



**Verified Carbon
Standard**

QINGDAO XIAOJIANXI PHASE II MSW LANDFILL SITE LFG RECOVERY TO POWER PROJECT



Document Prepared by Qingdao Baichang Environmental Technology
Co. Ltd.

Project Title	Qingdao Xiaojianxi Phase II MSW landfill site LFG recovery to power project
Version	2.0
Report ID	NA
Date of Issue	14-10-2021
Project ID	2353
Monitoring Period	13-04-2019 to 30-06-2021 (first and last days included)
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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Qingdao Xiaojianxi Phase II MSW landfill site LFG recovery to power project (hereafter referred to as the project) is located in Hongdao Economic zone, Qingdao City, Shandong Province, P.R. China. The project is invested, constructed and operated by Qingdao Baichang Environmental Technology Co. Ltd.

The project captures the landfill gas that would have been released to the atmosphere in the absence of the project and generates electricity with the landfill gas. The electricity is supplied to the North China Power Grid (NCPG) to replace the electricity generated from coal-fired power plants of NCPG.

The purpose of the project is to utilize landfill gas (LFG) from the Qingdao Xiaojianxi MSW landfill site, which consists mainly of methane, for electricity generation. The landfill handles an average of 3,500 tonnes MSW per day which is mainly from Qingdao City. The project activity consists in LFG collection, transmission and treatment system, with subsequent electricity generation and grid connection system. VERs are claimed from the methane destroyed by power generation system and the power displacement. The feed-in electricity is estimated to be 145,625MWh during the fixed 10 years crediting period. The expected average annual emission reductions are 73,156 tCO_{2e}.

The project started construction on 08/01/2019 and commissioned on 13/04/2019. This monitoring period is from 13/04/2019 to 30/06/2021. The total installed capacity is 5.95MW, including 7 sets with each capacity of 0.85MW. For this monitoring period, the net electricity delivered to NCPG was 54,472.151MWh. The total GHG emission reduction was 269,039 tCO_{2e}.

1.2 Sectoral Scope and Project Type

Scope 1: energy industries (renewable-/non-renewable sources)

Scope 13: Waste handling and disposal

1.3 Project Proponent

Organization name	Henan BCCY Environmental Energy Co., Ltd.
Contact person	Lei Wang
Title	Minister of carbon emission department
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1.4 Other Entities Involved in the Project

Organization name	Qingdao Baichang Environmental Technology Co. Ltd.
Role in the Project	Project Operation Entity
Contact person	Lei Wang
Title	Minister of carbon emission department
Address	8th Floor, Hengmei Business Building, Dongfeng Str.22, Zhengzhou, China
Telephone	+86 371 56737901
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1.5 Project Start Date

The project start date is 13/04/2019.

1.6 Project Crediting Period

The crediting period began on 13/04/2019, which is the project start date of operation. It will cease on 12/04/2029, for a total length of ten years.

1.7 Project Location

The Project is located in Xiaojianxi MSW landfill site, Hongdao Economic Zone, Qingdao City, Shandong Province, P.R. China. The geographical coordinates of the project site are longitude 120°9'26.06"E and latitude 36°16'53.04"N. Figure 1.1 shows the location of the Project.



1.8 Title and Reference of Methodology

Title: ACM0001: Flaring or use of landfill gas --- Version 19.0

Reference: <https://cdm.unfccc.int/methodologies/PAmethodologies/approved>

The methodology also refers to the latest approved versions of the following tools:

- “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 07.0);
- “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0);
- “Emissions from solid waste disposal sites” (Version 08.0);
- “Tool to calculate the emission factor for an electricity system” (Version 07.0);
- “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0);
- “Positive lists of technologies” (Version 02.0).

1.9 Participation under other GHG Programs

The project was not registered under other GHG Program.

1.10 Other Forms of Credit

The project does not reduce GHG emissions from activities that are included in emissions trading program or any other mechanism that includes GHG allowance trading, and include details about any such programs or mechanisms.

The project hasn't sought or received another form of GHG-related environmental credits.

1.11 Sustainable Development

The project contributes to the sustainable development, not only it because of mitigating global warming, but also because it increases the availability of electricity from renewable sources. It also minimizes the explosion risk at the landfill site and increases job availability through the operation and maintenance of the LFG capture system and the power units.

