline emissions
Additional comments:	In case records are missing due to meters failure or replacement the electricity consumption for that period and that part of the installation will be estimated by multiplying the installed capacity of the electric motors and devices involved times the working hours of the installation as per plant's records.

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	BGburnt,y
Unit	Nm ³
Description	Quantity of biogas generated by the anaerobic digesters
Measured/calculated/default	Measured

Source of data	Plant records
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 4 01/06/2016 – 31/12/2016: 7,533,227.06 01/01/2017 - 31/12/2017: 13,636,872.33 01/01/2018 – 31/08/2018: 7,307,154.53
Monitoring equipment	See Table 2
Measuring/reading/recording frequency:	Measured continuously. Recorded monthly and yearly.
Calculation method (if applicable):	N/A
QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007, ISO 45001:2018 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.
Purpose of data:	Project emissions calculation including emissions from incomplete flaring
Additional comments:	The analyser takes into consideration the pressure and temperature of the biogas. The final result is normalized.

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	Q_DGs_inlet
Unit	m3
Description	Quantity of sludge entering the anaerobic digesters
Measured/calculated/default	Measured
Source of data	Plant records
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 5 01/06/2016 – 31/12/2016: 394,520.00 01/01/2017 - 31/12/2017: 703,620.00 01/01/2018 – 31/08/2018: 471,140.00
Monitoring equipment	See Table 2
Measuring/reading/recording frequency:	Measured continuously. Results are integrated hourly, recorded monthly and yearly.
Calculation method (if applicable):	N/A
QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007, ISO 45001:2018 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.
Purpose of data:	Baseline emissions calculation.
Additional comments:	

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	ρ_{sludge}
Unit	t/m ³
Description	Dry substance content in the sludge
Measured/calculated/default	Measured/calculated
Source of data	Plant records
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 6 (monthly records)
Monitoring equipment	The tests are made by an accredited laboratory on-site the plant.
Measuring/reading/recording frequency:	Laboratory samples taken every hour. Results are recorded hourly, monthly and yearly
Calculation method (if applicable):	Calculated based on the laboratory samples taken every hour
QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007. ISO 45001:2018 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.
Purpose of data:	Baselines emissions calculation.
Additional comments:	

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	wCH _{4,y}
Unit	%
Description	Methane content in biogas in the year y
Measured/calculated/default	Measured
Source of data	Plant records
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 8 (monthly records)
Monitoring equipment	See Table 2
Measuring/reading/recording frequency:	Measured continuously. Aggregated hourly and recorded monthly and yearly.
Calculation method (if applicable):	N/A
QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007. ISO 45001:2018 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.

Purpose of data:	Project emissions calculation including emissions from incomplete flaring
Additional comments:	The analyser takes into consideration the pressure and temperature of the biogas. The final result is normalized.

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	FCy
Unit	t
Description	Quantity of fossil fuel (naphta) used for emergency needs.
Measured/calculated/default	Measured/Calculated
Source of data	Plant records
Value(s) of monitored parameter	01/06/2016 – 31/12/2016: 0 01/01/2017 - 31/12/2017: 0 01/01/2018 – 31/08/2018: 0
Monitoring equipment	Tank level indicator/meter
Measuring/reading/recording frequency:	yearly
Calculation method (if applicable):	The yearly quantity is calculated using accounting documents for the purchased quantity of fuel during the reported period the initial and the residual content of the reservoirs.
QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007. ISO 45001:2018 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.
Purpose of data:	Project emissions calculation
Additional comments:	

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data/parameter:	Vt,db
Unit	m ³ CH ₄
Description	Volumetric flow of the gaseous stream (methane) to the flares
Measured/calculated/default	Calculated
Source of data	Plant records (quantity of biogas generated)
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 13 01/06/2016 – 31/12/2016: 15,574.28 01/01/2017 - 31/12/2017: 143,856.25 01/01/2018 – 31/08/2018: 69,687.58
Monitoring equipment	
Measuring/reading/recording frequency:	Integrated hourly, recorded hourly and monthly.
Calculation method (if applicable):	Calculated based on the measured content of methane in the biogas wCH ₄ ,y , the time flares have been in operation and the capacity of the flares.

