



GUANGZHOU EASTERN SOLID RESOURCE RECYCLING CENTER MSW INTEGRATED TREATMENT PLANT PROJECT



Document Prepared by Climate Bridge (Shanghai) Ltd.

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Project Title	Guangzhou Eastern Solid Resource Recycling Center MSW Integrated Treatment Plant Project
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1 PROJECT DETAILS

1.1 Summary Description of the project

Guangzhou Eastern Solid Resource Recycling Center MSW Integrated Treatment Plant Project (hereinafter referred to as the project) is located at the Solid Resource Recycling Center, Fushan Village, Jiulong Town, Luogang District, Guangzhou City, Guangdong Province, P.R China. The project is owned and implemented by Guangzhou LEO-KING Environmental Technology Co., Ltd..

The purpose of the project is to treat MSW with anaerobic digesters and utilize recovered biogas for electricity generation. The project activity includes MSW collection, MSW pre-treatment system, biodiesel production system, anaerobic digester, biogas purification, electricity generation system and waste heat recovery. However, in terms of the biodiesel production system and waste heat recovery, waste oil sourced from MSW pre-treatment system will be used for biodiesel production, and the waste heat will be recovered to be the source of heat supply for the operation. To be conservative, emission reductions will not be claimed for waste heat recovery and biodiesel production system.

The fresh waste of the project is mainly kitchen and catering waste of the Guangzhou City and the design processing capacity of the project for the fresh waste is 2,040 tonnes per day. The biogas from anaerobic digestion will be used for electricity generation with internal combustion generators. The total installed capacity will be 10.45 MW included 4 generators with each 1.053 MW and 2 generators with each 3.119 MW.

The liquid digestate and solid digestate will be produced in anaerobic digester. The solid digestate will be outward transported and incinerated directly in thermal power plant and will not be stored under anaerobic conditions. And the wastewater will be treated aerobically by wastewater treatment plant nearby.

The project is to utilize the biogas produced by anaerobic digestion for power generation. The electricity generated by the project is supplied to China South Power Grid (CSPG) which is dominated by coal-fired power stations. Before the implementation of the project activity, the fresh waste would be treated in a landfill site with a partial capture of the landfill gas (LFG) and flaring of the captured LFG. This is the scenario that existed prior to the implementation of the project activity and is also the baseline scenario.

In absence of the project, equivalent amount of electricity exported to the grid by the project would have otherwise been supplied by China South Power Grid (CSPG). Greenhouse gas (GHG) emissions will be reduced by avoiding CO₂ emissions from those fossil fuel-based power plants connected to the grid and by avoiding GHG emissions at the landfill site.

The project started construction on 12/10/2017 and the operation start date of which is 01/04/2020. The annual average amount of exported electricity is estimated to 61,842 MWh in the twice renewable crediting period from 01/04/2020 to 31/03/2041. And the expected total emission reductions are 2,513,097 tCO₂e during the first crediting period, with average annual emission reductions 359,014 tCO₂e. In this monitoring period from 01/04/2020 to 31/12/2021, the emission reductions are 332,556 tCO₂e.

1.2 Sectoral Scope and Project Type

Sectoral Scope 1: Energy industries (renewable - / non-renewable sources)

Sectoral Scope 13: Waste handling and disposal.

The project is not a grouped project.

1.3 Project Eligibility

The scope of the VCS Program includes:

1) The six Kyoto Protocol greenhouse gases: The emissions reduction of the project comes from two sources: 1) CH₄ from anaerobic digestion will be recovered and destructed by the project to avoid CH₄ emissions from atmospheric released LFG at the landfill site that treated the MSW previously; 2) CO₂ emissions from the production of the equivalent amount of electricity replaced by the project that would otherwise have been purchased from the fossil fuel fired power plants of China South Power Grid (CSPG). Thus, the project applicable to this scope.

2) Ozone-depleting substances: NA

3) Project activities supported by a methodology approved under the VCS Program through the methodology approval process: NA

4) Project activities supported by a methodology approved under a VCS approved GHG program, unless explicitly excluded under the terms of Verra approval: The methodology ACM0022 (Version 03.0) of the project utilized is a methodology approved under CDM Program, that is a VCS approved GHG program.

