Verified Carbon Standard

BALIKESIR LANDFILL GAS (LFG) CAPTURE AND UTILIZATION PROJECT

GAIA CLIMATE

Document Prepared by Gaia Climate

Project Title	BALIKESIR Landfill Gas (LFG) Capture and Utilization Project
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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Balıkesir Landfill Gas (LFG) Capture and Utilization Project is being implemented by Landfill Enerji Sanayi ve Ticaret A.Ş. within the boundaries of Balıkesir Solid Waste Disposal Site (SWDS) in Balıkesir province in TÜRKİYE. The project activity has the installed capacity of 11.312 MW_e and 8 gas engines are in operation. Generation licence of project is for 14.14 MW_e installed capacity (operational 10 gas engines) however, current operational capacity is evaluated as sufficient up to end of 2023 due to generated LFG amount. 9th Gas engine will be commissioned in year 2024.

As planned, landfill has been rehabilitated for old lots and around 1,200 tons/day of municipal solid waste (MSW) of Balıkesir province has been disposed properly in the landfill. and to generate renewable electric power by capturing and utilizing landfill gas.

Project is made of a sanitary landfill area and electricity generation facility. The LFG gas generated from the sanitary landfill is converted into electrical energy at the Electricity Generation Facility and transferred to the interconnected system to generate income.

The project has begun to generate electricity on 27-October-2019, which is regarded as the project start date. There are 4 gas engines commissioned on 27-October-2019, another 2 gas engines commissioned on 03-October-2020 and 2 more gas engines commissioned on 31-July-2021. The operation continues as usual

The expected average annual emission reductions are 334,913 tCO_2e/year. Accordingly, the project is expected to generate 2,344,393 tCO_2e emissions reduction throughout the crediting period. Total emission reduction achieved in current monitoring period, which is 27-October-2019 to 31-December-2022 was 823,666 tCO_2e.

Audit Type	Period	Program	VVB Name	Number of years
Validation	27-October-2019- 26-October-2026	VCS	TUV SUD South Asia Private Limited	7 years
Verification	27-October-2019 – 31-December-2022	VCS	Earthood	3 years, 2 months
Total				

1.2 Sectoral Scope and Project Type

The project falls into sectoral scope 01: Energy industries (renewable - / non-renewable sources) (Type I Component), sectoral scope 13: Waste handling and disposal (Type III Component). The project is not a grouped project.

1.3 Project Proponent

Organization name	BIOTREND Çevre ve Enerji Yatırımları Anonim Şirketi
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Title	Plant Manager
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1.4 Other Entities Involved in the Project

N/A

1.5 Project Start Date

The project start date is 27-October-2019, as the operation start date on which the project began to eliminate the negative effects of municipal solid wastes on environment and human health. Also to generate emission reductions, create economic value and to establish a sustainable waste management system.

1.6 Project Crediting Period

This project adopts the renewable crediting period of 7 years from 27-October-2019 to 26-October-2026 (the start and end dates are included).

1.7 Project Location

The project is implemented in a total of 137 hectares of area within the boundaries of Balıkesir Solid Waste Landfill Facility in Balıkesir Province, Altıeylül District, Gökköy village.

The central coordinated of the project location are latitude of +39.612806 and longitude of +27.85313939.

1.8 Title and Reference of Methodology

Applied approved baseline and monitoring methodologies:

The large-scale methodology ACM0001 Version 19, “Flaring or use of landfill gas” has been employed in the project activity.

Applied tools:

TOOL02 “Combined tool to identify the baseline scenario and demonstrate additionality”

(Version 07.0) (hereafter also referred to as “Additionality tool”).

TOOL03 “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”

(Version 03.0).

TOOL04 “Emissions from solid waste disposal sites” (Version 08.1).

TOOL05 “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0).

TOOL06 “Project emissions from flaring” (Version 04.0).

TOOL08 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”

(Version 03.0):

TOOL11 “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” (Version 03.0.1).

1.9 Participation under other GHG Programs

The project has not been registered or is seeking registration under any other GHG programs.

1.10 Other Forms of Credit and Supply Chain (Scope 3) Emissions

The project does not reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading.
The project has not sought or received another form of GHG-related credit or renewable energy certificates.

In this project, emissions are reduced from the electricity sector in TÜRKİYE by implementing renewable energy sources and energy efficiency measures. The produced good in this project is electricity, which falls under Scope 1 and 2 emissions of industrial producers. As such, there is no direct involvement of any specific producer or retailer of the impacted good or service in this project.

Double counting is a common source of concern in the tracking and reporting of emissions reductions because it can result in overstated emissions reductions, misrepresentation of actual emissions, and undermine the integrity of the emissions reduction certification process. To address this concern, it is vital to have a robust and transparent tracking and reporting mechanism in place, which is exactly what we have done with our LFG project.
TÜRKİYE has a centralized national grid system, which means that all the electricity generated by the project is fed into the same grid and distributed to all consumers. This is a crucial factor in avoiding the risk of double counting, as the electricity generated from our project is not separately metered and credited, but instead blended with other sources of electricity in the grid, so there is no way to determine the exact proportion of electricity generated from our project.

Project Proponent “BIOTREND Çevre ve Enerji Yatırımları Anonim Şirketi” has understood and committed the importance of transparency and accountability in carbon credits and made an official statement about it. Signed declaration is given in appendix I.

1.11 Sustainable Development Contributions

The Project will contribute to sustainable development in the following ways:

• Increasing labor demand of skilled labor for the fabrication, installation, operation and maintenance of the methane recovery and electricity generation system and thus, contributing to the sustainable economic growth of the region,

• Generating and dispatching electricity from a renewable and sustainable energy source to a grid nowadays reliant on fossil,

• Contributing to the climate change fight by reducing CH_4 emissions.

• Constituting a new, clean and efficient technology model for the disposal and handling of waste

• Improving air quality (i.e. by reducing odor) and therefore having positive effects on the local environment.

Nevertheless, it is still possible to note that the project will make positive contributions to at least three Sustainable Development Goals (SDGs). These are:

SDG Goal 7: Affordable and Clean Energy

The proposed Project is a waste to power project that will generate renewable energy by capturing methane from municipal waste and utilizing it to produce thermal and electric energy through gas engine systems. By supplying renewable energy generated at the plant to the national grid, the proposed Project will contribute to increasing the share of renewable energy in the global energy mix and the proportion of the population with primary reliance on clean fuels and technology.

SDG Goal 8: Decent Work and Economic Growth

The demand for food and electric energy is rapidly increasing in TÜRKİYE for various reasons, such as industrialization, urbanization, economic development, and population growth. The country's external dependence on agricultural products has intensified because the increasing demand cannot be met by a decreasing domestic agricultural production capacity which is due to several reasons, such as shrinkage of agricultural land, increasing migration to urban spaces from rural areas where agricultural production is densely located, and dramatic increase in the cost of inputs for agricultural production. Therewithal, TÜRKİYE, which cannot meet its increasing electricity demand due to the deprivation of conventional resources used to generate energy, such as coal, oil, and natural gas, has also become foreign-dependent on energy. Through its implementation, the proposed project activity will contribute to reducing TÜRKİYE's foreign dependency by generating renewable energy out of municipal wastes. In addition, as an LFG-based renewable energy technology implementation, the proposed project activity will achieve higher levels of economic productivity; hence, increasing the annual growth rate of real GDP per employed person. Moreover, it will increase the region's employment capacity while decreasing the unemployment rate.

SDG Goal 13: Climate Action

The proposed project activity will reduce GHG emissions by capturing and utilizing methane, one of the most potent GHGs triggering climate change. It is estimated that the average annual emission reduction that the proposed Project will generate is around 334,913 tCO_2e/year.

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	7.2	7.2.1 Renewable energy share in the total final energy consumption	Implemented activities to increase : Towards addressing Quantity of net electricity supplied to the grid by project activity in year will replace equivalent amount of electricity feed to the grid by fossil fuel-based power plant.	143,160.012 MWh of net electricity from renewable sources has been supplied to the power grid during the reporting period.[1]	It was estimated that the project will generate 692,860 MWh over the first crediting period.[2]
2)	8.5	8.5.1 Numbers of job opportunities Provided by the project	Implemented activities to increase addressing the temporary and primary employment opportunity during the construction and operation phase.	26 people have been employed by the project as long-term employees, of which 1 women are employed.	26 people have been employed by the project as long-term employees by end of the reporting period, of which 1 women are employed.

[1] EPIAS Settlement Records provided by the project proponent

[2] Generation License

3)	13.2	13.2.1. Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase: Implemented activities to result in avoidance of greenhouse gas emission by methane avoidance practices as well as refraining generation of electricity in fossil fuel -based power plant connected to the grid.	Achieved total GHG emission reduction during the reporting period is 823,666 tCO_2e.	With this project it is expected to achieve an accumulated GHG emission reduction of 2,344,393 tCO_2e during validation period..

2 SAFEGUARDS

2.1 No Net Harm

The Ministry of Environment and Urbanization has given the Environmental Impact Assessment conformity decision for the project[3]. According to Turkish rules and regulations, an EIA's permission may only be granted if the project in question has no detrimental effects on the environment or the economy, thus the project has no net harm. All kinds of preventive measures will be taken to minimize the odor, dust, gas and similar negative effects that may arise from the facility. Some of these preventive measures are:

- Dust pollution management. Stones and gravels used on project site to cover gas collection system. They are bought from suppliers and carried to site via trucks. Top of trucks has cover material that prevents dust formation or material spill during transportation. Soil cover material is obtained from site and covering dump site operations cause temporarily insignificant dust raise. Wheel washer unit of landfill site (standard practice) also removes some of the collected dust and other pollutants from truck tires.
- Noise pollution management: During project feasibility, it has been found that calculated maximum noise level at the nearest settlement would be 40.11 dBA under conservative estimations (maximum) and wouldn't exceed legal threshold level of 65 dBA[4]. Regardless equipment malfunctions or worn that cause noise pollution are tracked and such parts are changed when needed.
- Gas and odour management: Gas engines stacks are subjected to biannual testing[5] in Türkiye to measure air pollutants such as NOx, SOx, CO and PM. Balıkesir project also complied with these testing requirements (see to appendix for test reports). Further biological desulphurization system reduced hydrogen sulfide to low concentrations (200 ppm threshold).
- Leachate Management. Balıkesir province Water and Sewerage Administration granted a permit for discharge quality control permit (Deşarj Kalite Kontrol Ruhsatı in Turkish) in 2019. Collected leachate is temporarily transferred to leachate collection pool system and treatment system that is consists of a grit system, equalization pool, sludge thickening pool and activated sludge treatment system. Leachate pools are made with special concrete to prevent any leaks to ground and a membrane system is layed over the concrete. Treated liquid fraction is sent to designated wastewater collection grid which is connected to wastewater treatment facility. Solid fraction is disposed to landfill.

[3] Please see the document showing the EIA affirmation decision

[4] EIA Report, page 318

[5] https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=13184&MevzuatTur=7&MevzuatTertip=5

2.2 Local Stakeholder Consultation

As per the VCS requirements, it is necessary to invite the relevant stakeholders, prior of the validation process.

Local stakeholder consultation was conducted through distributing questionnaires to local stakeholders by the project owner on 30-September-2021. Stakeholder's feedback has been taken by the interaction and by a feedback form on MS team platform. The questionnaire was reasonably designed to assess the project impacts on the local environment and social economic development.

Furthermore, a grievance book is put in the communication room at the project owner company. The local stakeholders can provide feedback through this way. Also, the village head will reach PO if any comments are received.

The stakeholders expressed unanimous support for the establishment of these projects in the region, and no negative comments or concerns were raised.

For the ongoing stakeholder's communication, PP has placed a grievance register onsite, where stakeholder can register their grievance or feedback and the same is reviewed by site manager/site in-charge and if found genuine addressed as per companies' policy.

Within first crediting period, no feedback or grievance has been received from the local shareholders. See to appendix for supporting material.

2.3 AFOLU-Specific Safeguards

Since the project is a non-AFOLU project, this section is not required.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

Electric power is generated from landfill gas and a significant investment will be realized in terms of renewable energy resources. There is no distribution of generated biogas through pipelines nor trucks to end users and it is not used for heat generation.

LFG leaving booster unit is considered dry, pressurized for gas engines, and measured by volume. Temperature (T), Pressure (P) and flow rate (Q) of LFG is measured at certain points for process controls. Flowmeter works together with pressure sensor and temperature sensor for pressurized LFG that has been destroyed in gas engines. Gas analyser measures cooled down dry LFG that had lost H_2S content in desulphurization. Electricity meters measures how much electricity generated and how much electricity consumed simultaneously.