QA/QC procedures:	The activities outlined here are undertaken under the OHSAS 18001:2007. ISO 45001:2018 and the internal quality procedures implemented. This will ensure that all management and operational systems will meet the requirements of external auditors. QA/QC internal procedures are implemented in the plant and all measurement processes, as device technical description and documentation, position, calibration, training, temporally replacing procedures etc. are included.
Purpose of data:	Project emissions calculation.
Additional comments:	

Relevant SDG Indicator	SDG 13(Climate action)– Target 13.1
Data / Parameter	F_{CH4}
Unit	KgCH ₄ /year
Description	Mass flow of methane in the residual biogas flared
Source of data	Plant's records
Value(s) of monitored parameter	See Attachment 1; Table 3; Column 15 01/06/2016 – 31/12/2016: 10,434.77 01/01/2017 - 31/12/2017: 96,383.69 01/01/2018 – 31/08/2018: 46,690.68
Measurement methods and procedures	The quantity and quality of biogas is measured continuously and normalized. The mass flow is calculated based on above measurements.
Monitoring frequency	Continuously, calculated for every minute interval
QA/QC procedures	The procedure is integrated in the ISO 9001:2015 system implemented by the plant. The meters are checked and calibrated every year.
Purpose of data	Ex-post project emissions calculation.
Additional comment	

Relevant SDG Indicator	SDG 11: Sustainable cities and communities / 11.6-By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
Data / Parameter	Emissions of SO ₂ , NO _x , CO and dust in the stack flue gas. Waste oil disposed
Unit	mg/Nm ₃ kg
Description	Emissions in the air by the project activities. Quantity of waste oil disposed by the project
Source of data	Plant records

Value(s) applied	Last available data from measurements are documented in Protocols NoNo E126 A, E127 A, E128 A dated 10.02.2016 issued by SGS and are as follows: - Engine 1; No 59115371 SO₂ – <1.39 mg/Nm₃ CO – 97+-5 mg/Nm₃ NO_x – 42.57+-2.13 mg/Nm₃ - Engine 2; No 59115391 SO₂ – <1.42 mg/Nm₃ CO – 97+-5 mg/Nm₃ NO_x – 43.29+-2.16 mg/Nm₃ - Engine 3; No 59115381 SO₂ – <1.39 mg/Nm₃ CO – 99+-5 mg/Nm₃ NO_x – 39.46+-1.97 mg/Nm₃ Waste oil disposed: 09.09.2016 – 810 kg. 10.11.2016 – 1,185 kg. 14.02.2017 – 610 kg. 20.04.2017 – 400 kg. 29.05.2017 – 870 kg. 08.09.2017 – 1,280 kg. 04.12.2017 – 1,110 kg. 29.01.2018 – 1,200 kg. 30.03.2018 – 900 kg. 15.08.2018 – 904 kg.
Measurement methods and procedures	Measured according to plant internal procedures
Monitoring frequency	Every 2 years for exhaust gases as by local law, yearly for waste oil
QA/QC procedures	As per internal procedures, ISO 14001: 2015, OHSAS 18001:2007 and ISO 45001:2018.
Purpose of data	Ex-post monitoring of dangerous emissions and pollutants
Additional comment	The project combusts biogas containing CH₄ and no measurement of its content as well as dust content in the flue gas is required. Corresponding to Indicator 001 of the GS Passport of the project. Relevant to Target 11.6 of the SDG11.

Relevant SDG Indicator	SDG6: Clean water and sanitation/6.3.1-Proportion of waste water safely treated
Data / Parameter	1.COD (Chemical Oxygen Demand) of the inlet wastewater; 1a.BOD₅ (Biochemical Oxygen Demand for 5 days) of the inlet wastewater; 2.COD (Chemical Oxygen Demand) of the effluent water; 2a.BOD₅ (Biochemical Oxygen Demand for 5 days) of the effluent water; Quantity of waste water (sludge) treated
Unit	mgO ₂ /l m ³