5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements: NA

Meanwhile, the project is not belonged to the projects excluded in Table 1 of VCS Standard 4.2.

Thus, the project is eligible under the scope of VCS program.

1.4 Project Design

The project has been designed to be a single installation of an activity, not a grouped project.

1.5 Project Proponent

Organization name	Guangzhou LEO-KING Environmental Technology Co., Ltd.
Contact person	Ding Lu
Title	General manager
Address	No.118 fushantandong Road, Huangpu District, Guangzhou City, Guangdong Province, P.R China.
Telephone	+86-2162462036
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1.6 Other Entities Involved in the project

Organization name	Climate Bridge (Shanghai) Ltd.
Role in the project	Consultancy
Contact person	Gao Zhiwen
Title	General Manager
Address	Block B, Level 24, Jiangong Mansion, 33 Fushan Road, Pudong New Area, Shanghai, China 200120

Telephone	+86-2162462036
Email	gao.zhiwen@climatebridge.com ; projects@climatebridge.com

1.7 Ownership

The project owner of the project is Guangzhou LEO-KING Environmental Technology Co., Ltd.. The approval of Environmental Impact Assessment (EIA), Project Approval, and the business license of the project owner is evidence for legislative right. Besides, the purchasing contract of generators, and the purchasing power agreement are the evidence for the ownership of the plant, equipment and power generating.

1.8 Project Start Date

01/04/2020 (operation start date is the date on which the project began recovering biogas for electricity generation and the project activity began generating GHG emission reductions).

1.9 Project Crediting Period

The project adopts seven years, twice renewable crediting period for a total of 21 years, and the first crediting period is from 01/04/2020 to 31/03/2027.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	
Large project	☒

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
01/04/2020~31/12/2020	120,089
01/01/2021~31/12/2021	241,497

01/01/2022~31/12/2022	324,942
01/01/2023~31/12/2023	382,808
01/01/2024~31/12/2024	420,831
01/01/2025~31/12/2025	445,354
01/01/2026~31/12/2026	462,562
01/01/2027~31/03/2027	115,015
Total estimated ERs	2,513,097
Total number of crediting years	7
Average annual ERs	359,014

1.11 Description of the project Activity

The fresh waste collected by the project is mainly kitchen and catering waste of the Guangzhou City and the design processing capacity of the project for the fresh waste is 2,040 tonnes per day. The project activity includes MSW collection system, MSW pre-treatment system, biodiesel production system, anaerobic digester, biogas purification, electricity generation system and waste heat recovery. However, in terms of the biodiesel production system and waste heat recovery, waste oil sourced from MSW pre-treatment system will be used for biodiesel production, and the waste heat will be recovered to be the source of heat supply for the operation. To be conservative, emission reductions will not be claimed for waste heat recovery and biodiesel production system.

The fresh waste collected by the project will be sent to MSW pre-treatment system, then the uniform organic slurry will be pumped into the anaerobic digestion system and waste oil will be used for biodiesel production system¹. The anaerobic digestion system will produce biogas under medium temperature anaerobic digestion. After at least 25 days retention time in the

¹ The designed production capacity of biodiesel production is 40t/day and its raw oil mainly sourced from waste oil treated by MSW pre-treatment system. Since emission reduction of biodiesel production will not be claimed in the project activity, the detailed production technology and facilities of biodiesel production will not be stated in this section.

anaerobic digester, the solid digestate will be outward transported and incinerated directly in thermal power plant and will not be stored under anaerobic conditions, and the wastewater will be treated aerobically by wastewater treatment plant nearby. The biogas from anaerobic digestion will be used for electricity generation with internal combustion generators. Detailed process is shown in Figure 1-1 below.