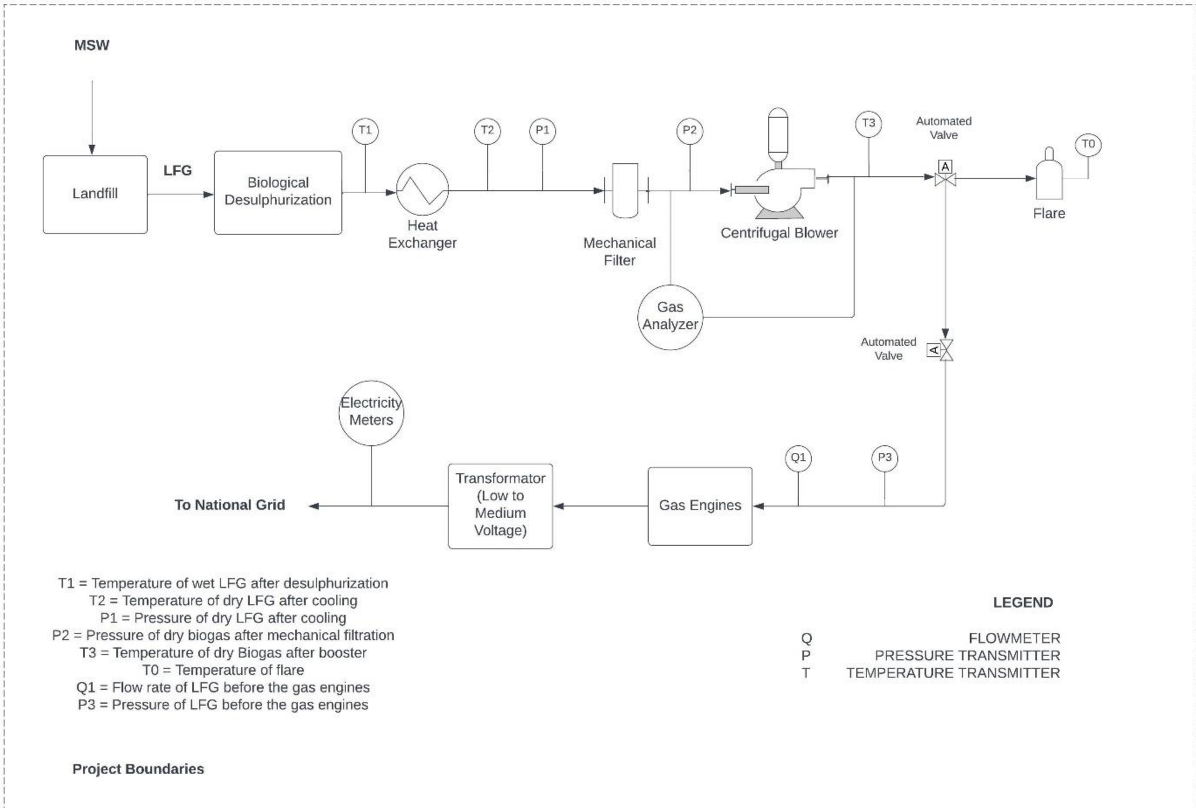


Figure 1 Process Flow Diagram of Balıkesir Landfill Biogas Utilization

The different units are presented in the following sections:

a. Landfill gas collection area:

The process of power generation from landfill gas is composed of various phases. The landfill gas is collected in sanitary landfill areas. The collected landfill gasses are absorbed by the blowers and transferred to the gas cooling and desulfurization unit of the facility.

Figure 2 Landfill Gas collection areas. Section a. area expansion for more waste depositing. Section b. Old waste deposition area (2005-2021)

b. Desulfurization and Biogas Cooling

In the desulfurization unit, Hydrogen sulfide (H_2S) gas is removed from biogas through biological processes. The dry biogas then enters the heat exchangers, and the condensates (water) are sent to the water treatment plant of the municipality together with the leakage water.

c. Flaring unit

The facility has a Flaring unit to prevent the release of the landfill gas in case of any breakdown or failure in the facility or when the facility is out of service. The landfill gas would be flared in such conditions.

d. Power generation by burning Landfill Gas in Internal combustion engines:

There are 8 gas engines with an installed capacity of 1.414 MW_e each, total capacity 11.312 MW_e, where the LFG is burnt and converted into electric power. The generated power is fed into the national grid and it is further delivered to the consumers through power transmission lines.

Since the internal combustion engines require less gas flow rate and are easier to switch on and off when compared to the gas turbines, they are more suitable for landfill gas power plants. Mostly all of the landfill gas power plants in our country consist of internal combustion engines.

● Internal Combustion Gas engines (ICE):
Internal combustion engines are the most suitable method for the utilization in landfill gas power plants.

The engines installed in the project are GE Janbacher Genset JGS 420 GS-L-L characterized by a high-power density and efficiency.

Table 2 Technical specifications GE Janbacher Genset JGS 420 GS-B121

Technical Specifications	
Electrical Output	1.414 MW_e
Voltage	480V-13.8kV
Thermal Output	0.98-1.720 MW_t
Thermal Efficiency	Up to 43%
Fuel Type	Flexible
	
Commissioning date of 4 gas engines	27-October-2019
Commissioning date of 2 gas engines	03-October-2020
Commissioning date of 2 gas engines	31-July-2021

There are 8 gas engines are operational as of 2023. This was taken into account for the emission reduction calculation.

●Technology and Units:
The technology employed will be the improvement of landfill gas collection and flaring through the installation of an active recovery system composed by:

Table 3. Machine and Equipment Information

Number	MACHINE AND EQUIPMENT (Type and Technical Properties)
8	GE Jenbacher Gas Engine (11,312 kW Total Capacity)
8	Transformer (2000 kVA)
8	Alternator
8	Turbo (ABB)[6]
1	Transformer (internal need) (800 kVA) (Maksan)
1	Chiller (122.18 kWh)
1	Chiller (255 kWh)
1	Exchanger (3-4,5 bar)
1	Exchanger (1-9 bar)
3	Blower (3*55 kW capacity)
1	CONVECO Booster and Flare Unit

Table 4. Technical Specification of Transformers (2000 kVA)

Technical Specifications	
Manufacturer	Maksan
Type	Hermetically Sealed Type
Nominal Power	2000 kVA
Voltage Class	36 kV
Rated Frequency	50 Hz.
Nominal Current	34.99 A
Manufacturing Standard	TS EN 60076-1
Year of Manufacture	2019

Table 5. Technical Specification of Alternators

Technical Specifications	
Manufacturer	Nidec Leroy-Somer

[6] Not a separate equipment, part of transformer unit (Meksan, 200 kVA)

Type	Low Voltage Alternator – 4 pole (LSA 52.3)
Power Rating	1400 kW - 1750 kVA
Y	400 V – 2526 A
UPM – R.P.M.	1500 – 50 Hz.
Manufacturing Standard	IEC 60034-1
Year of Manufacture	2019

Table 6. Technical Specification of Transformer (800 kVA)

Technical Specifications	
Manufacturer	Maksan
Type	Hermetically Sealed Type
Nominal Power	800 kVA
Phase	3
Rated Frequency	50 Hz.
Cos Phi	0.8
Manufacturing Standard	TS EN 60076-1
Year of Manufacture	2019

Table 7. Technical Specification of Chiller (122.18 kWh)

Technical Specifications	
Manufacturer	Ülker Chillers
Model	UC ASH 35.2
Compressor Type	Semi Hermetic
Cooling Capacity	122.18 kWh
Phase	3
Rated Frequency	50 Hz.
Electrical Supply	380V
Serial Number	081913
Year of Manufacture	2019

Table 8. Technical Specification of Chiller (255 kWh)

Technical Specifications	
Manufacturer	Thermocold
Model	AWA XEA 2290Z C XB
Phase	3Ph+N
Rated Frequency	50 Hz.
Electrical Supply	400V
Serial Number	GE-2557-G0
Year of Manufacture	2021

Table 8. Technical Specification of Heat Exchanger (3-4.5 bar)

Technical Specifications	
Manufacturer	Thermocold
Model	AWA XEA 2290Z C XB
Phase	3Ph+N
Rated Frequency	50 Hz.
Electrical Supply	400V
Serial Number	GE-2557-G0
Year of Manufacture	2021

Table 9. Technical Specification of Heat Exchanger (1-9 bar)

Technical Specifications	
Manufacturer	MBS
Model	MLI 406 337 16 0 2000 FG AA
Tube Side Fluid	Biogas
Shell Side Fluid	Glycol et. 20% 3C
Temperature Range	-10 / 110 °C
Serial Number	26934
Year of Manufacture	2019

Table 10. Technical Specification of Heat Exchanger (1-9 bar)

Technical Specifications	
Manufacturer	Enerkon
Type	BDS-700-00
Capacity	700 m^3/h
Max. Allowable Pressure	3 barg
Test pressure	4.5 barg

Temperature Range	38/ 100 °C
Serial Number	2021-2170
Year of Manufacture	2021
Manufacturing Standard	EN 13445

Table 11. Technical Specification of Blowers (55 kW)

Technical Specifications	
Manufacturer	SAVIO S.r.l
Model	MI.CO 220/4 ATEX
Rated Power	55 kW
Voltage	400/690 V
Speed	3500 rpm
Year of Manufacture	2019

Table 12. Technical Specification of CONVECO S. r. l. Static closed chamber flare

Technical specifications	
Capacity range	Designed for combustion of 300 m³/h of biogas Flow capacity range (50-2500 m³/h)
Combustion temperatures	850-1100 °C
Flame retention	>0.3 sec
Operation	PLC
	

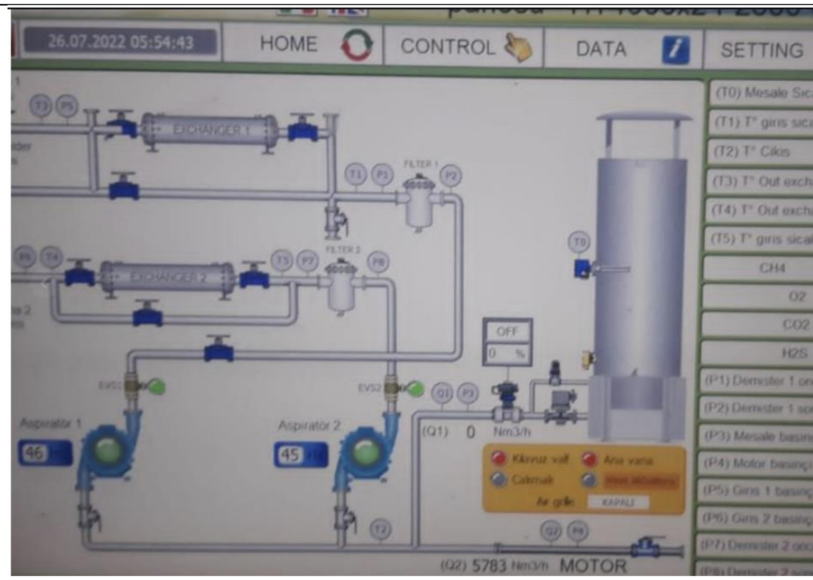
Control panel visualization on from flare system.	

Figure 3. Project site. Source: Google Earth

Figure 4. Panoramic of the Balikesir project. Source: Google Earth

Delayed gas engine commissioning

This is a registered project which is in operation since 27-October-2019. After validation, the operation continues with a slight change implementation. There are 8 engines in operation during first monitoring period, in oppose to 10 gas engines stated in the validation report. 9th Gas engine is planned to be commissioned in year 2024. This is caused by lower-than-expected LFG generation from rehabilitated lots of landfills. There is a complexity for the ex-ante estimation of rehabilitated landfills therefore such realized differences are considered normal. Prediction of remaining organic content in landfills includes uncertainties.

3.2 Deviations

3.2.1 Methodology Deviations

According to VCS Standard v4.7 paragraph 3.20, “Projects are permitted to deviate from the procedures set out in methodologies in certain cases, such as where alternative methods may be more efficient for project-specific circumstances, or where the deviation will achieve the same level of accuracy or is more conservative than what is set out in the methodology.”

There are three requirements:

3.20.1 Deviations from the applied methodology are permitted where they represent a deviation from the criteria and procedures relating to monitoring or measurement set out in the methodology (i.e., deviations are permitted where they relate to data and parameters available at validation, data and parameters monitored, or the monitoring plan)

3.20.2 Methodology deviations shall not negatively impact the conservativeness of the quantification of reductions or removals, except where they result in increased accuracy of such quantification. Deviations relating to any other part of the methodology shall not be permitted.

3.20.3 Methodology deviations shall be permitted at validation or verification, and their consequences shall be reported in the validation or verification report, as applicable, and all subsequent verification reports. Methodology deviations are not considered to be precedent setting.

Following methodological deviations are evaluated in accordance with paragraph 3.20 of VCS standard .4.7.

Flow measurement dry basis assumption where gaseous stream temperature is lesser than 60 °C wet basis assumption at the measurement of flow due to pressurization

According to methodological TOOL08 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” v03.0 paragraph 23, “Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

(a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or

(b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point.”