Description	Water quality and quantity																																																																																																																																																																																																																						
Source of data	Plant records																																																																																																																																																																																																																						
Value(s) applied	The average values recorded monthly for 2016,2017 & 2018 are given in the table below: <table border="1"> <thead> <tr> <th>Period</th><th>COD inlet [mgO₂/l]</th><th>BOD inlet [mgO₂/l]</th><th>COD effluent [mgO₂/l]</th><th>BOD effluent [mgO₂/l]</th><th>Quantity of waste water (sludge) treated [m³]</th></tr> </thead> <tbody> <tr><td>2016</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>June</td><td>115.8</td><td>287.5</td><td>5.6</td><td>16.0</td><td>57,600</td></tr> <tr><td>July</td><td>121.3</td><td>289.0</td><td>4.9</td><td>18.4</td><td>58,560</td></tr> <tr><td>August</td><td>123.6</td><td>285.4</td><td>5.7</td><td>18.5</td><td>55,320</td></tr> <tr><td>September</td><td>150.0</td><td>318.7</td><td>5.3</td><td>17.3</td><td>50,560</td></tr> <tr><td>October</td><td>124.5</td><td>270.2</td><td>6.2</td><td>16.1</td><td>56,880</td></tr> <tr><td>November</td><td>145.4</td><td>323.8</td><td>5.9</td><td>17.0</td><td>56,200</td></tr> <tr><td>December</td><td>148.9</td><td>315.9</td><td>6.4</td><td>18.4</td><td>59,400</td></tr> <tr><td>Total</td><td></td><td></td><td></td><td></td><td>394,520</td></tr> <tr><td>2017</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>January</td><td>131.7</td><td>293.2</td><td>5.9</td><td>13.5</td><td>56,300</td></tr> <tr><td>February</td><td>119.2</td><td>260.5</td><td>6.9</td><td>18.0</td><td>50,830</td></tr> <tr><td>March</td><td>120.5</td><td>259.7</td><td>5.3</td><td>19.5</td><td>59,320</td></tr> <tr><td>April</td><td>120.0</td><td>282.1</td><td>6.1</td><td>30.0</td><td>59,490</td></tr> <tr><td>May</td><td>143.5</td><td>333.6</td><td>5.9</td><td>30.0</td><td>62,000</td></tr> <tr><td>June</td><td>149.2</td><td>326.2</td><td>6.0</td><td>26.0</td><td>58,840</td></tr> <tr><td>July</td><td>130.5</td><td>289.4</td><td>5.8</td><td>19.5</td><td>60,600</td></tr> <tr><td>August</td><td>111.9</td><td>274.7</td><td>5.3</td><td>13.5</td><td>58,640</td></tr> <tr><td>October</td><td>122.1</td><td>293.9</td><td>8.2</td><td>14.5</td><td>57,280</td></tr> <tr><td>November</td><td>137.5</td><td>302.1</td><td>5.4</td><td>18.5</td><td>60,760</td></tr> <tr><td>December</td><td>150.5</td><td>330.9</td><td>5.4</td><td>18.5</td><td>60,760</td></tr> <tr><td>Total</td><td></td><td></td><td></td><td></td><td>703,620</td></tr> <tr><td>2018</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>January</td><td>141.5</td><td>308.2</td><td>5.6</td><td>14.5</td><td>60,760</td></tr> <tr><td>February</td><td>129.5</td><td>271.4</td><td>10.7</td><td>17.0</td><td>54,880</td></tr> <tr><td>March</td><td>96.2</td><td>218.2</td><td>5.2</td><td>28.5</td><td>60,760</td></tr> <tr><td>April</td><td>111.0</td><td>245.3</td><td>7.7</td><td>23.0</td><td>58,700</td></tr> <tr><td>May</td><td>123.2</td><td>284.9</td><td>7.5</td><td>25.5</td><td>60,760</td></tr> <tr><td>June</td><td>117.9</td><td>293.5</td><td>7.5</td><td>25.5</td><td>58,400</td></tr> <tr><td>July</td><td>101.2</td><td>262.7</td><td>7.1</td><td>23.0</td><td>58,640</td></tr> <tr><td>August</td><td>129.9</td><td>320.0</td><td>11.6</td><td>25.5</td><td>58,240</td></tr> <tr><td colspan="3">Average for the Monitoring period:</td><td>6.50</td><td>20.22</td><td></td></tr> <tr><td>Total</td><td></td><td></td><td></td><td></td><td>471,140</td></tr> <tr><td colspan="5">Total for the monitoring period</td><td>1,569,280</td></tr> </tbody> </table>					Period	COD inlet [mgO ₂ /l]	BOD inlet [mgO ₂ /l]	COD effluent [mgO ₂ /l]	BOD effluent [mgO ₂ /l]	Quantity of waste water (sludge) treated [m ³]	2016						June	115.8	287.5	5.6	16.0	57,600	July	121.3	289.0	4.9	18.4	58,560	August	123.6	285.4	5.7	18.5	55,320	September	150.0	318.7	5.3	17.3	50,560	October	124.5	270.2	6.2	16.1	56,880	November	145.4	323.8	5.9	17.0	56,200	December	148.9	315.9	6.4	18.4	59,400	Total					394,520	2017						January	131.7	293.2	5.9	13.5	56,300	February	119.2	260.5	6.9	18.0	50,830	March	120.5	259.7	5.3	19.5	59,320	April	120.0	282.1	6.1	30.0	59,490	May	143.5	333.6	5.9	30.0	62,000	June	149.2	326.2	6.0	26.0	58,840	July	130.5	289.4	5.8	19.5	60,600	August	111.9	274.7	5.3	13.5	58,640	October	122.1	293.9	8.2	14.5	57,280	November	137.5	302.1	5.4	18.5	60,760	December	150.5	330.9	5.4	18.5	60,760	Total					703,620	2018						January	141.5	308.2	5.6	14.5	60,760	February	129.5	271.4	10.7	17.0	54,880	March	96.2	218.2	5.2	28.5	60,760	April	111.0	245.3	7.7	23.0	58,700	May	123.2	284.9	7.5	25.5	60,760	June	117.9	293.5	7.5	25.5	58,400	July	101.2	262.7	7.1	23.0	58,640	August	129.9	320.0	11.6	25.5	58,240	Average for the Monitoring period:			6.50	20.22		Total					471,140	Total for the monitoring period					1,569,280
Period	COD inlet [mgO ₂ /l]	BOD inlet [mgO ₂ /l]	COD effluent [mgO ₂ /l]	BOD effluent [mgO ₂ /l]	Quantity of waste water (sludge) treated [m ³]																																																																																																																																																																																																																		
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Measurement methods and procedures	As per VLM NoWW-17/27.05.2008 and BDS EN 1899-1:2004, B.4.2																																																																																																																																																																																																																						
Monitoring frequency	As per approved internal procedures																																																																																																																																																																																																																						
QA/QC procedures	As per ISO 9001:2015																																																																																																																																																																																																																						
Purpose of data	Ex-post monitoring of the water quality																																																																																																																																																																																																																						
Additional comment	Corresponding to Indicator 002 of the GS Passport of the project. Quantity of waste water (sludge) treated is given in Attachment 1, Table 3, Column 5																																																																																																																																																																																																																						