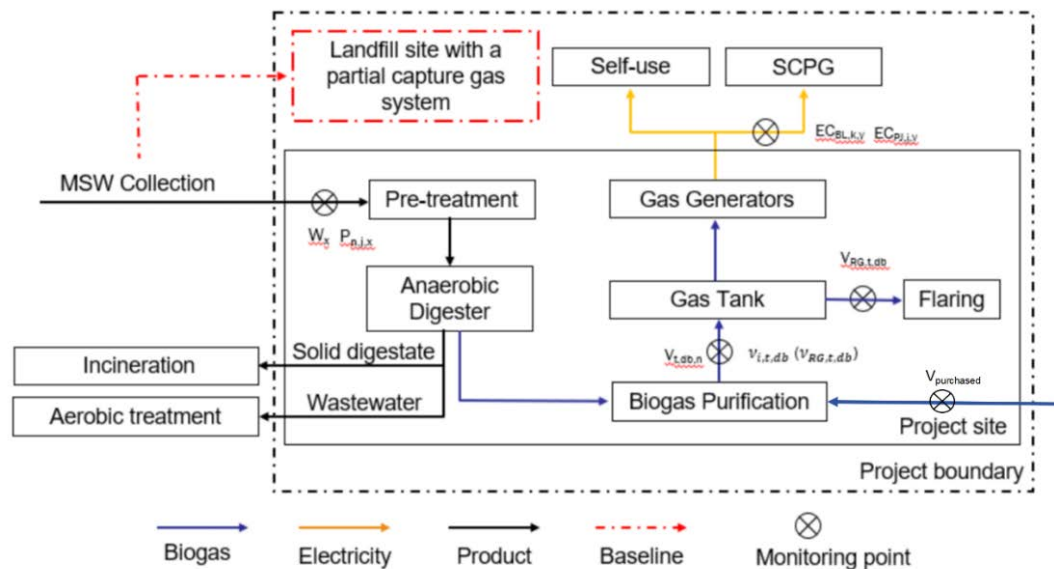


Figure 1-1 Project process diagram

The baseline scenario of the project is the situation existing before the implementation of the project. Before the implementation of the project activity, the fresh waste would be treated in a landfill site with a partial capture of the LFG and flaring of the captured LFG. In addition, the quantity of electricity produced using biogas would have been produced by fossil fuel-fired power plants connected to the grid. By replacing the electricity generated from fossil fuel-fired power plants dominated CSPG, the project activity will achieve considerable greenhouse gas emission reductions by reducing CO₂ and CH₄ emissions.

The project activity will install a comprehensive system for biogas recovery and utilization in the project boundary. The system will involve mainly MSW pre-treatment system, anaerobic digester, electricity generation system and flare system. The key systems involved in the project are as follows:

- MSW pre-treatment system

The MSW pre-treatment system including separation, heating, waste crude oil treatment and extraction, then the uniform organic slurry after pre-treatment will be pumped into the anaerobic digestion system and waste oil will be used for biodiesel production. The processing capacity of MSW pre-treatment system is 2,040 t/d.

- Anaerobic digester

This system adopts hydrolysis acidification and anaerobic digestion under the two-phase medium temperature anaerobic condition. After 2.5 days retention time in the hydrolysis acidification, the uniform organic slurry will be pumped into the anaerobic digester system and which will be stirred to make biogas at the temperature range from 35 to 38°C beyond 25 days retention time. The daily processing quantity of anaerobic digester for organic slurry is 2,500 t.

- Electricity generation system

The electricity generated by using biogas, except for on-site usage, will be predominantly sold to the CSPG through nearby distribution network. The total installed capacity will be 10.45 MW internal combustion engine generators included 4 generators with each 1.053 MW and 2 generators with each 3.119 MW. The annual average running time is 7,920 hours and the power generation efficiency are 42%. This is a well-known and high reliable technology for biogas utilization.

- Flare system

The biogas will be delivered to generators for generating electricity and the remaining biogas will be flaring if the gas tank malfunctions or its storage capacity is full.

The detailed information about the technology of the project is shown in the table below.

Table 1-1 Technical parameters of the gas generators and enclosed flare ²

Gas generator:		
Manufacturer	GE Jenbacher GmbH &Co OG	
Type	JMS 620 GS- F25	JGS 320GS- B.L
Quantity	2	4
Rated capacity	3.119	1.053 MW
Rated power factor	1	1
Rated frequency	50HZ	50HZ

² Sourced from nameplate and technical agreement.