And paragraph 24 states “If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement should be assumed to be on a wet basis and the corresponding option from Table 2 should be applied instead”.

Under project activity, wet gas is desulphurized, cooled within heat exchangers (accoupled with chiller units) and lose humidity, mechanically filtered, and pressurized for an efficient combustion within gas engines. According to methodological TOOL08 paragraph 23 (b), the temperature of the gaseous stream (T_t) should be less than 60ºC (333.15 K) at the flow measurement point to prove gaseous stream is dry. However, during pressurization of gaseous stream via blowers, temperature of landfill gas increases and exceeds 60ºC on some occasions (affected by seasonality as well). It has been found that 1491 hourly measurements out of 26308 measurements are affected by this issue. Therefore, applicability condition (b) should monitor gaseous stream's temperature at the inlet of heat exchanger where gaseous stream is not heated by pressurization. Conservatively option C is applied whenever gaseous stream is greater than 60ºC.

Paragraph 3.20.1 Evaluation: Applicable. Proposed deviation is related to monitoring of gaseous stream temperature,

Paragraph 3.20.2 Evaluation: Proposed deviation increases the accuracy of quantification since temperature increase of gaseous stream due to pressurization is unrelated with moisture content of gaseous stream. Quantity of methane gas in mass (only tracked greenhouse gas under project activity) would not change during cooling and pressurization processes due to conservation of mass, also measurements of flow, pressure and temperature of gaseous stream is made at the same point. Composition of gas does not change during pressurization and cooling as well. According to raw landfill gas temperature data, average temperature is 35.869 °C and it doesn't exceed 60 °C in any of the readings. This indicates that gaseous stream can be assumed dry at the measurement point. However, wet gas assumption is assumed for reading where temperature of pressurized gaseous stream exceeds 60 °C and dry gas assumption is made for the other measurements.

Paragraph 3.20.3 Evaluation: Proposed deviation allows the usage and quantification of emission reduction of measurements with two different methods at the point of flow measurement. Application of

Moisture content was not measured during first monitoring period therefore item (a) is not applicable.

Calculation of project emission from flaring:

Under project activity and during the first monitoring period, there is one flowmeter placed before gas engines and an operational flare is installed as a part of the booster unit. An installed flowmeter will count the flared biogas however this was not the case for first monitoring period. However, flow timer or total working hour parameter of flare unit is zero. The rationale behind these statements is; Although the flare was mechanically connected, equipped with manual (normally close) and solenoid valves and it was operational, it was not connected to automation system electronically and flare can only be operated by manually by opening the mechanical valve and ignition. Therefore, Flare unit is part of booster-unit and it's designed to protect the system during emergencies. Due to presence of diesel generator on-site (provides electricity when grid is off), landfill generating lower than expected LPG (lower than expected load factor) and not experiencing an emergency flare unit has not been activated manually on-site.

Paragraph 3.20.1 Evaluation: Applicable. Proposed deviation is related to criteria of monitoring and measurement of gaseous stream,

Paragraph 3.20.2 Evaluation: Proposed deviation increases the conservativeness of quantification since project flare is not selected purely for biogas destruction (capacity is 300 m^3/h) but to protect system during emergency situations. Proposed calculation method yields greater project emissions in respect to other verified projects from Türkiye where flare serves same purpose

Paragraph 3.20.3 Evaluation: Proposed deviation covers a quantification requirement temporarily and allows calculation of project emission from flaring.

Insufficient data collection for a certain period of time

Booster data from year 2019 is not kept properly until 02-January-2020 therefore baseline emissions from methane avoidance is not accounted for year 2019 and first day of year 2020. During the period of 27-October-2019 to January-2020 data measurements for parameters $v_{i,t,db}$ (Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis m^3 gas i/m^3 dry gas), $V_{t,db}$ (Volumetric flow of the gaseous stream in time interval t on a dry basis, m^3 dry gas/h), P (Absolute pressure of the gaseous stream in time interval t), and T (Temperature of the gaseous stream in time interval t).

Paragraph 3.20.1 Evaluation: Applicable. Proposed deviation is related to criteria of monitoring and measurement of gaseous stream,

Paragraph 3.20.2 Evaluation: Proposed deviation does not negatively impact the conservativeness of the quantification of reductions or removals

Paragraph 3.20.3 Evaluation: Proposed deviation discounts baseline emissions of methane from the SWDS from total baseline emission calculation for the period of 27-October-2019 to January-2020 due to lack of kept measured data.

Project Description Deviations

According to VCS Standard v4.7 paragraph 3.21.2 sub point 2; “) Where the deviation does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario, and the project remains in conformance with the applied methodology, the deviation shall be described and justified in the monitoring report. This shall include a description of when the changes occurred and the reasons for the changes. The deviation shall also be described in all subsequent monitoring reports. Examples of such deviations include changes in the procedures for measurement and monitoring, or project design changes that do not have an impact on the applicability of the methodology, additionality, or the appropriateness of the baseline scenario”.

Following changes are project description changes and does not affect the applicability of the methodology, additionality or the appropriateness of the baseline scenario, thus the project remains in conformance with the applied methodology.

A change in Project Proponent

During the validation process BIO SOLUTIONS Yenilenebilir Enerji ve Danışmanlık Hizmetleri Sanayi ve Ticaret Limited Şirketi (LLC) acted as project consultant and was one of the project proponents. Project owner had decided to continue the verification process with a different consultant hence the project proponents changed.

Calculation option change for mass flow of a greenhouse gas in a gaseous stream

In the registered validation report[7], section 3.2 (TOOL08 applicability table) and section 5.2 (parameter $v_{i,t,wb}$) determination of the mass flow of a greenhouse gas in a gaseous stream would be done by Option F and in page 46-47 Option A is indicated as the selected method (bold option). However, installed flowmeter is Endress Hause brand Deltabar S PMD75 Model that measures flow on differential pressure principle[8]. And Under project activity, wet gas is desulphurized, cooled within heat exchangers (accoupled with chiller units) and lose humidity, mechanically filtered, and pressurized for an efficient combustion within gas engines.

Therefore, following option F, which is on wet mass is not possible. It must be noted that flowmeters are part of booster unit, obtained from Conveco company and not been replaced since the start of the project activity.

3.3 Grouped Projects

The project is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	φ_y
Data unit	Dimensionless
Description	Model correction factor to account for model uncertainties
Source of data	Parameter is taken from the TOOL 04 “Emissions from solid waste disposal sites”.
Value applied	0.75
Justification of choice of data or description of measurement methods and procedures applied	For baseline emissions: according to the “Emissions from solid waste disposal sites”. The appropriate factor was taken based on the application of the tool (A).See table below and the climate where the SWDS is located (Dry conditions). <table><tr><td></td><td>Humid/Wet Conditions</td><td>Dry Conditions</td></tr><tr><td>Application A</td><td>0.75</td><td>0.75</td></tr><tr><td>Application B</td><td>0.85</td><td>0.80</td></tr></table>
Purpose of Data	Calculation of baseline emissions
Comments	-

[7]https://registry.verra.org/mymodule/ProjectDoc/Project_ViewFile.asp?FileID=77126&IDKEY=fiquwesdfmnk0iei23nnm435oiojnc909dsflk9809adlkmlkf106356754

[8] https://bdih-download.endress.com/files/DLA/005056A500261EEC9BA9D651C033DFF1/TI00382PEN_3421-00.pdf

Data / Parameter	OX_{top_layer}
Data unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool "Emissions from solid waste disposal sites" which is based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventory.
Value applied	0.1
Justification of choice of data or description of measurement methods and procedures applied	$OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the methodological tool "Emissions from solid waste disposal sites".
Purpose of Data	The oxidation factor shall be included in the calculation of baseline emissions whereas the effect of oxidation is, as a conservative assumption, neglected under the project activity.
Comments	The oxidation factor represents the proportion of methane that is oxidized to CO_2 This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

Data / Parameter	F
Data unit	Dimensionless
Description	Volume fraction of methane in the SWDS gas.
Source of data	First order decay model from the TOOL 04, "Emissions from solid waste disposal sites".
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	The default value 0.5 is recommended by the Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site is applied.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	MCF
Data unit	-
Description	Methane correction factor.
Source of data	Parameter is taken from the TOOL 04 "Emissions from solid waste disposal sites".
Value applied	0.8
Justification of choice of data or description of measurement methods and procedures applied	For baseline emissions: according to the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" and to the IPCC Guidelines for National Greenhouse Gas Inventories (2006). The following values are to be considered: 1.0 for anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste; 0.5 for semi-aerobic managed solid waste disposal sites. These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system; 0.8 for unmanaged solid waste disposal sites ñ deep and/or with high water table. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste; 0.4 for unmanaged-shallow solid waste disposal sites. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 meters. Due to the fact that the baseline emissions corresponds to an unmanaged SWDS. The value taken was 0,8.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	DOC_f
Data unit	Dimensionless
Description	Fraction of degradable organic carbon that can decompose

Source of data	First order decay model from the TOOL 04 "Emissions from solid waste disposal sites".
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	The default value 0,5 is recommended by the Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site is applied.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	DOC_j
Data unit	Dimensionless
Description	Fraction of degradable organic carbon (by weight) in the waste type j.
Source of data	First order decay model from the TOOL 04 "Emissions from solid waste disposal sites" (Version 08.1).
Value applied	DOC_j See table below
Justification of choice of data or description of measurement methods and procedures applied	For baseline emissions: according to the *TOOL 04* "Emissions from solid waste disposal sites", following values are applied for the different waste types of j.
Purpose of Data	Calculation of baseline emissions.
Comments	

Waste Type j	DOC j (% wet waste)
Wood and wood products	43
Pulp, paper, and cardboard (other than sludge)	40
Food, food waste, beverages, and tobacco (other than sludge)	15
Textiles	24
Garden, park, and yard waste	20
Glass, plastic, metal, other inert	0

Data / Parameter	k_j

Data unit	1/yr.
Description	Decay rate for the waste type j.
Source of data	First order decay model from the TOOL 04 “Emissions from solid waste disposal sites” (Version 08.1).
Value applied	kj See table below
Justification of choice of data or description of measurement methods and procedures applied	(see table below)

For baseline emissions: according to the TOOL 04“Emissions from solid waste disposal sites”, following values are applied for the different waste types of j.Type of Waste		Climate Zone			
		Boreal and Temperate		Tropical	
		(MAT $\leq$ 20 C)		(MAT > 20 C)	
		Dry	Wet	Dry	Moist and Wet
		(MAP/PET < 1)	(MAP/PET > 1)	(MAP < 1000 mm)	(MAP >= 1000 mm)
		Default	Default	Default	Default
Slowly degrading waste	Paper/textile waste	0.04	0.06	0.045	0.07
	Wood/straw waste	0.02	0.03	0.025	0.035
Moderately degrading waste	Other (non-food) organic putrescible/Garden and park waste)	0.05	0.1	0.065	0.17
Rapidly degrading waste	Food waste/Sewage sludge	0.06	0.185	0.085	0.4
Bulk Waste		0.05	0.09	0.065	0.17

Purpose of Data	Calculation of baseline emissions.
Comments	According to Turkish state meteorological service mean annual precipitation of Balıkesir province is 675.6 mm, Reference link: https://www.mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?m=BALIKESIR According to Turkish state meteorological service potential evapotranspiration is at least 1000 mm, Reference link: https://mgm.gov.tr/FILES/arastirma/buharlasma2016.pdf Therefore MAP/PET is below 1 , (see to page 15) Therefore MAP/PET ratio for Balıkesir province is below 1.

	MAT – mean annual temperature, MAP -Mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration. The values applied are for Climate Zone: Boreal and temperate (MAT ≤ 20 C), and dry (MAP/PET < 1)

Data / Parameter	W_{total}
Data unit	*tons*
Description	The amount of waste disposed in the landfill sites in year x .
Source of data	Historical waste data and waste projections
Value applied	(see table below)

	W_total (t/y)
2003	35,000
2004	35,700
2005	36,414
2006	37,142
2007	37,885
2008	38,643
2009	39,416
2010	40,204
2011	41,008
2012	41,828
2013	42,665
2014	43,518
2015	44,309
2016	67,560
2017	84,937
2018	315,850
2019	377,303
2020	423,338
2021	474,139
2022	531,035
2023	594,759
2024	666,131
2025	746,066

	2026	835,594
	2027	935,865
	2028	1,048,169
	2029	1,173,950
	2030	1,314,824
	2031	1,472,602
	2032	1,649,315
	2033	1,847,232
	2034	2,068,900
	2035	2,317,168
	2036	2,595,229
	2037	2,906,656
	2038	3,255,455
	2039	3,646,109
	2040	4,083,642

Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	The estimated amount of waste to be received is based on the Environmental Impact Assessment related to the landfill expansion. The characterization of the municipal solid waste is based on the study performed by Dr. A Seyfert (2019)[9]. The Balikesir Landfill has an old deposition area since 2003, and in 2014 the waste deposition progress at the west and south side of the old area, receiving only the disposal of the city center. From the beginning of 2017 up to the end 2018 the main focus of the waste deposition was the expansion to receive 3 more transfer stations. In 2020, 5 more transfer station were directed to the Balikesir LFG.