D.3. Implementation of sampling plan

N/A

SECTION E. Calculation of SDG outcomes

E.1. Calculation of baseline value or estimation of baseline situation of each SDG outcome

SDG 13

The baseline emissions due to methane avoidance are calculated according to the formula below:

$$BE_{s, final, y} = S_{final, BL, y} * DOC_s * UF_{BL} * MCF_{s, BL, final} * DOC_F * F * 16 / 12 * GWP_{CH4} \quad [tCO_{2e}]$$

Where

$S_{final, BL, y}$ Amount of dry matter in the final sludge generated by the baseline wastewater treatment systems in the year y (t). If the baseline wastewater treatment system is different from the project system, it will be estimated using the monitored amount of dry matter in the final sludge generated by the project activity ($S_{final, PJ, y}$) corrected for the sludge generation ratios of the project and baseline systems

$MCF_{s, BL, final}$ Methane correction factor of the disposal site that receives the final sludge in the baseline situation, estimated as per the procedures described in the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" – 0.4

UF_{BL} Model correction factor to account for model uncertainties (0.89)

DOC_s Degradable organic content of the untreated sludge generated in the year y (fraction, dry basis). Default values of 0.5 for domestic sludge shall be used

DOC_F Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)

F Fraction of CH₄ in biogas (IPCC default of 0.5)

The ex-post calculation of the baseline emissions is as follows:

$BE_{s, final, 2016}$: **29,867** tCO_{2e} (for the period 01/06/2016 – 31/12/2016)

$BE_{s, final, 2017}$: **57,343** tCO_{2e} (for the period 01/01/2017 – 31/12/2017)

$BE_{s, final, 2018}$: **42,035** tCO_{2e} (for the period 01/01/2018 – 31/08/2018)

The baseline emissions from thermal and electricity displacement are calculated as follows:

$$BE_{grid, y} = EG_{grid, y} \times EF_{grid, y}$$

Where:

$BE_{grid, y}$ = Baseline emissions for the grid electricity displaced by the project in year y (t CO_{2e})

$EG_{grid, y}$ = Amount of grid electricity displaced by project in year y (MWh)

$EF_{grid, y}$ = Emission factor of the grid (t CO_{2e}/MWh)

And

$$BE_{thermal,CO_2,y} = \left(\frac{EG_{thermal,y}}{\eta_{BL,thermal}} \right) \times EF_{FF,CO_2}$$

Where:

- $BE_{thermal,CO_2,y}$ = Baseline emissions from thermal energy displaced by the project activity during the year y (t CO₂e)
- $EG_{thermal,y}$ = Net quantity of thermal energy supplied by the project activity during the year y (TJ)
- EF_{FF,CO_2} = CO₂e emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available, alternatively, IPCC default emission factors can be used (t CO₂e/TJ)
- $\eta_{BL,thermal}$ = Efficiency of the plant using fossil fuel that would have been used in the absence of the project activity determined as per paragraph 39 or 40

The ex-post calculation of the baseline emissions from thermal and electricity displacement is as follows:

$BE_{grid,2016}$: **12,668** tCO₂e (for the period 01/06/2016 – 31/12/2016)

$BE_{grid,2017}$: **23,609** tCO₂e (for the period 01/01/2017 – 31/12/2017)

$BE_{grid,2018}$: **16,053** tCO₂e (for the period 01/01/2018 – 31/08/2018)

$BE_{thermal, CO_2,2016}$: **2,766** tCO₂e (for the period 01/06/2016 – 31/12/2016)