Rated Voltage	10500V	10500V
Rotate Current	167A	58A
Enclosed flare		
Manufacturer	Nanjing Carbon Cycling Biomass Technology Co., Ltd.	
Quantity	1	
Model	Φ 3100*14000	
Temperature range	0~1200℃	
Pressure range	0~20Kpa	
Flow range	450~4500m ³ /h	

Since January 2023, the PP purchased surplus biogas for power generation from a fresh waste anaerobic digestion project (started operation in 2022, later than the operation start date of the project) owned by Grandtop Fushan Environmental Protection Energy Co., Ltd. A new pipeline with a biogas flow meter has been built connecting the project activity with the Grandtop Fushan project. The purchased biogas is measured by the newly installed flow meter and then fed to the pre-treatment system of the project site. Based on the analysis in section 3.5 of this report and section 3.2.2 of the monitoring report for the 3rd monitoring period of the project, the deviation does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario. Appropriate measures have been taken to ensure that the ER of the project due to this deviation is not overestimated, please refer to section 4.1, 4.2 and the monitoring report for the 3rd monitoring period for details.

1.12 Project Location

The project is located at the Solid Resource Recycling Center, Fushan Village, Jiulong Town, Luogang District, Guangzhou City, Guangdong Province, P.R China. The geographical coordinates for the project site are east longitude 113°30'54" and north latitude 23°17'4". The geographic location of the project is shown in Figure 1-2.