2 SAFEGUARDS

2.1 No Net Harm

The Environmental Impact Assessment (EIA) Report for the project was compiled by Qingdao Jierui Environment and Technology Service Co. Ltd. The EIA Report for the project has been approved by Ecology and Environment Bureau of Qingdao City on 12/12/2018. According to the approval comments of the EIA Report by Ecology and Environment Bureau of Qingdao City, the environmental impacts likely to be caused by the project are considered insignificant and conforming to the laws and regulations. At the same time, the implementation of the project

improves local socio-economic development through creating career opportunities and paying taxes. Therefore, there is no net harm.

2.2 Local Stakeholder Consultation

The project owner distributed questionnaires to local residents who may be impacted by the project in order to collect advice for the project. The aim of these questionnaires was to collect opinions concerning the influence the project would have on the local society, environment, economy, daily life etc.

The following questions are from the questionnaires and stakeholder consultancy meeting:

1. What do you think about the environment of surrounding areas?
2. Do you support the construction of this LFG power station?
3. Do you think the implementation of the project will cause positive effect on living of local residents?
4. Do you think the implementation of the project will cause negative effect?

The stakeholders were informed about the stakeholder meeting through posters on 01/12/2018. In the bulletin, the company invited the potential stakeholders to get to know their opinions and/or suggestions about the implementation of the project and VCS application of the project. The stakeholder consultancy meeting for the parties interested in the project was organized at Xiaojianxi Landfill site on 15/12/2018 to collect opinions from all stakeholders, such as representatives of local residents, Xiaojianxi solid waste management station, and the project owner and so on. The project owner appointed one person to make a meeting minute.

30 questionnaires were distributed, and 30 questionnaires were returned. The age range of questioned people was 20-70 years old.

- About 40% of questioned people think the environment of surrounding areas is bad, and others think it is acceptable and good.
- 100% of questioned people support the construction of the project.
- 85% and 90% of questioned people think the implementation of the project will mitigate air pollution and lack of electricity, respectively.
- 7% of questioned people think the noise of implementation of the project will affect the living of local residents surround.

There are 15 stakeholders attended the stakeholder consultation meeting and the project owner had taken meeting minute.

During the stakeholder consultancy meeting, some stakeholders worried that the project will bring noise, land occupying and pollution on employees and local residents' living. For these issues, the project owner will offer some measures: i.e. installation of sound proof devices and plating of green isolation belts are used for mitigating noise; the area the project built on only will not occupy farms of local residents; at the project site, waste recycling will be carried out reduce emit of waste, and the project site meanwhile will be far from the residential area, so the effect of the noise from the plant is little to local residents. All attendances to the meeting were satisfied to the measures.

As a whole, the impacts of construction of the project are basically positive. All stakeholders were pleased with the development of the project. The VCS project would actually facilitate the development of the local economy and increase the income of local residents.

LSC during the operation period

Communications with Local stakeholders have been carried out at periodic intervals. Key implementation schedules and changes of the project have been communicated to the local authority, the neighbourhood committee, and local residents. The comments and suggestions from residents were collected by the local authority, if any.

The project owner carried out questionnaire survey for the local stakeholders to collect the relevant comments and suggestions every two or three years. The local authority also conducts spot checks on the implementation of the project at periodic intervals as per relevant regulations. There have been no negative comments received for the project so far.

In line with VCS requirements all the processes have been implemented to receive comments from local stakeholders as well as communicate with them at periodic intervals.

2.3 AFOLU-Specific Safeguards

For non-AFOLU projects, this section is not required.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project activity consists in LFG collection, transmission and treatment system, with subsequent electricity generation and grid connection system.

LFG collection system

LFG is extracted from MSW under negative pressure by blower pumps and moved through wells, then collected by gas collection stations and transferred by sub-pipes and a main pipe to LFG treatment equipment. Flow rate of the LFG is regulated at the collection points in order to always fit with the consumption capacity of the generation engines.

LFG treatment system

Prior to electricity generation, LFG is treated to remove impurities and moisture, to avoid corrosion in the engines. The treatment consists of filtration, de-moisturing, cooling and pressurization.

Electricity generation and grid connection system

7 gas engines of 850kW rated power each are fed with the LFG and generate electricity, which is then exported to the grid.