$BE_{thermal, CO_2,2017}$: **5,298** tCO₂e (for the period 01/01/2017 – 31/12/2017)

$BE_{thermal, CO_2,2018}$: **3,428** tCO₂e (for the period 01/01/2018 – 31/08/2018)

The total baseline emissions estimated for the project are:

BE_{2016} : **45,301** tCO₂e (for the period 01/06/2016 – 31/12/2016)

BE_{2017} : **86,301** tCO₂e (for the period 01/01/2017 – 31/12/2017)

BE_{2018} : **62,113** tCO₂e (for the period 01/01/2018 – 31/08/2018)

Total for the monitored period 01/06/2016 – 31/08/2018: **193,121** tCO₂e

The calculation of the baseline emissions is presented in details in the excel file named "Sofiyska_voda_VER_Calculation_ver.02_216-2018.xlsm" which is attached to this Monitoring report.

SDG 6

1. COD (Chemical Oxygen Demand) of the inlet wastewater;
- 1a. BOD₅ (Biochemical Oxygen Demand for 5 days) of the inlet wastewater;
2. COD (Chemical Oxygen Demand) of the effluent water;
- 2a. BOD₅ (Biochemical Oxygen Demand for 5 days) of the effluent water;

Quantity of waste water (sludge) treated

The parameter did not exist prior the project implementation.

SDG 11

Emissions of SO₂, NO_x, CO and dust in the stack flue gas.

Waste oil disposed

The parameter did not exist prior the project implementation.

E.2. Calculation of project value or estimation of project situation of each SDG outcome

SDG 13

The project emissions are determined as per the formula:

$$PE_y = PE_{power,y} + PE_{fugitive,y} + PE_{flare}$$

Where

$PE_{power,y}$ = Project emissions from combustion of fossil fuel (naphtha) in case of emergency;

$PE_{fugitive,y}$ = Project emissions from leaking methane from capturing system;

PE_{flare} = Project emissions from incomplete flaring.

And

$$PE_{power,y} = PE_{FC,y} = FC_{,y} \times COEF_{,y}$$

$$COEF_{,y} = NCV_{,y} \times EF_{CO_2,y}$$

Where

$PE_{FC,,}$ Are the CO₂ emissions from emergency fossil fuel (naphtha) combustion (tCO₂/yr);

FC Is the quantity of naphtha combusted (mass or volume unit/yr);

$COEF$ Is the CO₂ emission coefficient of naphtha (tCO₂/mass or volume unit)

NCV Is the net calorific value of the emergency fuel, (GJ/mass or volume unit)

EF_{CO_2} Is the CO₂ emission factor of emergency fuel (naphtha), (tCO₂/GJ)

For the monitored period there was no use of emergency fuel, hence

$$PE_{power} = 0$$

$PE_{fugitive}$ are calculated as follows:

The fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y will be determined as per paragraph 42 (b) of AMS-III.H: a default value of 0.05 m³ biogas leaked/m³ biogas produced will be used as an alternative.

$$PE_{fugitive,2016}: 3,913 \text{ tCO}_2$$

$$PE_{fugitive,2018}: 7,593 \text{ tCO}_2$$

$$PE_{fugitive,2018}: 4,008 \text{ tCO}_2$$

PE_{flare} are determined as follows:

$$F_{CH_4,t} = V_{t,db} * V_{CH_4,t,db} * \rho_{CH_4,t} \quad \text{which is equivalent to}$$

$$F_{CH_4,t} = V_{t,db} * w_{CH_4,y} * D_{CH_4}$$

Where:

$F_{CH_4,t}$ Mass flow of the methane in the gaseous stream in time interval t (kg CH₄/h)

$V_{t,db}$	Volumetric flow of the gaseous stream in time interval t on a dry basis ($m^3 CH_4/h$)
$V_{CH_4,t,db} = W_{CH_4}$	Volumetric fraction of methane in the gaseous stream in a time interval t on a dry basis ($m^3 CH_4/m^3$ dry gas)
$\rho_{CH_4,t} = D_{CH_4} = 0.670$	Density of CH_4 in the gaseous stream in time interval t ($kg CH_4/m^3 CH_4$)
η_{flare}	80%

and

$$PE_{flare} = F_{CH_4,t} * GWP_{CH_4} * ((100 - \eta_{flare})/100)$$

$PE_{flare,2016}$: **52 tCO₂e**

$PE_{flare,2017}$: **481 tCO₂e**

$PE_{flare,2018}$: **233 tCO₂e**

The project emissions during the monitored period are as follows:

PE_{2016} : **3,965 tCO₂e**

PE_{2017} : **8,074 tCO₂e**

PE_{2018} : **4,241 tCO₂e**

Total project emissions for the monitored period: **16,280 tCO₂e**

The calculation of the project emissions is presented in the excel file named "Sofiyska_voda_VER_Calculation_ver.02_216-2018.xlsm" which is attached to this Monitoring report.