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e/ t CH_4
Description	Global warming potential of methane.

Source of data	Decisions under UNFCCC and the Kyoto Protocol (a value of 28 is to be applied)
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$EF_{CO2,grid,y}$
Data unit	t CO_2e/MWh
Description	Emission factor for the Turkish National Grid
Source of data	Published data from The Ministry of the Energy and Natural Resources in TÜRKİYE
Value applied	0.5706
Justification of choice of data or description of measurement methods and procedures applied	Obtained from the most recent official national grid emission factor data published by the Ministry of the Energy and Natural Resources in TÜRKİYE[10]
Purpose of Data	Used in • Calculation of baseline emissions • Calculation of project emissions
Comments	-

Data / Parameter	$TDL_{j,y}$
Data unit	Percentage (%)
Description	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data	Data is taken from Turkish Electricity Transmission Corporation (TEIAS)[11] in accordance with Methodological Tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, Version 3.0
Value applied	9.101

10 https://enerji.gov.tr/evced-cevre-ve-iklim-turkiye-ulusal-elektrik-sebekesi-emisyon-faktoru

11 https://webim.teias.gov.tr/file/ba3a35b0-2393-4d0a-89e2-7351f149e88d?download

Justification of choice of data or description of measurement methods and procedures applied	Scenario A, option 1. Use annual average value based on the most recent data available within the host country. The annual average value based on the most recent data available within TÜRKİYE is for year 2022 and data is provided by TEİAŞ.
Purpose of Data	Calculation of baseline and project emissions
Comments	$TDL_{j,y}$ is equal to $TDL_{k,y}$

Data / Parameter	ρ CH4
Data unit	kg/m^3
Description	Density of methane gas at reference conditions
Source of data	Default Value of TOOL06
Value applied	0.716
Justification of choice of data or description of measurement methods and procedures applied	Biogas at the entrance co-generation units is a dry gas and default density value from TOOL06 is applicable.
Purpose of Data	Determination of the methane mass flow of the residual gas
Comments	

Data / Parameter	$SPEC_{flare}$
Data unit	Temperature, flow rate and Flame detection sensor
Description	Stainless steel burner with multiple nozzle • Combustion range: 25-50% methane • Combustion temperature 850 – 1100 °C • Operating logic managed by PLC • Designed for combustion of 300 m^3/h of biogas. (Flow range 50 to 1500 m^3/h) • Flame retention >0.3 sec
Source of data	Conveco Model AS 3000X2CO
Value applied	Enclosed flare
Justification of choice of data or description of measurement methods and procedures applied	High temperature combustion and extraction system A UV sensor is used for flare detection and ensures safety. Total flared biogas volume is tracked and displayed in booster HMI.
Purpose of Data	Calculation of project emissions from residual gas

Comments	Please find the specifications on the O&M manual of equipment[12].

4.2 Data and Parameters Monitored

Data / Parameter	Management of SWDS
Data unit	-
Description	Management of SWDS
Source of data	Original design of the landfill
Description of measurement methods and procedures to be applied	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
Frequency of monitoring/recording	Annually
Value monitored	PO stated that there is no change to the design.
Monitoring equipment	
QA/QC procedures to be applied	-
Purpose of the data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	$EG_{PJ,y}$
Data unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year y
Source of data	Electricity *Market Operator Company* (EPIAS) records
Description of measurement methods	Monitor net electricity generation by the project activity using LFG

[12] O&M Manual of Booster Unit

and procedures to be applied	
Frequency of monitoring/recording	Continuous measurement every 10 min (24/7) all year and data can be downloaded and saved anytime
Value monitored	2019 (01-December-2019 – 31-December-2019): 778.646 MWh 2020: 43,790.472 MWh 2021: 56,179.247 MWh 2022: 42,434.513 MWh
Monitoring equipment	Calibrated electricity meter
QA/QC procedures to be applied	The accuracy of electricity meters is strictly controlled by the government through regular maintenance and testing, in accordance with the stipulations of the meter supplier. The transmission system operator, a government-owned corporation, is responsible for calibrating these meters. As part of the maintenance and testing process, the meters undergo calibration every 10 years, ensuring their accuracy in measuring electricity consumption. This government oversight guarantees the reliability and precision of the meters used in the Turkish power grid. The readings are double checked by the electricity distribution company. The calibration of meter, including the frequency of calibration, will be done in accordance with national standards or requirements set by the meter supplier or requirements set by the grid operators. The accuracy class of the meter is in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. The metering device Installed at the power plant was calibrated by the manufacturer prior to its installation in 2019. As per the manufacture''s specifications and industry practices, the calibration of the metering device is conducted at the manufacturing facility to ensure its accuracy and compliance with regulatory standards. Therefore, no additional calibration took place on-site at the power plant yet[13].

Model	Serial Number	Date of Calibration	Accuracy Class
Landis + Gyr E550	97821853	28-November-2019	0.5s

[13] Please see Electicity meter seal reports

	Landis + Gyr E550 | 97838980 | 28-November-2019 | 0.5s
Purpose of the data	Calculation of baseline emissions
Calculation method	
Comments	This parameter is required for calculating baseline emissions associated with electricity generation ($BE_{EC,y}$) using the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". These values are taken from "UEV"" column of settlement records which is an official record, sent by government agency to power plants. Regular billing is based on these reports.

Data / Parameter	$EC_{PJ,y}$
Data unit	MWh
Description	Amount of electricity consumed by the project activity in year y
Source of data	Electricity meters
Description of measurement methods and procedures to be applied	Sources of consumption shall include, where applicable, electricity consumed for the operation of the LFG capture system, for any processing and upgrading of the LFG, for transportation of the LFG to the flare or other applications (boilers, power generators), for the compression of the LFG into the natural gas network, etc.
Frequency of monitoring/recording	Continuous measurement and monthly recording
Value monitored	2019 (01-December-2019 – 31-December-2019): 10.35 MWh 2020: 3.450 MWh 2021: 5.091 MWh 2022: 3.975 MWh
Monitoring equipment	Electricity meter
QA/QC procedures to be applied	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The meter is calibrated and maintained by the grid company. The readings will be double checked by the electricity distribution company. The calibration of meter,

	including the frequency of calibration, will be done in accordance with national standards or requirements set by the meter supplier or requirements set by the grid operators. The accuracy class of the meter should be in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements The metering device installed at the power plant was calibrated by the manufacturer prior to its installation in 2019. As per the manufacture''s specifications and industry practices, the calibration of the metering device is conducted at the manufacturing facility to ensure its accuracy and compliance with regulatory standards. Therefore, no additional calibration took place on-site at the power plant yet[14]. Model / Serial Number / Date of Calibration / Accuracy Class: Landis + Gyr E550 / 97821853 / 28-November-2019 / 0.5s Landis + Gyr E550 / 97838980 / 28-November-2019 / 0.5s
Purpose of the data	Calculation of project emissions
Calculation method	-
Comments	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process t $PE_{EC,y}$) using the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" These values are taken from "UEÇ"" column of settlement records which is an official record, sent by government agency to power plants. Regular billing is based on these reports.

Model	Serial Number	Date of Calibration	Accuracy Class
Landis + Gyr E550	97821853	28-November-2019	0.5s
Landis + Gyr E550	97838980	28-November-2019	0.5s

Data / Parameter	$O_{pj,h}$
Data unit	Hour (h)
Description	Operation of the equipment that consumes the LFG
Source of data	Project participants

[14] Please see Electicity meter seal reports

Description of measurement methods and procedures to be applied	Hours of operation for gas engines *and* flare using LFG monitored
Frequency of monitoring/recording	Hourly
Value monitored	125,307 (Total, for 8 Gas engines and years 2020, 2021 and 2022 full years) 46,053 hours off-time
Monitoring equipment	Flare program logic controller
QA/QC procedures to be applied	-
Purpose of the data	Calculation of baseline emissions
Calculation method	Calculated in the workbook using a formula that checks the flow from the meters against the flare temperature and UV sensor and or electricity flow meter. When there is no flow recorded by flowmeter that is located before flare or gas engines, equipment that destroys methane is not working and $O_{pj,h}$=0.
Comments	For baseline emission calculation, flowmeter value "0" is excluded from the calculation. Therefore, whenever flowmeter value is greater than "0", methane is destroyed via either co-generation units or flare. Currently there is no flowmeter assigned to flowmeter. However, working hours of flare is tracked and value""0" hasn't been changed from the start of the project activity. Therefore, all generated biogas is destroyed via co-generation-units. Currently facility is operating below its full capacity therefore it's considered very unlikely to operate flares during regular operations.

Data / Parameter	$v_{i,t,db}$
Data unit	m^3 gas i/m^3 dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Source of data	Measurement
Description of measurement methods	Continuous in-situ analyzers

and procedures to be applied	
Frequency of monitoring/recording	Continuous measurement and hourly recording
Value monitored	December 2019: 0.543 2020: 0.551 (average) 2021: 0.548 (average) 2022: 0.522 (average)
Monitoring equipment	Infrared Gas Analyzer The instrument is calibrated regularly utilizing a certified span gas on site until the unit is no longer able to be calibrated on site. Should the instrument not be able to be calibrated then the instrument sensor is replaced. According to manufacturer's specifications, calibration frequency is every 6 months[15][16][17]. There are 4 gas analyzer units on-site, two of them are stationary, continuous measurement devices (SWG 100) and device with serial number "081087" is part of booster unit. Mobile devices are used for inspecting landfill site regularly and device with serial number "081476" is located in desulphurization unit that controls the desulphurization process (oxygen content). Methane content data is obtained with stationary continuous measurement device SWG 100 with serial number "081087.
QA/QC procedures to be applied	On-site calibration for stationary gas analyzers conducted on 11-April-2022 for SWG-100 unit with a serial number of "081087".

Model	Serial Number	Calibration Date
SWG100 Biogas	081087	16-July-2019 11-April-2022
SWG100 Biogas	081476	17-May-2022
BIOGAS 5000	G506493	26-July-2019
BIOGAS 5000	G506480	24-July-2019

[15] https://mru-instruments.com/faq/?gclid=Cj0KCQiAo7KqBhDhARIsAKhZ4ujgZawe80UiQO8G8f0SMyvN1lw7at6-JOD-RH3NHbx9wEZqv1I6VkYaAjHEEALw_wcB

[16] https://www.mru.eu/fileadmin/user_upload/files/bedienungsanleitungen-en/9512EN_USER_MANUAL_SWG100-BIOGAS.pdf

[17] https://d3pcsg2wjq9izr.cloudfront.net/files/9549/download/413002/5-biogas_5000_operating_manual.pdf

	A pressurized test tube with known gas concentration is used for initial readings then device is calibrated. After calibration, gas analyzer is tested again with test tube to see if calibration is conducted properly. According to the document "CDM validation and verification standard for project activities" Version 03.0, paragraph 366. (a); When the calibration period is delayed, following procedure has to be applied: a) Applying the maximum permissible error of the instrument to the measured values taken during the period between the scheduled date of calibration and the actual date of calibration, if the results of the delayed calibration do not show any errors in the measuring equipment, or if the error is smaller than the maximum permissible error It has been found that methane reading error was around 1.62% at the time of calibration (11-April-2022) which indicates error is smaller than permissible error (3% accuracy rating of device). Therefore, device accuracy rate of 3% is subtracted from methane content readings. Baseline emission calculation utilized these corrected methane content (%).

	Gas Analyzer (081087) of Booster unit
Period	Calibration status
27-October-2019 – 23-April-2020	Calibrated
24-April-2020 – 11-April-2022	Calibration delayed
12-April-2022 – 08-October-2022	Calibrated
09-October-2022 – 31-12-2022	Calibration delayed

Purpose of the data	Calculation of Baseline Emissions
Calculation method	Not Applicable
Comments	This parameter will be monitored in Option A as per the applied "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0). Biogas analyzer with "081087" is located in the booster unit and responsible gas analyzer unit.

	The BIOGAS 5000 is not a continuous measuring device.