Table 3.1 Equipment technical parameters

Main Equipment	Parameter	Value
Generator	Type	850GF-NK
	Manufacturer	CNPC Jichai Power Company Limited
	Rated Capacity	850 kW
	Rated rotation speed	1000 r/min
	Capacity factor	0.8 (lagging)

During the monitoring period from 13/04/2019 to 30/06/2021, the generation units have been working for about 76,553 hours in total, the 1#, 2#, 3#, 4#, 5#, 6# and 7# gas engine have been operating for 19,159, 19,160, 19,199, 19,035, 0, 0 and 0 hours, respectively. The important events during the operation of the project have been recorded in operation log. During this monitoring period, the project is in good operation.

3.2 Deviations

3.2.1 Methodology Deviations

There is no deviation applied to this monitoring period.

3.2.2 Project Description Deviations

There is no deviation applied to this monitoring period.

3.3 Grouped Projects

The project is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

The parameter of methane generation from the landfill in the absence of the project ($BE_{CH_4, SWDS,y}$) is used for ex-ante estimation of relevant parameter $F_{CH_4,PJ,y}$. For $F_{CH_4,PJ,y}$, there is an ex post determination method. Thus, in this monitoring period, $BE_{CH_4,SWDS,y}$ and the relevant basic parameters (ϕ_y , OX , F , DOC_f , MCF_f , K_j , $W_{j,x}$, DOC_j , f_y , η_{PJ}) for calculation of $BE_{CH_4, SWDS,y}$ are not included here.

Data / Parameter	$OX_{top,layer}$
Data unit	-
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	"Emission from the solid waste disposal sites" (version 8.0)
Value applied	0.1
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	GWP_{CH_4}
Data unit	tCO_2e/tCH_4
Description	Global warming potential of CH_4
Source of data	IPCC
Value applied	Default value of 25/28
Justification of choice of data or description of measurement methods and procedures applied	Shall be updated according to any future COP/CMP decisions
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	ρ_{CH_4}
Data unit	t/m^3
Description	Density of methane gas at Normal Conditions
Source of data	-
Value applied	0.0007168(Normal contidions:0°C and101.325kPa)
Justification of choice of data or description of measurement methods and procedures applied	At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m^3CH_4
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$EF_{grid,OM,y}$
Data unit	tCO_2/MWh
Description	Operation margin emission factor of NCPG
Source of data	2017 Bulletin on the Baseline Emission Factors of the China Grids

Value applied	0.9680
Justification of choice of data or description of measurement methods and procedures applied	The value is published by Ministry of Ecology and Environment of the People's Republic of China, based on China Electric Yearbook(2014-2016) , Electricity Industry Statistics(2013-2015),China Energy Statistic Yearbook(2014-2016) and IPCC data.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$EF_{grid,BM,y}$
Data unit	tCO ₂ /MWh
Description	Build margin emission factor of NCPG
Source of data	2017 Bulletin on the Baseline Emission Factors of the China Grids
Value applied	0.4578
Justification of choice of data or description of measurement methods and procedures applied	The value is published by Ministry of Ecology and Environment of the People's Republic of China, based on China Electric Yearbook(2014-2016) , Electricity Industry Statistics(2013-2015),China Energy Statistic Yearbook(2014-2016) and IPCC data.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$TDL_{j,y}$ and $TDL_{k,y}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j,k in year y
Source of data	Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation(version 03.0)
Value applied	Use as default values of 20% for project consumption sources; Use as default values of 3% for baseline electricity consumption

	sources. i.e.: $TDL_{j,y} = 3\%$, $TDL_{k,y} = 20\%$
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of Baseline, project and/or leakage emissions from electricity consumption
Comments	-

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 applied	Since the implementation of the project activity, no changes have taken place in the management of the landfill. By the end of the implementation of the project, the provisions on methane recovery and utilization have not changed in the current effective laws and standards in China, and it is a common phenomenon in China that methane is discharged into the atmosphere without utilization.
Monitoring equipment	-
QA/QC procedures to be applied	-

Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	$Op_{j,h}$
Data unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Project participants
Description of measurement methods and procedures to be applied	For each equipment unit j using the LFG monitor that the plant is operating in hour h by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnaces. This option is not applicable to brick kilns. $Op_{j,h}=0$ when: (a) One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); (c) No products are generated in the hour h. Otherwise, $Op_{j,h}=1$
Frequency of monitoring/recording	Hourly
Value applied	In this monitoring period, the operation hours of each generator are as follows. According to the gas production, 4 units are in operation during this monitoring period, and 5#, 6#, 7# units are used as standby units when the gas production increases. 19,159 h (generator 1#)