Calculation of leakage

No leakage emissions are generated by the project.

SDG 6

Air pollutants:

Last available data from measurements are documented in Protocols NoNo E126 A, E127 A, E128 A dated 10.02.2016 issued by SGS and are as follows:

2. Engine 1; No 59115371

SO₂ – <1.39 mg/Nm³

CO – 97+-5 mg/Nm³

NO_x – 42.57+-2.13 mg/Nm³

2. Engine 2; No 59115391

SO₂ – <1.42 mg/Nm³

CO – 97+-5 mg/Nm³

NO_x – 43.29+-2.16 mg/Nm³

3. Engine 3; No 59115381

SO₂ – <1.39 mg/Nm³

CO – 99+-5 mg/Nm³

NO_x – 39.46+-1.97 mg/Nm³

Acceptable values by the law:

SO₂ – 35 mg/Nm³
CO – 100mg/Nm³
NO_x - 250 mg/Nm³

As demonstrated by the protocols the content of SO₂, CO and NO_x gases in the stack flue gas of the co-generator units is in the permitted range according to the relevant Regulation No1 of 27.06.2005 for gaseous fuels.

In order to keep values inside permitted limits the operating personnel is paying higher attention to the operating regime of the gas engines in order to provide optimal conditions for the combustion of the biogas. In order to reduce emissions the operating team cleans at a regular base the oxidizing catalyst and adjusts the combusting process to reach optimal performance of the process.

The project combusts biogas containing CH₄ and no measurement of its content as well as dust content in the flue gas is required.

The data is measured on 2 years as by local law and per internal procedures, ISO 14001: 2015, OHSAS 18001:2007 and ISO 45001:2018.

Waste oil disposal:

Waste oil is disposed according to the Decision for Waste Treatment No 12-ДО-1204-00 dated 20.02.2013, issued by the Regional Inspection for Environment.

According to the delivery documents the WwTP has delivered for further utilization to the authorized company "Moby-shop" Ltd (Agreement No OO120-00/2013-A of 11.04.2013) and company Ecologika Bulgaria Ltd. (Agreement No 6625 of 26.06.2015, Annex No 1 of 11.05.2016) the following amounts of waste mineral motor oil (code No 13 02 05):

1. 09.09.2016 – 810 kg.
3. 10.11.2016– 1,185 kg.
4. 14.02.2017 – 610 kg.
5. 20.04.2017 - 400 kg.
6. 29.05.2017 – 870 kg.
7. 08.09.2017 – 1,280 kg.
8. 04.12.2017 – 1,110 kg.
9. 29.01.2018 – 1,200 kg.
10. 30.03.2018 – 900 kg.
11. 15.08.2018 – 904 kg..

Total for the monitoring period: 9,269 kg.

The waste oil has been transported in steel barrels by trucks.

All protocols for waste oil delivery are available at the plant for inspection.

The process follows strictly all requirements of the Decision for Waste Treatment No 12-ДО-1204-00 dated 20.02.2013, issued by the Regional Inspection for Environment.

SDG 11

The average values recorded monthly for 2016,2017 & 2018 are given in the table below:

Period	COD inlet [mgO ₂ /l]	BOD inlet [mgO ₂ /l]	COD effluent [mgO ₂ /l]	BOD effluent [mgO ₂ /l]	Quantity of waste water (sludge) treated [m ³]
2016					

June	115.8	287.5	5.6	16.0	57,600
July	121.3	289.0	4.9	18.4	58,560
August	123.6	285.4	5.7	18.5	55,320
September	150.0	318.7	5.3	17.3	50,560
October	124.5	270.2	6.2	16.1	56,880
November	145.4	323.8	5.9	17.0	56,200
December	148.9	315.9	6.4	18.4	59,400
Total					394,520
2017					
January	131.7	293.2	5.9	13.5	56,300
February	119.2	260.5	6.9	18.0	50,830
March	120.5	259.7	5.3	19.5	59,320
April	120.0	282.1	6.1	30.0	59,490
May	143.5	333.6	5.9	30.0	62,000
June	149.2	326.2	6.0	26.0	58,840
July	130.5	289.4	5.8	19.5	60,600
August	111.9	274.7	5.3	13.5	58,640
October	122.1	293.9	8.2	14.5	57,280
November	137.5	302.1	5.4	18.5	60,760
December	150.5	330.9	5.4	18.5	60,760
Total					703,620
2018					
January	141.5	308.2	5.6	14.5	60,760
February	129.5	271.4	10.7	17.0	54,880
March	96.2	218.2	5.2	28.5	60,760
April	111.0	245.3	7.7	23.0	58,700
May	123.2	284.9	7.5	25.5	60,760
June	117.9	293.5	7.5	25.5	58,400
July	101.2	262.7	7.1	23.0	58,640
August	129.9	320.0	11.6	25.5	58,240
Average for the Monitoring period:			6.50	20.22	
Total					471,140
Total for the monitoring period					1,569,280

Acceptable values by the standard (effluent water):

2.COD – 125 mgO₂/l

2a.BOD₅ – 25.0 mgO₂/l

As demonstrated by the table all measured values of effluent water are lower than the values permitted by the standard.