Data / Parameter	CAPEX and OPEX
Data unit	Currency (USD)
Description	Total investment to implement the project and total cost to operate the project.
Source of data	Engineering, procurement, and construction contracts; and maintenance contracts.
Description of measurement methods and procedures to be applied	Measured and calculated
Frequency of monitoring/recording	At the first issuance request after each phase of the project is fully implemented.
Value monitored	CAPEX (Initial): 21,102.16 USD OPEX (27-10-2019 – 31-12 -2022): 13,691.99 USD
Monitoring equipment	Not applicable
QA/QC procedures to be applied	The VVB should only verify that the data provided corresponds to the data from independent financial auditors.
Purpose of the data	In order to collect the information that is required for the update of the provisions in section 5.3.1 of ACM0001 (version 19). Project activities that are registered using these simplified procedures are required to report cost and revenue information at the first issuance request after each phase of the project is fully implemented.
Calculation method	Not applicable
Comments	CAPEX provided during validation. No other CAPEX observed during monitoring period.

Data / Parameter	Tariff or electricity exported
Data unit	Currency – Lira
Description	Tariff of electricity exported
Source of data	Power Purchase Agreement

Description of measurement methods and procedures to be applied	Monitored annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
Frequency of monitoring/recording	At the first issuance request after each phase of the project is fully implemented
Value monitored	13.3 ¢ /kWh
Monitoring equipment	-
QA/QC procedures to be applied	Audited by professional, independent financial auditors. The VVB should only verify that the data provided corresponds to the data from independent financial auditors
Purpose of the data	-
Calculation method	-
Comments	The monitoring of this parameter is only required for projects applying simplified procedures to identify the baseline scenario and demonstrate additionality. Parameter in accordance with the applied ACM0001.

Data / Parameter	$V_{,t,db}$
Data unit	m^3 gas / hours
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measurement
Description of measurement methods and procedures to be applied	Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required
Frequency of monitoring/recording	Continuous measurement and hourly recording
Value monitored	2019: - 2020: 2,352.632 (average) 2021: 3,444.526 (average) 2022: 2,748.713 (average)
Monitoring equipment	Flow meter

	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory for all projects applying large scale methodology(ies). Calibration and frequency of calibration is according to manufacturer's specifications. According to manufacturer's specifications, calibration frequency is every 5 to 10 years. Model | Serial Number | Calibration Date Deltabar S PMD75 | P808470109D | 16-July-2019
QA/QC procedures to be applied	-
Purpose of the data	Calculation of Baseline Emissions
Calculation method	Not applicable
Comments	Due to a technical problem occurring during commissioning period, booster data in 2019 has certain gaps. Due to this problem, 2019 booster data was deemed insufficient for baseline emission calculations therefore they are excluded from $BE_{,ch4,swds}$ calculations.

Data / Parameter	T
Data unit	^{o}C
Description	Temperature of the gaseous stream in time interval t
Source of data	Measurement
Description of measurement methods and procedures to be applied	Booster unit Temperature sensor
Frequency of monitoring/recording	Continuous measurement and hourly recording
Value monitored	2019: - 2020: 42.541 (average) 2021: 45.692 (average) 2022: 51.288 (average)
Monitoring equipment	Temperature sensor of Booster Unit

	<table><tr><td>Flowmeter Brand/ Model</td><td>Serial Number</td><td>Calibration Date</td></tr><tr><td>Endress+Hauser Deltabar S PMD75</td><td>P808470109D</td><td>16-July-2019</td></tr></table> Temperature sensors: <table><tr><td>Manufacturer</td><td>Model</td><td>Serial Number</td></tr><tr><td>Metron</td><td>RCT-L</td><td>1393/2019</td></tr><tr><td>Metron</td><td>RCT-L</td><td>0419/2019</td></tr></table> Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory for all projects applying large scale methodology(ies). Calibration and frequency of calibration is according to manufacturer's specifications. According to manufacturer's specifications, calibration frequency is every 5 to 10 years. Flowmeter is controlled and calibrated with it's sensors by the manufacturer Conveco.
QA/QC procedures to be applied	-
Purpose of the data	Calculation of Baseline Emissions
Calculation method	Not applicable
Comments	This parameter is equal to T_t of option A and C.

Data / Parameter	P
Data unit	Pascals (Pa)
Description	Pressure of the gaseous stream in time interval t
Source of data	Measurement
Description of measurement methods and procedures to be applied	Calculated via addition of depression value (in Pa) from absolute pressure of site. HMI system describes depression value at pressure side as minus (log (P)) and positive at suction side. Thus, positive pressure value in respect to normal pressure is added to the absolute pressure.
Frequency of monitoring/recording	Continuous measurement and hourly recording
Value monitored	-

Monitoring equipment	Pressure Sensor of Booster Units Flowmeter Brand/ Model: Endress+Hauser Deltabar S PMD75; Serial Number: P808470109D; Calibration Date: 16-July-2019 Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory for all projects applying large scale methodology(ies). Calibration and frequency of calibration is according to manufacturer's specifications. According to manufacturer's specifications, calibration frequency is every 5 to 10 years. Flowmeter is controlled and calibrated with it's sensors by the manufacturer Conveco.
QA/QC procedures to be applied	-
Purpose of the data	Calculation of Baseline Emissions
Calculation method	Not applicable
Comments	This parameter is equal to P_t of option A and C.

Flowmeter Brand/ Model	Serial Number	Calibration Date
Endress+Hauser Deltabar S PMD75	P808470109D	16-July-2019

Data / Parameter	$W_{c,l,y}$
Data unit	Mass unit/volume unit
Description	Weighted average density of fuel type i in year y
Source of data	Fuel analysis report by an accredited laboratory
Description of measurement methods and procedures to be applied	Measurements should be undertaken in line with national or international fuel standards
Frequency of monitoring/recording	Only valid for first monitoring period.
Value monitored	0.8343 kg/m³
Monitoring equipment	N/A
QA/QC procedures to be applied	-

Purpose of the data	Project emissions calculation
Calculation method	The numerical average of the two commonly used fuels' density
Comments	All fuels purchased in TÜRKİYE comply with legal standards. The facility has fuel analysis reports.

Data / Parameter	$\rho_{i,y}$
Data unit	Mass unit/volume unit
Description	Weighted average density of fuel type i in year y
Source of data	Fuel analysis report by an accredited laboratory
Description of measurement methods and procedures to be applied	Measurements should be undertaken in line with national or international fuel standards
Frequency of monitoring/recording	*Only valid for first monitoring period.*
Value monitored	N/A
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of the data	Project emissions calculation
Calculation method	The numerical average of the two commonly used fuels' density
Comments	All fuels purchased in TÜRKİYE comply with legal standards. The facility has fuel analysis reports.

Data / Parameter	$NCV_{i,y}$
Data unit	GJ per mass or volume unit (e.g. GJ/m³, GJ/ton)
Description	Weighted average net calorific value of fuel type i in year y
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Table 1.2, page 1.18 -Gas/Diesel Oil - Default
Description of measurement methods	Measurements be undertaken in line with national or international fuel standards

and procedures to be applied	
Frequency of monitoring/recording	*Only valid for first monitoring period.*
Value monitored	43
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of the data	Calculation of project emissions
Calculation method	-
Comments	All fuels purchased in TÜRKİYE comply with legal standards. The facility has fuel analysis reports.

Data / Parameter	$EF_{CO2,I,y}$
Data unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of fuel type i in year y
Source of data	IPCC Report
Description of measurement methods and procedures to be applied	Measurements be undertaken in line with national or international fuel standards
Frequency of monitoring/recording	The CO_2 emission factor be obtained for each fuel delivery, from which weighted average annual values be calculated.
Value monitored	74.100
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of the data	-
Calculation method	-
Comments	*IPCC data are eligible with national standards. Updated IPCC reports are being tracked.*

Data / Parameter	$F_{CH4,EG,t}$
Data unit	kg
Description	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period t
Source of data	Measurements undertaken by a third-party accredited entity
Description of measurement methods and procedures to be applied	Values taken form the system that has been calibrated
Frequency of monitoring/recording	*Only valid for first monitoring period.*
Value monitored	0
Monitoring equipment	-
QA/QC procedures to be applied	According to standard applied
Purpose of the data	-
Calculation method	-
Comments	The project implements an enclosed flare. Operating hours is and flow rate is tracked. Flare working hour is 0 for the first crediting period.

Data / Parameter	$T_{EG,m}$
Data unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in the minute m
Source of data	Project operator's Monitoring reports
Description of measurement methods and procedures to be applied	Values display on the PLC of calibrated instruments
Frequency of monitoring/recording	Once per minute if the flare in is on meaning 100% operation.
Value monitored	-
Monitoring equipment	-

QA/QC procedures to be applied	Temperature measurement equipment should be replaced or calibrated in accordance with their maintenance schedule. Calibration frequency is 5-10 years.
Purpose of the data	-
Calculation method	-
Comments	The project implements an enclosed flare therefore. Flare working hour is 0.

<table>
<tr><td>Data / Parameter</td><td>$V_{i,RG,m}$</td></tr>
<tr><td>Data unit</td><td>-</td></tr>
<tr><td>Description</td><td>Volumetric fraction of component i in the residual gas on a dry basis in the minute m where i = CH_4, CO_2, O_2, H_2S, Other</td></tr>
<tr><td>Source of data</td><td>Measurements by project operator using a continuous gas analyzer (values are recorded with the same frequency as the flow).</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>Measurement may be made on wet basis. Analyzers are periodically calibrated according to the manufacturer’s recommendation.
<table><tr><td>Model</td><td>Serial Number</td></tr><tr><td>SWG100 Biogas</td><td>081087</td></tr></table></td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Continuously. Values are to be averaged on a minute basis if flare is on operation 100% status.</td></tr>
<tr><td>Value monitored</td><td><table><tr><td>Residual Gas</td><td>2019</td><td>2020</td><td>2021</td><td>2022</td></tr><tr><td>CH_4</td><td>-</td><td>55.149%</td><td>54.835%</td><td>55.265%</td></tr><tr><td>CO_2</td><td>-</td><td>38.762%</td><td>40.003%</td><td>40.467%</td></tr><tr><td>O_2</td><td>-</td><td>0.144%</td><td>0.249%</td><td>0.453%</td></tr><tr><td>H_2S</td><td>-</td><td>0.0498%</td><td>0.0309%</td><td>0.029%</td></tr><tr><td>Other</td><td>-</td><td>5.895%</td><td>4.882%</td><td>3.786%</td></tr></table></td></tr>
<tr><td>Monitoring equipment</td><td>Infrared Gas Analyzer
The instrument is calibrated regularly utilizing a certified span gas on site until the unit is no longer able to be calibrated on site. Should the instrument not be able to be calibrated then the instrument sensor is replaced. According to manufacturer’s</td></tr>
</table>

specifications and industrial practices, calibration frequency is every 6 months[18][19][20].

There are 4 gas analyzer units on-site, two of them are stationary, continuous measurement devices (SWG 100) and device with serial number “081087” is part of booster unit. Mobile devices are used for inspecting landfill site regularly and device with serial number “081476” is located in desulphurization unit that controls the desulphurization process (oxygen content). Methane content data is obtained with stationary continuous measurement device SWG 100 with serial number “081087.

Model	Serial Number	Calibration Date
SWG100 Biogas	081087	16-July-2019 11-April-2022
SWG100 Biogas	081476	17-May-2022
BIOGAS 5000	G506493	26-July-2019
BIOGAS 5000	G506480	24-July-2019

QA/QC procedures to be applied

On-site calibration for stationary gas analyzers conducted on 11-April-2022 for SWG-100 unit with a serial number of “081087”.

A pressurized test tube with known gas concentration is used for initial readings then device is calibrated. After calibration, gas analyzer is tested again with test tube to see if calibration is conducted properly.

According to the document “CDM validation and verification standard for project activities” Version 03.0, paragraph 366. (a); When the calibration period is delayed, following procedure has to be applied:

b) Applying the maximum permissible error of the instrument to the measured values taken during the period between the scheduled date of calibration and the actual date of calibration, if the results of the delayed calibration do not show any errors in the measuring

[18] https://mru-instruments.com/faq/?gclid=Cj0KCQiAo7KqBhDhARIsAKhZ4ujgZawe80UiQO8G8f0SMyvN1lw7at6-JOD-RH3NHbx9wEZqv1I6VkYaAjHEEALw_wcB

[19] https://www.mru.eu/fileadmin/user_upload/files/bedienungsanleitungen-en/9512EN_USER_MANUAL_SWG100-BIOGAS.pdf

[20] https://d3pcsg2wjq9izr.cloudfront.net/files/9549/download/413002/5-biogas_5000_operating_manual.pdf

	equipment, or if the error is smaller than the maximum permissible error It has been found that methane reading error was around 1.62% at the time of calibration (11-April-2022) which indicates error is smaller than permissible error (3% accuracy rating of device). Therefore, device accuracy rate of 3% is subtracted from methane content readings. Baseline emission calculation utilized these corrected methane content (%). <table><tr><td rowspan="2">Period</td><td>Gas Analyzer (081087) of Booster unit</td></tr><tr><td>Calibration status</td></tr><tr><td>27-October-2019 – 23-April-2020</td><td>Calibrated</td></tr><tr><td>24-April-2020 – 11-April-2022</td><td>Calibration delayed</td></tr><tr><td>12-April-2022 – 08-October-2022</td><td>Calibrated</td></tr><tr><td>09-October-2022 – 31-12-2022</td><td>Calibration delayed</td></tr></table>
Purpose of the data	Calculating project emissions
Calculation method	-
Comments	Project operators measure the content CH_4, CO_2, O_2 and H_2S. This parameter will be monitored in Option A as per the applied "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0). Biogas analyzer with "081087" is located in the booster unit and responsible gas analyzer unit. The BIOGAS 5000 is not a continuous measuring device.