	19,160 h (generator 2#) 19,199 h (generator 3#) 19,035 h (generator 4#) 0 h (generator 5#) 0 h (generator 6#) 0 h (generator 7#)
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	$F_{CH_4,BL,R,y}$										
Data unit	tCH ₄ /yr										
Description	Amount of methane in the LFG which is flared due to a requirement in year y										
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns.										
Description of measurement methods and procedures to be applied	-										
Frequency of monitoring/recording	Annually										
Value applied	2,550.51 tCH ₄ during this monitoring period <table border="1"> <thead> <tr> <th>Date</th><th>$F_{CH_4,BL,R,y}(tCH_4)$</th></tr> </thead> <tbody> <tr> <td>13/04/2019-31/12/2019</td><td>813.67</td></tr> <tr> <td>01//01/2020-31/12/2020</td><td>1,177.38</td></tr> <tr> <td>01//01/2021-30/06/2021</td><td>559.46</td></tr> <tr> <td>Total</td><td>2,550.51</td></tr> </tbody> </table>	Date	$F_{CH_4,BL,R,y}(tCH_4)$	13/04/2019-31/12/2019	813.67	01//01/2020-31/12/2020	1,177.38	01//01/2021-30/06/2021	559.46	Total	2,550.51
Date	$F_{CH_4,BL,R,y}(tCH_4)$										
13/04/2019-31/12/2019	813.67										
01//01/2020-31/12/2020	1,177.38										
01//01/2021-30/06/2021	559.46										
Total	2,550.51										

Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	Applicable to Case 2 of section 5.4.1.3 of ACM0001“Flaring or use of landfill gas” (version 19.0)

Data / Parameter	$P_{reg,y}$
Data unit	Dimensionless
Description	Fraction of LFG that is required to be flared due to a requirement in year y
Source of data	Information of the host country’s regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns.
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Annually
Value applied	20%
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	Applicable to Case 2 of section 5.4.1.3 of ACM0001“Flaring or use of landfill gas” (version 19.0)

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	Project participant				
Description of measurement methods and procedures to be applied	Monitor net electricity generation by the project activity using LFG				
Frequency of monitoring/recording	The recording frequency was hourly measured and recorded, and monthly aggregated.				
Value applied	54,472.151				
Monitoring equipment	Electricity meter				
	Model	Serial number	Accuracy class	Date of calibration	Validity
	DSZ331	110029364505	0.5S	01/04/2019	31/03/2020
				31/03/2020	30/03/2021
				30/03/2021	29/03/2022
QA/QC procedures to be applied	The calibration was done once a year by a qualified third party.				
Purpose of data	Calculation of baseline emissions				
Calculation method	-				
Comments	-				

Data / Parameter	EG _{EC,y}
Data unit	MWh
Description	Amount of electricity consumed by the project activity in year y
Source of data	Project participant
Description of measurement methods and procedures to be applied	Sources of consumption include 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

applied	power generators, etc.				
Frequency of monitoring/recording	The recording frequency was hourly measured and recorded, and monthly aggregated.				
Value applied	0.370				
Monitoring equipment	Electricity meter				
	Model	Serial number	Accuracy class	Date of calibration	Validity
	DSZ331	110029364505	0.5S	01/04/2019	31/03/2020
				31/03/2020	30/03/2021
				30/03/2021	29/03/2022
QA/QC procedures to be applied	The calibration was done once a year by a qualified third party.				
Purpose of data	Calculation of baseline emissions				
Calculation method	-				
Comments	-				

Data / Parameter	$V_{t,db}$
Data unit	m ³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Monitored by project participant
Description of measurement methods and procedures to be applied	Volume flow measurement always refers to the actual pressure and temperature.
Frequency of monitoring/recording	Measured continuously by a flow meter (average hourly value was used in the calculations of baseline emission reductions). Data to be aggregated monthly.
Value applied	2,109.45 (hourly average for this monitoring period at normal conditions)
Monitoring equipment	Flow meter

	Model	Serial number	Accuracy class	Date of calibration	Validity
	BF-3000-2400	E01325000003	1.5	29/03/2019	28/03/2020
				28/03/2020	27/03/2021
				27/03/2021	26/03/2022
QA/QC procedures to be applied	Flow meter was subject to a regular maintenance and testing regime to ensure accuracy				
Purpose of data	Calculation of project emissions				
Calculation method	-				
Comments	-				