Data is collected following plant internal procedures and as per VLM NoWW-17/27.05.2008 and BDS EN 1899-1:2004, B.4.2.

E.3. Calculation of net benefits as difference of baseline and project values or direct calculation for each SDG outcome

SDG13: Total emission reductions generated in the monitored period:

$$ER = 193,121 - 16,280 = 176,841 \text{ tCO}_2e$$

The calculation of the project emissions is presented in the excel file named "Sofiyska_voda_VER_Calculation_ver.02_216-2018.xlsm" which is attached to this Monitoring report.

SDG 6:

Quantity of waste oil disposed:
9,269 kg.

SDG 11:

Quantity of waste water (sludge) treated:

1,569,280 m³

E.4. Summary of ex-post values of each SDG outcome for the current monitoring period

Item	Baseline estimate	Project estimate	Net benefit
SDG 13	193,121	16,280	176,841
SDG 6	0	9,269 kg.	9,269 kg.
SDG 11	0	1,569,280 m ³	1,569,280 m ³

E.5. Comparison of actual value of outcomes with estimates in approved PDD

Item	Values estimated in ex ante calculation of approved PDD	Actual values achieved during this monitoring period
SDG 13	158,121	176,841

E.6. Remarks on difference from estimated value in approved PDD

The difference of 11.8 % from the estimated value in the approved PDD is due mainly to the increased volume of municipal wastewater from one hand and the experience that the personnel of the plant accumulated during operation of the project in the previous period from the other.

The biological processes that are used to treat the sludge and to generate biogas in the reactors are highly sensitive and require high level of knowledge and experience to operate and control.

SECTION F. Stakeholder inputs and legal disputes

- F.1. List all inputs/grievances which have been received for the project during the monitoring period together with their respective answers/actions**

No inputs/grievances have been registered during the current monitoring period

- F.2. List all inputs/grievances from previous monitoring period where follow up action is to be verified in this monitoring period**

No inputs/grievances have been registered from the previous monitoring period that require any follow up action.

- F.3. Provide details of any legal contest or dispute that has arisen with the project during the monitoring period**