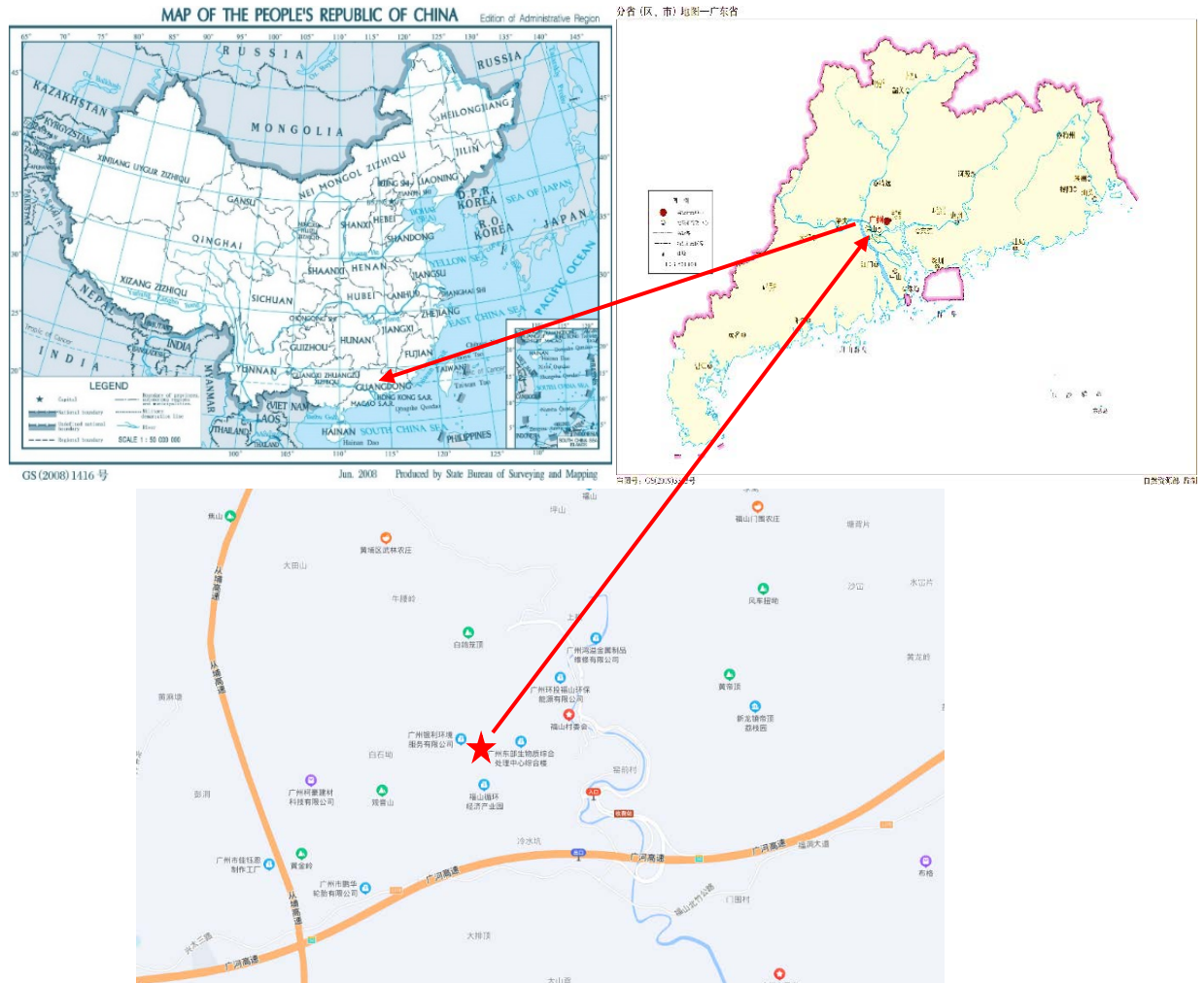


Figure 1-2 Location of the project

1.13 Conditions Prior to Project Initiation

The scenario existing prior to the start of the implementation of the project activity is:

- 1) The fresh waste would be treated in a landfill site with a partial capture of the landfill gas (LFG) and flaring of the captured LFG. In addition;
- 2) The quantity of electricity produced using biogas would have been produced by power plants connected to the grid (CSPG).

The baseline scenario is the same as the conditions existing prior to the project initiation.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project complies with all Chinese relevant laws and regulations. Mainly include:

1. Environmental Protection Law of the People's Republic of China;
2. Prevention and Control of Environmental Pollution by Solid Waste Law of the People's Republic of China;
3. Catalogue for the Guidance of Industrial Structure Adjustment (2019 version)³;

The project obtained the project approval and EIA approval from governmental authorities: Guangzhou City Development and Reform Commission and Guangzhou City Environment Bureau. The two approvals well demonstrate that local government permits the construction of the project. Consequently, the project is compliance with laws, status and other regulatory frameworks.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project has neither been registered nor seeking registration under any other GHG programs.

The project is seeking registration only in VCS program.

1.15.2 Projects Rejected by Other GHG Programs

NA.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

China has a national emissions trading scheme only cover the high-emission industries, such as thermal power generation, petrochemical, chemical, building materials, iron and steel, non-ferrous, paper, aviation and other key emission industries that emitted at least 26,000 tons of CO₂e/year, not including renewable project⁴. And the project activity is not included the mandatory emission control scheme and there is no emission cap enforced for the project

³ http://www.gov.cn/xinwen/2019-11/06/content_5449193.htm

⁴ http://www.mee.gov.cn/xxgk2018/xxgk/xxgk05/202103/t20210330_826728.html

owner according to the enforced company list⁵ in public information. Hence, it is confirmed that the emission reductions will not be double counted.

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.

1.16.2 Other Forms of Environmental Credit

The project hasn't sought or received another form of environmental credits, including renewable energy certificates.

1.17 Sustainable Development Contributions

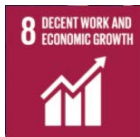
1.17.1 Sustainable Development Contributions Activity Description

The project is to utilize the biogas produced by anaerobic digestion for power generation, which is located at the Solid Resource Recycling Center, Fushan Village, Jiulong Town, Luogang District, Guangzhou City, Guangdong Province, P.R China.

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



The project will utilize fresh waste to generate biogas that would otherwise be treated in a landfill site with a partial capture of the landfill gas (LFG) and flaring of the captured LFG, effectively reducing air pollution and improving the environment around landfills. The project will achieve a GHG emission reduction of 359,014 tCO₂e/yr during first crediting period. Thus, the project will achieve SDG 13 Climate Action⁶. This contributes to achieve one of China's stated sustainable development priorities "Actively adapt to climate change and strengthen resistance capacity to climate risks in agriculture, forestry, water resources and other key fields, as well as cities, coastal regions and ecologically vulnerable areas".



⁵ <http://mee.gov.cn/xxgk2018/xxgk/xxgk03/202012/W020201230736907682380.pdf>

⁶ <https://sdgs.un.org/goals/goal13>

The construction and operation of the project will provide 328 employment positions for local villagers and increase tax revenue, which will have a positive effect on the local economy. During first crediting period, direct and indirect employment opportunities will be generated. Thus, the project will achieve SDG 8 Decent Work and Economic Growth⁷. This contributes to one of the China's actions for promoting sustainable developing, "Increase labor force participation rate through implementation of the classification policy. Vigorously enforce the Law on Promotion of Employment".