Data / Parameter	$V_{RG,m}$
Data unit	m^3
Description	Volumetric flow of the residual gas on a dry basis at reference conditions in the minute m
Source of data	Measurements by project participants using a flare timer
Description of measurement methods	Measurements by project operator using a calibrated *flow meter*

and procedures to be applied	
Frequency of monitoring/recording	Continuously. In flare operation is 100% or on.
Value monitored	0
Monitoring equipment	Flare timer (for working hours)
QA/QC procedures to be applied	During the monitoring period flare was never used.
Purpose of the data	Calculation of baseline emission
Calculation method	A methodological deviation is proposed for calculating project emissions from flaring.
Comments	This parameter is monitored through the flame timer since there was no dedicated flowmeter for flaring during first monitoring period. Project implements enclosed flare. Booster unit has flare stack therefore data is directly obtained from booster. Since flare has never been used during crediting period, this value is "0".

Data / Parameter	$M_{RG,m}$
Data unit	kg
Description	Mass flow of the residual gas on a dry basis at reference conditions in the minute m
Source of data	-
Description of measurement methods and procedures to be applied	Instruments with recordable electronic signal (analogical or digital) With calibrated instruments
Frequency of monitoring/recording	Continuous
Value monitored	0
Monitoring equipment	*Flare timer (for working hours)*
QA/QC procedures to be applied	Calibration and frequency of calibration is according to manufacturer's specifications

Purpose of the data	Calculating project emissions
Calculation method	A methodological deviation is proposed for calculating project emissions from flaring.
Comments	This parameter is monitored through the flame timer since there was no dedicated flowmeter for flaring during first monitoring period. Project implements enclosed flare. Booster unit has flare stack therefore data is directly obtained from booster. Since flare has never been used during crediting period, this value is “0”. This parameter is monitored, project implements enclosed flare. Values are calculated with density and volumetric flow.

Data / Parameter	$v_{O2,EG,m}$
Data unit	-
Description	Volumetric fraction of O_2 in the exhaust gas on a dry basis at reference conditions in the minute m
Source of data	Measurements by project operator using a continuous gas analyser
Description of measurement methods and procedures to be applied	Extractive sampling analysers with water and particulates removal devices or in situ analysers for wet basis determination.
Frequency of monitoring/recording	Continuous
Value monitored	N/A
Monitoring equipment	N/A
QA/QC procedures to be applied	Analysers must be periodically calibrated according to the manufacturer’s recommendation.
Purpose of the data	-
Calculation method	-
Comments	This parameter is monitored, project implements enclosed flare. According to project owner, manufacturer stated there can be no excess oxygen in exhaust gas due to fact co-generation unit

	works with 100% burning efficiency at equipment' respective capacity.

Data / Parameter	$fc_{CH4,EG,m}$
Data unit	mg/m^3
Description	Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute m
Source of data	Measurements by project operator using a continuous gas analyser
Description of measurement methods and procedures to be applied	Extractive sampling analysers with water and particulates removal
Frequency of monitoring/recording	Continuously
Value monitored	0
Monitoring equipment	*N/A*
QA/QC procedures to be applied	Analysers must be periodically calibrated according to the manufacturer's recommendation.
Purpose of the data	*Project emission calculation.*
Calculation method	-
Comments	This parameter is monitored, project implements enclosed flare. According to project owner, manufacturer stated there can be no unburnt methane left in exhaust gas due to fact co-generation unit works with 100% burning efficiency at equipment' respective capacity.

Data / Parameter	$Flame_m$
Data unit	Flame on or Flame off (0% or 100%)
Description	Flame detection of flare in the minute m
Source of data	Measure using a fixed installation optical flame detector with calibrated instrument
Description of measurement methods	Once per minute. Detection of flame recorded as a minute that the flame was on.

and procedures to be applied	
Frequency of monitoring/recording	Continuously
Value monitored	*0*
Monitoring equipment	Flame timer
QA/QC procedures to be applied	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations
Purpose of the data	Calculation of flared gas amount
Calculation method	N/A
Comments	This parameter is monitored, project implements enclosed flare

Data / Parameter	$FC_{i,j,y}$
Data unit	tC/mass unit of the fuel
Description	Weighted average mass fraction of carbon in fuel type i in year y
Source of data	Onsite measurements
Description of measurement methods and procedures to be applied	Measurements should be undertaken in line with national or international fuel standards
Frequency of monitoring/recording	*Only valid for first monitoring period.*
Value monitored	N/A
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of the data	-
Calculation method	-
Comments	TÜRKİYE complies with legal standards based on European Fuel Standard. This parameter is not monitored constantly.

Data / Parameter	$Maintenance_y$
Data unit	Calendar dates
Description	Maintenance events completed in year y
Source of data	Project operator
Description of measurement methods and procedures to be applied	Record the date that maintenance events were completed in year y. Records of maintenance logs must include all aspects of the maintenance including the details of the person(s) undertaking the work, parts replaced, or needing to be replaced, source of replacement parts, serial numbers and calibration certificates
Frequency of monitoring/recording	Annual
Value monitored	Maintenance records
Monitoring equipment	Log book
QA/QC procedures to be applied	Records must be kept in a maintenance log for two years beyond the life of the flare
Purpose of the data	Tracking equipment down time.
Calculation method	N/A
Comments	This parameter is monitored, project implements enclosed flare

4.3 Monitoring Plan

The responsible entity for the monitoring system is Biotrend personnel. The monitoring activities primarily involve four types of personnel: the Operation Site Manager, Field Operator, Electrical & Mechanical Operator and the Laboratory Operator.

The Field Operators are tasked with monitoring and adjusting LFG extraction wells, checking operations of the blower and flare, recording data at the blower/flare station, routine maintenance of collection system components, preparing daily logs and completing checklists, and sending data to the Operation Site Manager.

The Operation Manager's responsibilities include reviewing the data collected both manually by the Field Technicians and the one recorded automatically by analytical equipment, making recommendations and/or implementing system adjustments to maximize methane capture and destruction, scheduling monitoring and O&M activities, performing quality assurance checks on operations, coordinating with system component manufacturers as needed, to maintain proper operations and calibration, and compiling data as required by the Methodology.

Only for manual data collection, the Operation Manager is responsible for reviewing the data collected.

Project Management Responsibility

The operators of the LFG recovery and electricity generation system are responsible for collecting all data monitored on-site. These operating and maintenance personnel are skilled technicians, with extensive experience in equipment operation, maintenance and calibration, and emergency procedures. Overall responsibility for the monitoring and maintenance of all required tasks and their adequate management lies with the project manager. Detailed roles and responsibilities of the relevant staff involved in VCS monitoring are placed.

Training of Monitoring Personnel

The monitoring personnel is trained in the beginning of the project; the purpose of this training is to operate the project in a well manner. Biotrend defines periodic training sessions to enhance and update their skills as needed.

The project activity has been successfully implemented with the involvement of the designated personnel and their assigned responsibilities.

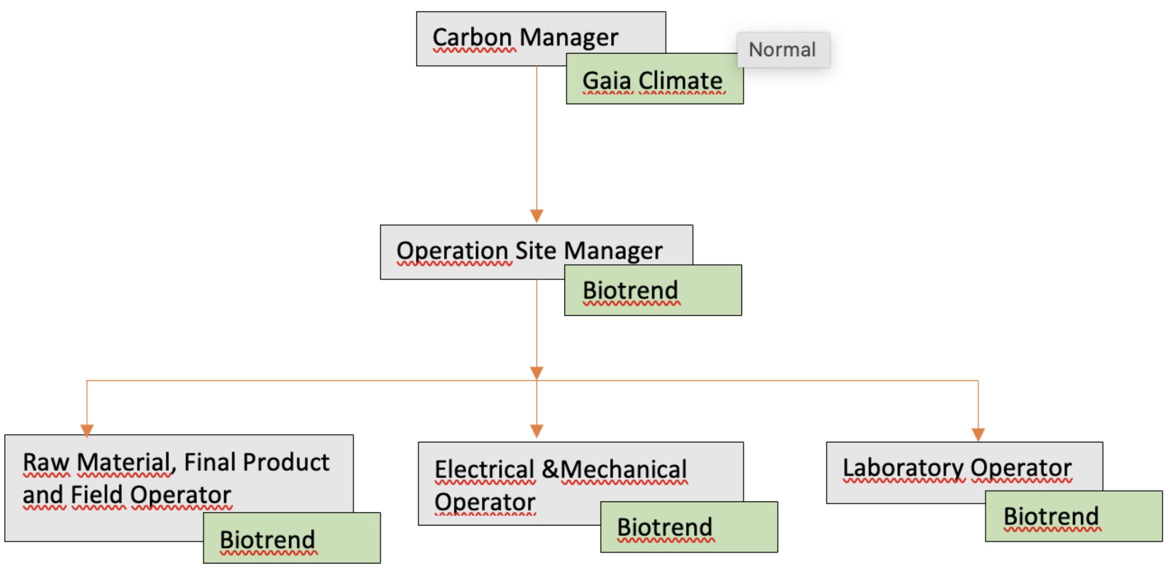


Figure 1 Organizational Structure of the Carbon Project

Data Analysis

The collected data will be reviewed and analyzed on a daily basis by the Operation Manager. In case of a drift of one parameter the Manager or Technician can react quickly to fix potential problems. All data required for the emission reduction calculations will be kept in the onsite-monitoring database. The Monitoring Manager will be the responsible to report the necessary information to Biotrend.

The quality actions that will guarantee the success of the monitoring plan are the following:

Maintenance Plan

The LFG plant's computerized management and control system includes: the management of level management in gas meters through the level indicators; monitoring and control of the heating system; alarm management of minimum and maximum levels and security; and monitoring of the data analysis of the LFG analysis. With regards to the electricity generation component of the project, given that it dispatches electricity to the National Grid, measuring, recording, storing, aggregating, collating and reporting data and parameters will follow the procedure described by the authorities.

The following aspects are core to the maintenance of the monitoring system in order to assure proper data

monitoring during the project:

- Equipment preventive maintenance
- Equipment calibration

All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the last crediting period. Regarding the monitoring equipment of the methane recovery component of the project, maintenance and calibration will be performed in line with manufacturers' recommendations. With regards to the electricity meter, it is a high accuracy measurement device/s and meets all relevant metrological requirements prescribed by the state authority. Procedures for maintenance of the meter will be conducted in accordance with national procedures and standards.

Quality assurance and Control (QA/QC)

Quality control and quality assurance procedures will guarantee the quality of monitored data.

All data is archived electronically, backed up regularly and kept at least for 2 years after the end of the last crediting period. There are corrective actions when the parameters are out of the permitted range.

Regarding the monitoring equipment of the methane recovery component of the project, maintenance and calibration will be performed in line with manufacturers' recommendations. With regards to the electricity meter, as mentioned above, it is a high accuracy measurement device/s and meets all relevant metrological requirements prescribed by the state authority. Procedures for maintenance of the meter will be conducted in accordance with national procedures and standards.

Calibration plans:

The company MRU BACA GAZI LTD. Performs every 6 months calibration visits from the gas analyser in the booster unit, the values of O_2%, H_2S ppm, CO_2% and CH_4% are measured. Please see the calibration certificates documents.

The gas engines have their own monitoring system and parameters can be seen every time on the display. There is an internal storage of the data on PC and on the cloud. All data can be downloaded in an excel file.

Emergencies Procedures

The running hours of the power plants will be monitored as part of the monitoring procedures. In case of failure of one of the monitoring devices, portable instruments will be used in order to carry out periodic daily monitoring of the missing parameter(s). These data are recorded on paper. Biotrend defined emergency procedures according to the provider recommendations.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

Baseline emissions scenario of the project is the methane from the open-air, SWDS, and the electricity supplied by the grid to be substituted, which will be calculated as follows according to the methodology ACM0001 V.19.