N/A

Month/Year	Net thermal energy by cogenerators & boilers EGthermal,y	El. Energy produced by cogenerators EGgrid,y	Biogas generated BGburnt,y	Quantity of sludge at inlet digesters Q_DGs_inlet	Specific content of dry matter in the sludge psludge	Quantity of dry matter in the sludge at inlet digesters Sfinal,Pj,y	CH4 content in the biogas Wch4,y	Quantity of CH4 in the biogas BGCH4burnt	Quantity of CH4 in the biogas BGCH4burnt	Quantity of emergency fuel used FCy	Flare debit	Quantity of CH4 to flare Vt,db	Flare working hours	Quantity of CH4 in the biogas to flare FCH4
	[TJ]	[MWh]	[Nm3]	[m3]	[t/m3]	[t]	[%]	[m3]	[t]	[t]	[m3/h]	[m3CH4]	[h]	[kg]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Jun 2016	6.63	1,785.72	1,094,908.00	57,600.00	0.06	3,542.11	63.00	689,839.13	462.19	0.00	500.00	1,947.88	6.18	1,305.08
Jul 2016	6.39	1,723.05	1,075,714.06	58,560.00	0.05	3,213.50	61.73	664,059.87	444.92	0.00	500.00	1,198.63	3.88	803.08
Aug 2016	5.73	1,450.73	956,820.00	55,320.00	0.05	2,659.73	61.00	583,660.20	391.05	0.00	500.00	6,216.92	20.38	4,165.33
Sep 2016	5.60	1,443.01	904,280.00	50,560.00	0.05	2,539.07	60.47	546,788.65	366.35	0.00	500.00	1,849.27	6.12	1,239.01
Oct 2016	7.17	1,937.26	1,159,680.00	56,880.00	0.05	2,929.42	59.43	689,185.92	461.75	0.00	500.00	703.24	2.37	471.17
Nov 2016	7.33	1,943.15	1,146,585.00	56,200.00	0.05	2,628.74	62.00	710,882.70	476.29	0.00	500.00	2,970.83	9.58	1,990.46
Dec 2016	8.02	2,149.58	1,195,240.00	59,400.00	0.04	2,622.75	66.00	788,858.40	528.54	0.00	500.00	687.50	2.08	460.63
TOTAL	46.88	12,432.49	7,533,227.06	394,520.00		20,135.33		4,673,274.87	3,131.09	0.00		15,574.28		10,434.77
Jan 2017	7.25	1,630.98	1,012,350.00	56,300.00	0.04	2,434.66	67.00	678,274.50	454.44	0.00	500.00	3,852.50	11.50	2,581.18
Feb 2017	7.91	1,755.56	1,062,720.00	50,830.00	0.06	2,800.73	67.00	712,022.40	477.06	0.00	500.00	4,271.25	12.75	2,861.74
Mar 2017	7.16	1,911.34	1,056,250.00	59,320.00	0.05	3,160.70	68.00	718,250.00	481.23	0.00	500.00	2,465.00	7.25	1,651.55
Apr 2017	7.79	2,022.00	1,111,680.00	59,490.00	0.05	2,905.26	68.00	755,942.40	506.48	0.00	500.00	3,400.00	10.00	2,278.00
May 2017	8.07	2,024.76	1,278,900.00	62,000.00	0.06	3,444.00	68.00	869,652.00	582.67	0.00	500.00	46,580.00	137.00	31,208.60
Jun 2017	7.17	1,944.36	1,217,989.30	58,840.00	0.06	3,692.09	67.00	816,052.83	546.76	0.00	500.00	41,875.00	125.00	28,056.25
Jul 2017	7.46	2,024.28	1,193,191.59	60,600.00	0.06	3,772.90	66.00	787,506.45	527.63	0.00	500.00	11,467.50	34.75	7,683.23
Aug 2017	6.85	1,857.57	1,096,283.99	58,640.00	0.06	3,394.10	66.00	723,547.43	484.78	0.00	500.00	3,877.50	11.75	2,597.93
Sep 2017	6.60	1,790.17	1,095,011.51	57,280.00	0.05	2,891.74	67.00	733,657.71	491.55	0.00	500.00	4,103.75	12.25	2,749.51
Oct 2017	7.94	2,106.95	1,355,941.94	60,760.00	0.05	3,132.28	65.00	881,362.26	590.51	0.00	500.00	15,600.00	48.00	10,452.00
Nov 2017	8.22	2,111.97	1,123,154.00	58,800.00	0.06	3,268.10	64.00	718,818.56	481.61	0.00	500.00	3,520.00	11.00	2,358.40
Dec 2017	7.35	1,989.61	1,033,400.00	60,760.00	0.06	3,762.02	65.00	671,710.00	450.05	0.00	500.00	2,843.75	8.75	1,905.31
TOTAL	89.77	23,169.54	13,636,872.33	703,620.00		38,658.60		9,066,796.55	6,074.75	0.00		143,856.25		96,383.69
Jan 2018	7.78	2,100.06	1,084,516.94	60,760.00	0.06	3,385.41	63.00	683,245.67	457.77	0.00	500.00	945.00	3.00	633.15
Feb 2018	7.23	1,912.62	903,600.00	54,880.00	0.06	3,395.70	62.55	565,201.80	378.69	0.00	500.00	1,641.94	5.25	1,100.10
Mar 2018	7.97	2,126.46	973,211.30	60,760.00	0.07	4,241.54	62.68	610,026.28	408.72			313.41	1.00	209.98
Apr 2018	7.92	2,071.83	923,240.00	58,700.00	0.06	3,436.00	64.22	592,886.76	397.23			3,692.54	11.50	2,474.00
May 2018	8.47	2,235.34	977,994.29	60,760.00	0.06	3,714.69	67.86	663,686.57	444.67	0.00	500.00	4,580.69	13.50	3,069.06
Jun 2018	7.68	2,075.29	907,142.00	58,400.00	0.07	3,851.44	68.69	623,105.62	417.48	0.00	500.00	9,015.41	26.25	6,040.33
Jul 2018	6.16	1,663.72	751,430.00	58,640.00	0.05	3,191.45	67.12	504,387.57	337.94			587.33	1.75	393.51
Aug 2018	5.80	1,568.80	786,020.00	58,240.00	0.05	3,122.49	69.13	543,395.46	364.07	0.00	500.00	48,911.26	141.50	32,770.54
TOTAL	59.01	15,754.11	7,307,154.53	471,140.00		28,338.72		4,785,935.73	3,206.58	0.00		69,687.58		46,690.68
TOTAL for the period	195.66	51,356.14	28,477,253.92	1,569,280.00		87,132.64		18,526,007.15	12,412.42	0.00		229,118.11		153,509.13