61,842 MWh/yr of electricity from renewable sources will be supplied to the power grid in the twice renewable crediting period from 01/04/2020 to 31/03/2041. Thus, the project will achieve SDG 7 Affordable and Clean Energy⁸. This contributes to achieve one of China's stated sustainable development priorities "By 2030, increase the share of non-fossil fuels in primary energy consumption to about 25 percent. Optimize the energy mix by improving fossil-fuel efficiency and increasing the share of clean energy consumption, so that non-fossil fuels and natural gas become the main energy sources".

1.17.2 Sustainable Development Contributions Activity Monitoring

The project utilized the biogas produced by anaerobic digestion for power generation, in this monitoring period, the project has generated 39,353.600 MWh of electricity exported to CSPG and achieved 332,556 tCO_{2e} emission reduction, which also offered 308 employment positions for local villagers. Therefore, the project achieved SDG 7, SDG 8 and SDG 13 in this monitoring period and contributed to China's stated sustainable development priorities mentioned in the section 1.17.1.

Evidence for SDG Target 8.3: The payroll of the project will be submitted as a separate document to Verra to protect employee privacy.

⁷ <https://sdgs.un.org/goals/goal8>

⁸ <https://sdgs.un.org/goals/goal7>

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	Renewable energy supplied to the power grid	Implemented activities to increase	39,353.600 MWh of electricity from renewable sources have been supplied to the CSPG during this monitoring period, replacing fossil fuel powered electricity.	From 01/04/2020 onwards, 39,353.600 MWh of electricity from renewable sources has been supplied to the power grid.
2)	8.3	Provide job opportunities by implementation of the project	Implemented activities to increase	Provided 308 employment positions for local villagers in this monitoring period.	From 01/04/2020 onwards, the project has provided 308 employment positions for local villagers.
3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	The project achieved a GHG emission reduction of 332,556 tCO ₂ e during this monitoring period.	From 01/04/2020 onwards, the project has achieved a GHG emission reduction of 332,556 tCO ₂ e.

1.18 Additional Information Relevant to the project

Leakage Management

Not applicable as the project is not a AFOLU project.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

Further Information

NA.

2 SAFEGUARDS

2.1 No Net Harm

The EIA Report for the project has been approved by Guangzhou City Environment Bureau on 02/05/2017, with approval *Sui Huan Guan Ying No. [2017] No.16*. Every aspect of environmental impact has been considered in the EIA report with corresponding measures during project development, and no net harm has been detected. Meanwhile, the implementation of the project will improve local socio-economic development through creating career opportunities and paying taxes.

In conclusion, the project has no negative impacts on local environment and socio-economy. And no net harm on local environment and social community has been detected for the project.

2.2 Local Stakeholder Consultation

Local Stakeholder Consultation during the project preparation stage:

The project owner collected comments by local stakeholders on the project activity. Survey questionnaires were distributed to relevant personnel of the project, local villagers and government officials by the project owner on 20/08/2017. The survey questionnaire was designed to assess the project impacts on the local environment and social economic development. The structure of the survey respondents is listed in Table 2-1 below.

Table 2-1 Structure of stakeholders surveyed

Item	Distribution	Quantity	Percentage
Amount of stakeholders surveyed	Male	23	57.5%
	Female	17	42.5%
Age	<25	7	17.5%
	25-45	16	40%
	45-55	11	27.5%
	>55	6	15%
Education	Junior high school or below	18	45%
	Senior high school	15	37.5%
	College or above	7	17.5%
Occupation	Worker	14	35%
	Peasant	12	30%
	Management personnel	8	20%
	Civil servant	4	10%
	Unspecified	2	5%

40 questionnaires were distributed to local stakeholders, and all questionnaires have been recollected. Comments from these questionnaires are summarized in Table 2-2 below:

Table 2-2 Summary of stakeholders' comments

No.	Questions	Attitude or Opinion	Amount	Percentage
1	Do you know about the project activity?	Very much	31	77.5%
		Heard of	9	22.5%
		Nothing	0	0
2	Do you think the project will improve the current situation of landfill?	Yes	37	92.5%
		No	0	0
		Don't know	3	7.5%
3	Do you think the project will promote local economic development?	Yes	36	90%
		No	0	0
		Don't know	4	10%
4	Do you think the project will improve the local employment situation?	Yes	33	82.5%
		No	0	0
		Don't know	7	17.5%
5	What impact do you think will the project bring to your family?	Positive impact	28	70%
		No impact	12	30%
		Negative impact	0	0%
6	What is the most probable environmental impact do you think the project will cause after the construction finish? (multiple choice)	None	35	87.5%
		Air pollution	0	0%
		Water pollution	0	0
		Noise pollution	0	0%
		Harm to indigenous animals	0	0%

		and plants		
		Don't know	5	12.5%
7	What do you think will be the project's impact on the local community? (multiple choices)?	Promote economic development	28	70%
		Improve electricity supply condition	34	85%
		No great impact	3	7.5%
8	What is your attitude to the project activity?	Support	38	95%
		Against	0	0
		Indifferent	2	5%

In general, local stakeholders are supportive of the project construction. The survey shows that a majority of local stakeholders think the project will help improve the life of local people and promote local economic development without much adverse environmental impact. The survey shows that almost all of the stakeholders are supportive to the proposed project, believing that the project will provide more employment opportunities, help local economic development, and increase local power supply.

Therefore, the implementation of the project is regarded as beneficial by most of the local stakeholders.

Local Stakeholder Consultation during the project implementation stage:

Communications with local stakeholders are being carried out at periodic intervals. Key implementation schedules or changes of the project will be communicated to the local authority, who will inform the neighborhood committee and the local residents, the comments and suggestions from residents will be collected by the local authority meanwhile. And the local government agencies and competent authorities will conduct spot checks on the implementation of the project from time to time and give suggestions on the involved rectification problems. 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.

In this monitoring period from 01/04/2020 to 31/12/2021, the project owner carried out questionnaire survey for the local stakeholder to collect the relevant comments and suggestions. Questionnaire was implemented by filling the stakeholder comments investigation. The comments, from the government, environmental protection bureau, local farmers, teachers and other relevant stakeholders, were collected. 30 copies questionnaires were distributed on 14/01/2021 and all of them were collected. The recovery rate is 100%. There are no negative comments received for the project according to every questionnaire survey.

2.3 Environmental Impact

The final EIA report of the project was approved by Guangzhou City Environment Bureau on 02/05/2017. The environmental impacts of the project are summarized as follows.

Air pollution

The contribution value of the exhaust pollutants emitted by the project to the predicted range is small, and the impact of pollutants on the surrounding area of the project is relatively light.

Wastewater

Wastewater concentration of the project is within the acceptable range of the sewage plant and has no impact on the surface water environment. According to the latest *technical Guidelines for environmental impact Assessment (HJ610-2016)*, groundwater impact assessment is not required for the project.

Noise

After the facilities of each workshop are rationally arranged, and the main noise equipment is noise-isolated and noise-muffled, which has a small impact on the surrounding sound environment during the operation period, and the contribution value of the noise at the plant boundary can meet the requirements of II in the *Environmental Noise Emission Standard for Industrial Enterprises at the Plant Boundary (GB12348-2008)*. It does not affect sensitive points of sound environment outside the field boundary.

Solid waste

After effective treatment measures are taken, all kinds of solid wastes generated during the operation of the project can be effectively treated and not be directly discharged into the external environment, so there is no adverse impact on the surrounding ecological environment.

In conclusion, the project will be minor impact on the surrounding ecological environment according to the EIA Approval. The project owner takes appropriate measures to minimize adverse environmental impacts. The project activity can reduce greenhouse gas emissions and environmental pollution caused by methane release and combust and coal-fired power generation.

2.4 Public Comments

The project was open for public comment from 21/12/2021 to 20/01/2022. And there is no comment received.

2.5 AFOLU-Specific Safeguards

NA.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The approved consolidated methodology applied in the project activity is ACM0022 Alternative waste treatment processes (Version 03.0).