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 ton s dry basis				
Source of data	Monitored by the project participant				
Description of measurement methods and procedures to be applied	Continuous gas analyzer operating in operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature.				
Frequency of monitoring/recording	Continuous if not specified in the underlying methodology				
Value applied	46.07%				
Monitoring equipment	Gas analyzer				
	Model	Serial number	Accuracy class	Date of calibration	Validity
	GTR196	61584/45	2%	29/03/2019	28/03/2020
				28/03/2020	27/03/2021
27/03/2021				26/03/2022	
QA/QC procedures to be	Gas analyzer was subject to a regular maintenance and testing				

applied	regime to ensure accuracy
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	CAPEX and OPEX
Data unit	CNY
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	-
Frequency of monitoring/recording	At the first issuance request after each phase of the project is fully implemented
Value applied	CAPEX: 33 million OPEX: 6.29 million
Monitoring equipment	-
QA/QC procedures to be applied	Audited by professional, independent financial auditors. The DOE should only verify that the data provided corresponds to the data from independent financial auditors.
Purpose of data	Identify the baseline scenario and demonstrate additionality
Calculation method	-
Comments	The information provided for CAPEX shall indicate the investment made: (i) in the collection and flaring system; (ii) in the power plant and connection to the grid (if applicable); and (iii) in the purchase of the new boiler or refurbishment of the existing one and in the steam/hot air pipeline if steam/hot air is exported out of the project boundary (if applicable). The information supplied for OPEX shall indicate the costs for: (i) staff and maintenance involved in the operation of the collection and flaring system; and (ii) staff and maintenance involved in the

	operation of the collection and power generation system. The monitoring of this parameter is only required for projects applying the simplified procedures to identify the baseline scenario and demonstrate additionality.
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Data / Parameter	Tariff of electricity exported
Data unit	CNY/kWh
Description	Tariff of the electricity exported
Source of data	On-grid tariff approval
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	At the first issuance request after each phase of the project is fully implemented
Value applied	0.594
Monitoring equipment	-
QA/QC procedures to be applied	Audited by professional, independent financial auditors. The DOE should only verify that the data provided corresponds to the data from independent financial auditors
Purpose of data	Identify the baseline scenario and demonstrate additionality
Calculation method	-
Comments	The monitoring of this parameter is only required for projects applying the simplified procedures to identify the baseline scenario and demonstrate additionality

4.3 Monitoring Plan

1. The requirement of monitoring plan

The project participant monitors the emission reductions by methods, indicators, and frequency required by Monitoring Methodology ACM0001 (Version 19.0) to ensure project ERs are measurable and real. The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed by the project and electricity generating units.

2. Responsibilities of operational and management structure

The project participant implements this monitoring plan. The plan could be revised according to suggestions from VVB and the practical circumstances, in order to keep it consistent, transparent and conservative during the monitoring process.

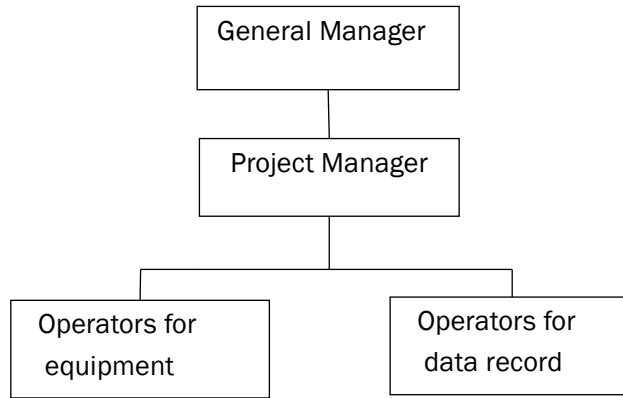


Figure 4.1 Operational and management structure

(1) Principal of the monitoring procedure

The general manager of the project is the leader of the monitoring tasks: he sets out the responsibility of everyone in the monitoring system, and establishes the related documents. The general manager ensures that staff in the monitoring system has the ability to deal with the assigned tasks.