It comprises the following sources:

(a) Methane emissions from the SWDS in the absence of the project activity;

(b) Electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;

(c) Heat generation using fossil fuels in the absence of the project activity; and

(d) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \text{Equation(1)}$$

Where:

BE_y = Baseline emissions in year y (tCO_2e/yr)

$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year y (tCO_2e/yr)

$BE_{EC,y}$ = Baseline emissions associated with electricity generation in year y (tCO_2/yr)

$BE_{HG,y}$ = Baseline emissions associated with heat generation in year y (tCO_2/yr)

$BE_{NG,y}$ = Baseline emissions associated with natural gas use in year y (tCO_2/yr)

Table 13. Baseline emissions from project activity ($BE_{CH4,y}$ and $BE_{EC,y}$)

Year	$BE_{CH4,y}$ (tCO_2e)	$BE_{EC,y}$ (tCO_2e)	Baseline Emission (tCO^2e)
2019	0	478.288	478
2020	216,182.03	27,258.748	231,017
2021	317,975.63	34,970.115	335,007
2022	245,281.12	26,414.296	257,307

Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline emissions of methane from the SWDS are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account:

$$BE_{CH4} = ((1 - OX_{top\_layer}) \times F_{CH4,Pj,y} - F_{CH4,BL,y}) \times GWP_{CH4}$$ Equation (2)

Where:

$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year y (tCO_2e/yr)

OX_{top_layer} = Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)

$F_{CH4,BL,y}$ = Amount of methane in the LFG that would be flared in the baseline in year y (tCH_4/yr)

GWP_{CH4} = Global warming potential of CH_4 (tCO_2e/tCH_4)

Ex post determination of $F_{CH4,PJ,y}$

During the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane

flared and used in power plant(s), boiler(s), etc as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$$ Equation (3)

Where:

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)

$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year y (tCH_4/yr)

$F_{CH4,EL,y}$ = Amount of methane in the LFG which is used for electricity generation in year y (tCH_4/yr)

$F_{CH4,HG,y}$ = Amount of methane in the LFG which is used for heat generation in year y (tCH_4/yr)

$F_{CH4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year y (tCH_4/yr)

The working hours of the gas engines are monitored, and no emission reduction should be claimed for methane destruction during non-working hours. The project does not utilize KFG for heat generation nor supply LPG to natural gas distribution network. Therefore, $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$ are zero. Project utilizing the LFG only for power generation. Although there a flare is installed as part of booster unit, instrument setup during the fist monitoring period and data collection didn't allow emission reduction claim from flaring. Therefore $F_{CH4,flared,y}$ is also zero. This leads to:

$$F_{CH4,PJ,y} = F_{CH4,EL,y}$$

$F_{CH4,EL,y}$ is determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". The following requirements apply:

(e) As per the gaseous stream tool, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g. by means of flame detectors records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices. The destruction efficiency of the least efficient among the destruction devices shall be used as the destruction efficiency for all destruction devices monitored by this flow meter. If there are any periods for which one or more destruction devices are not operational, paragraph 5 (a) and (b) of the Appendix of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" tool shall be followed;

(f) CH_4 is the greenhouse gas for which the mass flow should be determined;

(g) The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations (3) or (17) in the tool);

(h) The mass flow should be calculated on an hourly basis for each hour h in year y;

(i) The mass flow calculated for hour h is 0 if the equipment is not working in hour h ($Op_{j,h}$=not working), the hourly values are then summed to a yearly unit basis.

Amount of the methane used for power generation ($F_{CH4,EL,y}$) The "Tool to determine the mass of a greenhouse gas in a gaseous stream" provides following 6 options for measuring mass flow of a greenhouse gas i in a gaseous stream Table.

Option	*Flow gaseous stream*	*Volumetric Fraction*
A	***Volume flow – dry basis***	***Dry or wet basis***
B	*Volume flow – wet basis*	*Dry basis*
C	*Volume flow – wet basis*	*Wet basis*
D	*Mass flow – dry basis*	*Dry or wet basis*
E	*Mass flow – wet basis*	*Dry basis*
F	*Mass flow – wet basis*	*Wet basis*

Option A is selected. It must be noted that in the registered validation report[21], section 3.2 (TOOL08 applicability table) and section 5.2 (parameter $v_{i,t,wb}$) determination of the mass flow of a greenhouse gas in a gaseous stream would be done by Option F and in page 46-47 Option A is indicated as the selected method (bold option). However, installed flowmeter is Endress Hause brand Deltabar S PMD75 Model that measure flow on differential pressure principle[22]. Therefore, option following option F is not possible. Option C is also applied conservatively for gaseous stream measurements with temperature greater than 60 °C(see to section 3.2.1)

Determination of the absolute humidity of the gaseous stream

The absolute humidity parameter can be determined from measurement of the moisture content (Option 1), or by assuming the gaseous stream is dry or saturated in a simplified conservative approach (Option 2). Option 2 is selected and $m_{H2O,db}$ is zero.

The determination of the molecular mass of the gaseous stream ($MM_{t,wb}$) requires measuring the volumetric fraction of all gases (k) in the gaseous stream. However, as a simplification, the volumetric fraction of only the gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.

Under project activity, CH_4, CO_2, O_2 and H_2S gases are monitored. According ACM0001 methodology, only methane (CH_4) gas can be considered in the emission reduction calculation.

[21]https://registry.verra.org/mymodule/ProjectDoc/Project_ViewFile.asp?FileID=77126&IDKEY=fiquwesdfmnk0iei23nnm435oiojnc909dsflk9809adlkmlkf106356754

[22] https://bdih-download.endress.com/files/DLA/005056A500261EEC9BA9D651C033DFF1/TI00382PEN_3421-00.pdf

Therefore, emission calculation reduction only calculated mass flow of methane (MM_i) via option A.

Option A

Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

(a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or

(b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point

Option (b) is followed here.

The mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t}$$ Equation (5)

With:

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t}$$ Equation (6)

Where:

$F_{i,t}$ = Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)

$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval t on a dry basis (m^3 dry gas/h)

$v_{i,t,db}$ = Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m^3 gas i/m^3 dry gas)

$\rho_{i,t}$ = = Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m^3 gas i)

P_t = Absolute pressure of the gaseous stream in time interval t (Pa)

MM_i = Molecular mass of greenhouse gas i (kg/kmol)

R_u = Universal ideal gases constant (Pa.m^3/kmol.K)

T_t = Temperature of the gaseous stream in time interval t (K)

It has been found that 1491 hourly measurements out of 26308 measurements have temperature greater than 60ºC. As explained in section 3.2.1 Methodology deviations, option C is adopted for those measurements.

The mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,wb,n} \times v_{i,t,wb} \times \rho_{i,n}$$ Equation (9)

With:

$$\rho_{i,n} = \frac{P_n \times MM_i}{R_u \times T_n}$$ Equation (10)

Where:

$F_{i,t}$ = Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)

$V_{t,wb,n}$ = Volumetric flow of the gaseous stream in time interval t on a wet basis at normal conditions (m³ wet gas/h)

$v_{i,t,wb}$ = Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m³ gas i/m³ dry gas)

$\rho_{i,n}$ = = Density of greenhouse gas i in the gaseous stream at normal conditions (kg gas i/m³ gas i)

P_n = Absolute pressure at normal conditions (Pa)

MM_i = Molecular mass of greenhouse gas i (kg/kmol)

R_u = Universal ideal gases constant (Pa.m³/kmol.K)

T_n = Temperature at normal conditions (K)

The following equation should be used to convert the volumetric flow of the gaseous stream from actual conditions to normal conditions of temperature and pressure:

$$V_{t,wb,n} = V_{t,wb}\ x\ \left[\left(\frac{T_n}{T_t}\right) x\ \left(\frac{P_t}{P_N}\right))\right]$$ Equation (11)

Where:

$V_{t,wb,n}$ = Volumetric flow of the gaseous stream in time interval t on a wet basis at normal conditions (m³ wet gas/h)

$V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval t on a wet basis (m³ dry gas/h)

T_n = Temperature at normal conditions (K)

T_t = Temperature of the gaseous stream in time interval t (K)

P_n = Absolute pressure at normal conditions (Pa)

P_t = Absolute pressure of the gaseous stream in time interval t (Pa)

Baseline emissions associated with electricity generation ($BE_{EC,y)}$

The baseline emissions associated with electricity generation in year y ($BE_{EC,y}$) shall be calculated using the "Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". When applying the tool:

(a) The electricity sources k in the tool correspond to the sources of electricity generated identified in the selection of the most plausible baseline scenario; and

(b) $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated using LFG in year y ($EG_{PJ,y}$).

Taking into account the approach provided by the tool, baseline emissions are then calculated using the generic approach based on the quantity of electricity dispatched into the National Grid, an emission factor for electricity generation and a factor to account for transmission losses, as follows:

$$BE_{EC,y} = \Sigma EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y}) \quad \text{Equation (2)}$$

Where;

$EC_{BL,k,y}$ = Net amount of electricity generated using LFG in year y (MWh/yr)

$EF_{EF,k,y}$ = Emission factor for electricity generation for source k in year y (tCO_2/MWh)

$TDL_{k,y}$ = Average technical transmission and distribution losses for providing electricity to source k in year y

k = Sources of electricity generated in the baseline

The Emission Factor is considered as fixed parameter in project description document.

(i) Emission Factor calculation

The Emission Factor is given from Turkish National Electricity Network calculated annually using TOOL07, Tool to calculate the emission factor for an electricity system for the year 2019 and the combined emission factor is 0.5706 tCO_2/MWh[23].

5.2 Project Emissions

In this section all project emission sources are taken into account; assumptions and simplifications are justified. Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y} + PE_{FC,j,y} + PE_{flare,y} \quad \text{Equation (22)[25]}$$

[23] https://enerji.gov.tr/evced-cevre-ve-iklim-turkiye-ulusal-elektrik-sebekesi-emisyon-faktoru

[25] Parameters $PE_{FC,j,y}$ and $PE_{flare,y}$ are incorporated into equation 22 of ACM0001 methodology, version 19.

Where:

PE_y = Project emissions in year y (tCO_2/yr)

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year y (tCO_2/yr)

$PE_{FC,y}$ = Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year y (tCO_2/yr)

$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (tCO_2/yr)

$PE_{SP,y}$ = Emissions from the supply of LFG to consumers through a dedicated pipeline, in year y (tCO_2/yr)

PE_{FC},j,y = Are the CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr)

$PE_{flare,y}$ = Project emissions from flaring of the residual gas in year y

The project does not involve the distribution of compressed/liquefied LFG using trucks nor pipelines. Therefore, PE_{DT},y, PE_{SP},y,y will be 0. Hence, PEy will be equal to PE_{EC},y + PE_{FC},y.

$PE_{EC,y}$ is determined by "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" as follow:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y}) \qquad \text{Equation (1)}$$

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO_2/yr)

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)

$EF_{\mathrm{EF},j,y}$ = Emission factor for electricity generation for source j in year y(tCO_2/MWh)

$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y

The "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" provides 3 scenarios for different sources of electricity consumption. Since the electricity generated through the project is partly consumed by the project scenario A is applicable. In the case of applying scenario A, two options are available for determining emission factor. For this project, Option A1 ($EF_{EF,j,y}$=$EF_{grid,CM,y}$) is chosen.

In reality the Balıkesir LFG project does not take electrical energy from the grid, since it is not allowed. However, the emissions generated by the project are calculated as if they were fed into the grid first and then taken from it.

Project emissions from fossil fuel combustion

According to regulation there is to have a captive power plant or urgency diesel generator in case of shortage on methane for electricity production in case the electricity needs to be maintained and the engines don't provide it temporarily.

CO_2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_j FC_{PJ,j,y} \times COEF_{i,y}$$ Equation (1)

Where:

$PE_{FC,j,y}$ = Are the CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr)

$FC_{PJ,j,y}$ = Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr)

$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)

I = Are the fuel types combusted in process j during the year y

$$COEF = 0{,}00268 \frac{tCO_2}{L} fuel$$

As per tool 3, in order to determine the parameter COEF, option A is the preferred approach as the necessary data is available.

The fuel used in the project is commercial diesel fuel and the quantities are shown below.

Table 14. Project Emissions from fossil fuel consumption

Year	Diesel oil consumption (L, y)	COEF (kg CO_2/L)	PE_{FC} (tCO_2)

2019	1,350	2.68	3.61
2020	2,331	2.68	6.24
2021	2,586	2.68	6.92
2022	2,703	2.68	7.23

In the table above accounted the emissions form fossil fuel consumption ex post project activity.

See all values in the excel sheet 'Achieved GHG Emissions".

Project emissions from flaring

Methodological TOOL06 show the calculation procedure to determine the project emissions form flaring the residual gas PE, flare based on the flare efficiency (flare) and the mass flow of methane to the flare ($FC_{H4,RG,m}$). The flare efficiency is determined based on monitored data or default values.

In the annex is attached an example of the store data form the monitoring values

The methodological TOOL shows a procedure form three steps to calculate those emissions. The excel tool EB102_repan06_Tool06_Emissions from flare_ was planned to be used to calculates the project emissions from flaring, if working hours wouldn't have been 0.

(a) STEP 1: Determination of the methane mass flow of the residual gas;

(b) STEP 2: Determination of the flare efficiency;

(c) STEP 3: Calculation of project emissions from flaring.

a. STEP 1: Determination of the methane mass flow of the residual gas

The residual gas is monitored continuously in normal conditions (Nm^3/h) every 10 min for 24/7. The mass flow of methane in the residual gas in (kg/m) is calculated

$$F_{CH4,RG,t} = V_{t,db} \times V_{CH4,db,t} \times \rho_{CH4,n} \quad \text{Equation (5)}$$

Where:

$F_{CH4,RG,t}$	=	Mass flow of greenhouse gas (CH_4) in the gaseous stream in time interval t (kg gas/h)
$V_{,t,db}$	=	Volumetric flow of the gaseous stream in time interval t on a dry basis (m^3 dry gas/h)

$V_{CH4,db,t}$	=	Volumetric fraction of greenhouse gas CH_4 in the gaseous stream in a time interval t on a dry basis (m^3 gas i/m^3 dry gas)
$\rho_{CH4,n}$	=	Density of greenhouse gas CH_4 in the gaseous stream at normal conditions t (kg gas i/m^3 gas i)

b. STEP 2: Determination of the flare efficiency;

✓ Enclosed flare

In this case the project implemented an enclosed flare, there are two options to determine

the flare efficiency for minute m ($\eta_{flare,m}$)

(a) Option A: Apply a default value for flare efficiency;

(b) Option B: Measure the flare efficiency.

Option A is chosen because:

(a) The temperature of the flare (TEG.m) and the flow rate of the residual gas to the flare (FRG,m) is within the Convecos's operating specification for the flare (SPECflare) in the minute m;

- the operating temperature of Conveco's flare system is 850 – 1100 °C, and according to records temperature were from (0°C to 40°C) due to weather conditions meaning not operation. Before electricity production (commission day 25-October-2019) production the thermocouples showed for 1 day in 22 and 23 September 2019 (3200 °C) before system was set, calibrated and producing energy.

(b) The flame is detected in the minute m (Flame).

The set of thermocouples, measure continuously temperature and allow the detection of the presence and absence of flame, which can be cross check with the flare working hours and amount of residual gas to flare. T (0) flare is the parameter can be read form the compiled store data from the control system.

Since the enclose flare could be define as low height (8.40 m Height) flare the efficiency is adjusted 10 percentile points less form the default value:

Ŋ flare,m	80%

c. STEP 3: Calculation of project emissions from flaring.

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times \left(1 - \eta_{flare,m}\right) * 10^{-3} \quad \text{Equation (15)}$$

Where:

$PE_{\ flare,y}$ = Project emissions from flaring of the residual gas in year y (tCO_2e)

GWP_{CH4} = Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)

$F_{CH4,RG,m}$ = Mass flow of methane in the residual gas in the minute m (kg)

$\eta_{flare,m}$ = Flare efficiency in the minute m

Since the commission date the working hours of flare have been recorded as zero. However, a methodological deviation has been presented to provide more conservative project emission from flaring value. Therefore $F_{CH4,RG,m}$ has been calculated cumulatively from landfill gas amount that has been assumed to be flared under conservative conditions. To do that first theoretical energy generation under conservative conditions has been calculated. Then difference between gross energy production and theoretical energy production is found. Thirdly, the difference is used for calculating $F_{CH4,RG,m}$ to answer how much LFG can be assumed flared under conservative conditions.

Table 15. Parameters used to calculate project emission from flaring

Period	**Amount of LFG destroyed in gas engines (Nm^3)**	**Conservative weighted average methane gas content of LFG (%)**	**Conservative thermal energy to electricity generation efficiency**	**Net Energy Content (NCV) of Methane (MJ/Nm^3)**	**Conversion Factor (MJ to MWh)**
27-October-2019 – 30-September-2022	74,770,386	54.134	40	35.9	1/3600

Theoretical Energy generation can be calculated as[26]

$$EG_y = \frac{\sum_i LFG_{i,y} \text{ x } NCV_{CH4} \, x \, EE_y}{3600}$$

Where:

EG_y = Theoretical Electricity generation in year y (MWh)

$LFG_{i,y}$ = Landfill gas destroyed via method i year y (m^3 LFG).

NCV_{CH4} = NCV of methane (MJ/Nm^3) use default value: 35.9 MJ/Nm^3

EE_y = Energy Conversion Efficiency (Default efficiency of 40 per cent)

3600 = Conversion factor (1 MWh = 3600 MJ)

Theoretical electricity generation has been calculated with the above formula and result was found to be 161,456.0137 MWh. Gross electricity generation value for same period is 151,793.93 MWh. The difference between two value is "9,662.0858" MWh.

[26] https://cdm.unfccc.int/UserManagement/FileStorage/HN2W3BMY6RKUQOZDCVXS08F9LT1AI7

How much of LFG is flared, is assumed under conservative conditions.

Following the same formula, how much LFG is required to produce "9,662.0858" MWh is calculated. It has been found that 4,474,518.3019 Nm^3 LFG would be required. To convert gas volume to mass, following equation is used:

$$F_{CH4,RG} = V_{t,db} \times V_{CH4,db} \times \rho_{CH4}$$

Where:

$V_{t,db}$	=	Cumulative LFG flow of the gaseous stream on a dry basis (668,995.579 Nm^3)
$V_{CH4,db}$	=	Volumetric fraction of greenhouse gas CH_4 in the gaseous stream on a dry basis (54.134% weighted average of first crediting period)
$\rho_{CH4,n}$	=	Density of greenhouse gas CH_4 in the gaseous stream at normal conditions t (0.716 kg/m^3 = 7.16E-04)

Thus: $F_{CH4,RG} = F_{CH4,RG,m}$ = (3,203.7551) tCH_4

Project emission from flaring has been calculated as below:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times \left(1 - \eta_{flare,m}\right) * 10^{-3} \quad \text{Equation (15)}$$

$$PE_{flare,y} = 28 \times 3{,}203.7551 \times (1 - 0.50) * 10^{-3} = 44{,}852.571\ tCO_2e$$

Where flare efficiency has been adopted as 50% due to conservative estimations.

Therefore:

$F_{CH4,RG,m}$ (tCH_4)	3,203.7551
$PE_{flare,y}$ (tCO_2e)	44,852.571

Then $PE_{flare,y}$ distributed to each year linearly based on coefficients; LFG destroyed in year t over cumulative LFG destroyed.

Table16. Project Emission from flaring

Period	**$F_{CH4,EG}$ (tCH_4)**	**$PE_{flare,y}$**
27-October-2019 – 31-December-2019	9.485	132.785
2020	886.737	12,414.323
2021	1,280.551	17,927.710
2022	1,026.982	14,377.752
Sum	3,203.755	44,852.571

$PE_{FC,j,y}$ is determined by "TOOL03 Methodological tool: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion. Version 04.0" . They are the CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr).

5.3 Leakage

No leakage effects are accounted for under the ACM0001 Methodology.

5.4 Net GHG Emission Reductions and Removals

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Equation (26)}$$

Where:

ER_y = Emission reductions in year y (tCO_2e/yr)

BE_y = Baseline emissions in year y (tCO_2e/yr)

PE_y = Project emissions in year y (tCO_2e/yr)

The baseline emissions are calculated as follows:

$$BE_y = BE_{CH4,y} + BE_{EC,y} \quad \text{Equation (1)}$$

Emissions of methane from the SWDS are calculated as follows:

$$BE_{CH4} = ((1 - OX_{top_{layer}}) \times F_{CH4,PJ,y} - F_{CH4,BL,y}) \times GWP_{CH4} \quad \text{Equation (2)}$$

Table 16. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Year	$F_{CH4,PJ,y}$ (*tCH_4*)	$F_{CH4,BL,y}$ (tCH_4)	GWP_{CH4} (tCO_2e/tCH_4)	$BE_{CH4,y}$ (tCO_2e/yr)
27-October-2019 - 31-December-2019	0	0	28	0
2020	8,578.652	0	28	216,182.03
2021	12,618.081	0	28	317,975.63
2022	9,733.377	0	28	245,281.12

Project emissions are calculated as follows:

$$PE_y = PF_{EC,y} + PF_{FC,y} + PF_{DT,y} + PF_{SP,y}$$ Equation (22)

Project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) are calculated as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$$ Equation (1)

Table 17. Net GHG emission reductions or removals

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
27-October-2019 - 31-December-2019	478	143	-	335
2020	243,440	12,423	-	231,017
2021	352,945	17,938	-	335,007
2022	271,695	14,388	-	257,307
Total	868,558	44,892	-	823,666

Table 18. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Ex-ante emissions reductions /removals	Achieved emissions reductions /removals	Percent difference	Justification for the difference
909,530	823,666	-9.440%	The Balıkesir Solid Waste Disposal Site serves as the primary landfill for the entire Balıkesir province, and as such, waste from various districts is delivered to the site. Changes in waste generation rates and composition in different districts contributed to fluctuations in waste volume. In PD ex-ante ER calculation, real data was used for calculations up to 2021 and 12% waste quantum increase

was projected after year 2021 for each consecutive year. However, disposed waste amount fluctuates between 2020 to 2022 and disposed waste quantum is significantly less than projected ex-ante waste quantum[27]. This factor is the main contributor to the difference.

Due to delayed calibration of gas analyzers (for a total period of approximately 14 months), a number of emission reduction from methane avoidance is subtracted from the calculations.

YEAR	EX-ANTE WASTE QUANTUM (t)	DISPOSED WASTE QUANTUM (t)	DIFFERENCE
2020	423,338	450,964	6.12%
2021	474,139	419,986	-12.89%
2022	531,035	427,702	-24.16%
AVERAGE DIFFERENCE			-9.99%

Explanations for the waste quantum difference is given below:

1) Balıkesir province has touristic facilities in some districts such as Ayvalık, Burhaniye, Edremit and Gönen. During pandemic, tourism activities are cancelled or delayed until the outbreak is contained[28].
2) Balıkesir province population change trend (steadily increase) was decreased between years of 2019 and 2022[29].
3) The composition of municipal solid waste can vary depending on a number of factors, such as population demographics, socio-economic conditions, and cultural practices. Changes in waste composition in different districts of Balıkesir province contributed to fluctuations in waste volume at the Balıkesir Solid Waste Disposal Site.

[27] Supporting Document "WASTE QUANTUM".

[28] https://cdn.istanbul.edu.tr/file/JTA6CLJ8T5/3D77034FEE7D4341AA104F107F863AF4#:~:text=Salg%C4%B1n%20hastal%C4%B1klar%20ve%20turizm%20aras%C4%B1nda,tedbirler%20turizm%20hareketlerini%20olumsuz%20etkileyebilmektedir.

[29] https://www.nufusune.com/balikesir-nufusu

APPENDIX I: <SCOPE 3 DECLARATION>

BIOTREND

OFFICIAL STATEMENT

Dear Valued Stakeholders,

We, the owner of the Balikesir Landfill Gas (LFG) Capture and Utilization Project, are proud to announce our participation in the Verified Carbon Standard (VCS) program. Our project has been designed to capture and utilize landfill gas, reducing greenhouse gas emissions and contributing to a sustainable future. We declare our commitment to the sustainable development and carbon crediting under VERRA.

Our project aims to capture and utilize the methane emissions from the Balikesir landfill site, which would otherwise contribute to the greenhouse gas emissions and harm the environment. By capturing and utilizing the methane, we not only reduce the emissions, but also generate clean energy that can be used for various purposes, such as heating, electricity generation, and fuel for vehicles.

As a responsible project owner, we have applied for carbon crediting under VERRA to measure and verify the carbon reduction benefits of our project. As a result, we will be able to issue VCUs (Verified Carbon Units) that can be used by companies and individuals to offset their own emissions.

We understand the importance of transparency and accountability in carbon crediting, and that is why we are making this public statement. We want to assure all our stakeholders, including the local community, the government, and the wider public, that our project is in compliance with the highest standards of carbon crediting, and that the VCUs issued will reflect the genuine and measurable carbon reduction benefits of our project.

We are proud to be part of the solution to tackle climate change, and we hope that our project will inspire others to adopt similar initiatives and contribute to a sustainable future.

Hereby declared!

İlhan Doğan
President
BIOTREND Çevre ve Enerji Yatırımları Anonim Şirketi

Ekinciler Caddesi, Ertürk Sokak 3,
Kavacık - Beykoz 34810 İstanbul
T: +90 216 680 00 00
biotrendenerji.com.tr

APPENDIX II: <NO RECEIVED GRIEVANCE/ FEEDBACK EVIDENCE>

BIOTREND

Dear Secretariat,

We did not receive any complaints between 27.10.2019 and 31.12.2022 for our project code 2645 registered in the VERRA VCS program.

Best regards,

Mehmet Ali Nalcacioglu

Deputy General Manager

Biotrend Cevre ve Enerji Yatirimlari A.S

DOĞANLAR HOLDİNG

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