(2) Executive person of the monitoring procedure

Project Manager: a Project Manager is appointed, specifically responsible for training, checking the daily operation, reporting forms and archiving emergency situation reports. The VCS Manager reports monthly to the General Manager (GM) about the project performance and monitored data. In the event that non-conformance in the performance to the mentioned procedures and/or functioning problems of the monitoring equipment is identified, the VCS manager informs the GM about the situation and work out relevant measures to be taken. The VCS manager also is responsible for aggregating the monitored data monthly and yearly, archiving and keeping data during the crediting period and two years after.

(3) Operators of the monitoring procedure

Operators take turns to work in the control center 24 hours a day. They are in charge of data supervision, filling operation report forms and, checking and inspecting the system. If necessary, they have the responsibility for executing the emergency plan and drafting emergency situation reports.

3. Monitoring system

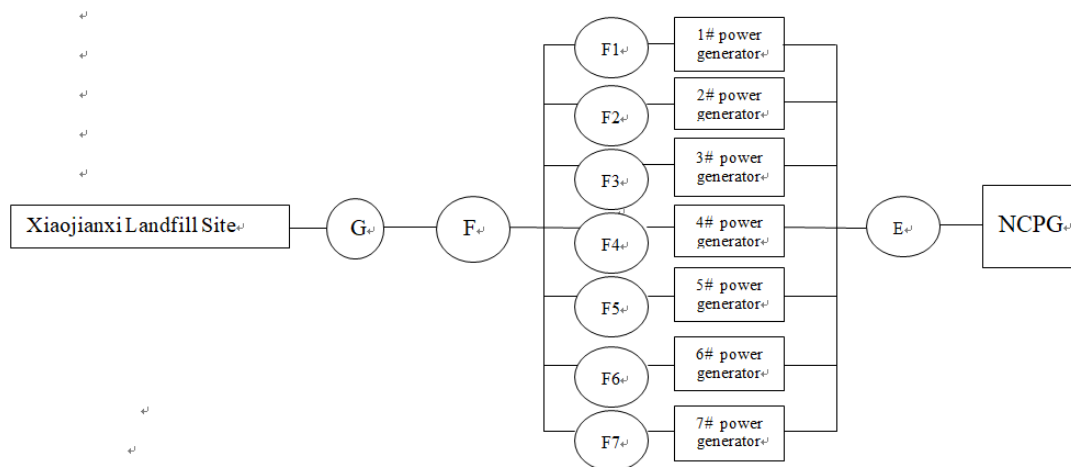


Figure 4.2 Monitoring system

Main parameters:

G	Gas analyzer to continuously measure methane fraction in LFG
F	Flow meter to continuously measure flow rate of total captured LFG, with automatic measure adjustment for temperature and pressure
F1 F2 F3 F4 F5 F6 F7	Flow meters to continuously measure flow rates of combusted LFG for power generation of each generator set, with automatic measure adjustment for temperature and pressure. To be conservative, the min value of F and F1+F2+F3+F4+F5+F6+F7 was used to calculate the ex-post emission reductions.
E	Electricity meter (main meter, bi-directional) to continuously measure the electricity supplied to the NCPG and the electricity supplied by the grid

QA/QC

All the monitoring devices listed above (flow meter, gas analyzer and electricity meter) were calibrated once a year by a qualified third party. The calibration reports were kept in the archives by the project owner, and checked by Project Manager. When the data is not available from the main monitoring devices, the data measured by the back-up devices is used.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

$$BE_y = BE_{CH_4,y} + BE_{EC,y} \quad (1)$$

Parameter	Description	Unit	2019	2020	2021	Total
BE_y	Baseline emissions	tCO ₂ e	84,814	120,678	63,548	269,040
$BE_{CH_4,y}$	Baseline emissions of methane from the SWDS	tCO ₂ e	71,196	103,020	54,827	229,043
$BE_{EC,y}$	Baseline emissions associated with electricity generation	tCO ₂ e	13,618	17,658	8,721	39,997

$$BE_{CH_4} = ((1 - OX_{top_layer}) \times F_{CH_4,pj,y} - F_{CH,BL,y}) \times GWP_{CH_4} \quad (2)$$

Parameter	Description	Unit	2019	2020	2021	Total
$BE_{CH_4,y}$	Baseline emissions of methane from the SWDS in year y	tCO ₂ e	71,196	103,020	54,827	229,043
OX_{top_layer}	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)	/	0.1	0.1	0.1	/
$F_{CH_4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year y	tCH ₄	4,068.36	5,886.90	2,797.30	12,752.56
$F_{CH_4,BL,y}$	Amount of methane	tCH ₄	813.67	1,177.38	559.46	2,550.5

	in the LFG that would be flared in the baseline in year y					1
GWP_{CH_4}	Global warming potential of CH_4	tCO_2e/tCH_4	25	25	28	/

$$F_{CH_4,PJ,y} = F_{CH_4,EL,y} \quad (3)$$

Parameter	Description	Unit	2019	2020	2021	Total
$F_{CH_4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year y	tCH_4	4,068.36	5,886.90	2,797.30	12,752.56
$F_{CH_4,EL,y}$	Amount of methane in the LFG which is for electricity generation	tCH_4	4,068.36	5,886.90	2,797.30	12,752.56

$F_{CH_4,EL,y}$ is determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. The mass flow of CH_4 shall be determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \quad (4)$$

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad (5)$$

Where:

$F_{i,t}$ = Mass flow of greenhouse gas I in the gaseous stream in the 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 dry gas)

P_t = Absolute pressure of the gaseous stream in time interval t (101,325Pa)

T_t = Temperature of the gaseous stream in time interval t (273.15K)

MM_i = Molecular mass of greenhouse gas i(16.04 Kg/kmol)

R_u = Universal ideal gases constant (8,314Pa.m³/kmol.k)

$$BE_{EC,y} = EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y}) \quad (6)$$

Parameter	Description	Unit	2019	2020	2021	Total
$BE_{EC,y}$	Baseline emission from electricity consumption in year y	tCO ₂	13,618	17,658	8,721	39,997
$EC_{BL,k,y}$	Quantity of electricity that would be consumed by the baseline electricity consumer k in year y	MWh	18,546.35	24,047.96	11,877.84	54,472.15
$EF_{EF,k,y}$	Emission factor for electricity generation for source k in year y	tCO ₂ /MWh	0.7129	0.7129	0.7129	/
$TDL_{k,y}$	Average technical transmission and distribution losses for providing electricity to source k in year y	/	3%	3%	3%	/

5.2 Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} \quad (7)$$

Parameter	Description	Unit	2019	2020	2021	Total
PE_y	Project emission in year y	tCO ₂	0	1	0	1
$PE_{EC,y}$	Emissions from consumption of electricity due to the project activity in year y	tCO ₂	0	1	0	1

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y}) \quad (8)$$

Parameter	Description	Unit	2019	2020	2021	Total
$PE_{EC,y}$	Project emissions from electricity consumption in year y	tCO ₂	0	1	0	1
$EC_{PJ,j,y}$	Quantity of electricity consumed by the project electricity consumption source j in year y	MWh	0	0.37	0	0.37
$EF_{EL,j,y}$	Emission factor for electricity generation for source j in year y	tCO ₂ /MWh	0.7129	0.7129	0.7129	/
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y	/	20%	20%	20%	/

5.3 Leakage

According to ACM0001, no leakage effects need to be accounted.

5.4 Net GHG Emission Reductions and Removals

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad (9)$$

Where:

ER_y = Emission reduction in year y (t CO₂e/yr)

BE_y = Baseline emissions in year y (t CO₂e/yr)

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
13/04/2019-31/12/2019	84,814	0	0	84,814
2020	120,678	1	0	120,677
01/01/2021-30/06/2021	63,548	0	0	63,548
Total	269,040	1	0	269,039

The monitoring period covers from 13/04/2019 to 30/06/2021, with totally 810 days. Based on the registered VCS PD, the amount of estimated emission reductions for this monitoring period would be $59,774 + 123,006 + 146,971 / 365 * 181 = 255,661 \text{ tCO}_2\text{e}$. The actual emission reductions in this monitoring period are 269,039 tCO₂e, which is 5.23% more than the estimation in the registered VCS PD.

For LFG power project, with many external factors affecting the amount and quality of LFG generated, including climate, quantity of domestic waste landfill, waste composition, gas collection efficiency and technology etc., it is reasonable that the amount of LFG generated differs with the estimated value based on hypothetical model given by the tool given by CDM EB. Comparing to the estimated emission reductions, the mainly reasons of the difference are for that (1) with the improvement of gas collection efficiency and technology, more LFG is captured; (2) When calculating the emission reductions in 2021, GWP is 25 in advance estimation and 28 is used in actual calculation according to the

updated GWP. Therefore, the increase 5.23% is reasonable and acceptable for LFG power project.