This methodology also refers to the latest approved version of the following tools:

“Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0);

“Common practice” (version 03.1);

“Investment analysis” (version 11.0);

“Emissions from solid waste disposal sites” (version 08.0);

“Project and leakage emissions from anaerobic digesters” (version 02.0);

“Tool to calculate the emission factor for an electricity system” (version 07.0);

“Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0);

“Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0);

“Project emissions from flaring” (version 04.0);

For more detail information about the methodology and tools, please reference to the following link: <https://cdm.unfccc.int/methodologies/DB/AUR5PLW743TS00OCWRS55XXT86WV4J>

3.2 Applicability of Methodology

The project satisfies all the applicability criteria of the methodology ACM0022 (Version 03.0), of which the detailed description is listed in Table 3-1 below:

Table 3-1 Applicability of ACM0022

No.	Applicability conditions in ACM0022	The project
1	The methodology applies to project activities that install and operate new plants for the treatment of fresh waste through any combination of the following processes: (a) Composting process under aerobic conditions; (b) Anaerobic digestion with biogas recovery and flaring and/or its use; (c) Co-composting of wastewater in combination with solid waste; (d) Anaerobic co-treatment of wastewater in combination with solid waste; (e) Mechanical/thermal treatment process to produce refuse-derived fuel (RDF) or stabilized biomass (SB) that is produced within the project boundary and its use ; (f) Gasification process to produce syngas and its use; (g) Incineration of fresh waste for the generation of thermal/electric energy. (h) The following conditions apply to all project activities using this methodology: (i) The project plant only treats fresh waste/wastewater for which emission reductions are claimed, except for cases involving composting, co-composting and anaerobic digestion; (j) Neither the fresh waste nor the products from the project plant are stored on-site under anaerobic conditions; (k) Any wastewater discharge resulting from the project activity is treated in accordance with applicable regulations; (l) The project activity does not reduce the amount of waste that would be recycled in the absence of the project activity. This shall be justified and documented in the clean development mechanism project design document (CDM-PDD); (m) When applicable regulations mandate	Applicable. The project utilizes the biogas from anaerobic digestion of fresh waste for power generation. Therefore, the project is applicable to (b). According to condition (h), condition (i) to (n) applies to all project activities using this methodology: (i) The project is disposing fresh waste in the case of anaerobic digestion. only emission reductions from treatment of fresh waste are claimed, emission reductions will not be claimed for waste heat recovery and biodiesel production system. (j) Fresh waste is treated through anaerobic digestion in the project and the digestate produced from the anaerobic digestion will be outward transported and incinerated directly in thermal power plant, which all will not be stored on-site under anaerobic conditions. (k) The wastewater produced by the project will be treated aerobically by wastewater treatment plant nearby in accordance with applicable regulations such as GB18918-2016 “Discharge standard of pollutants for municipal wastewater treatment plant” and HJ/T91-2002 “Technical Specifications Requirements for Monitoring of Surface Water and Wastewater”. (l) Prior to the implementation of the project, the fresh waste was disposed of at nearby landfill with a partial LFG capture system. The project will not reduce the amount of waste that would be recycled in the absence of the project activity. (m) Currently, there are no applicable laws or regulations in China that require anaerobic digestion of fresh waste, and landfill is still the most common disposal

	any waste treatment process implemented under the project activity, the rate of compliance with such regulations for the treatment process is below 50 per cent ; (n) Hazardous wastes/wastewater are not eligible under this methodology.	method. (n) The fresh MSW treated by anaerobic digestion in the project does not involve hazardous waste or wastewater.
2	The methodology is only applicable if the baseline scenario is: (a) The disposal of the fresh waste in a SWDS with or without a partial LFG capture system (M2 or M3); (b) In the case of co-composting or co-treatment of wastewater in an anaerobic digester, the treatment of organic wastewater in either an existing or new anaerobic lagoon or sludge pit without methane recovery (W1 or W4); (c) In the case of electricity generation, the electricity is generated in an existing/new captive fossil fuel fired power-only plant, captive cogeneration plant and/or the grid (P2, P4 or P6); (d) In the case of heat generation, the heat is generated in an existing/new fossil fuel fired cogeneration plant, boiler or air heater (H2 or H4).	Applicable. The project utilizes the biogas from anaerobic digestion of fresh waste for power generation. The fresh waste was disposed at nearby landfill with a partial capture of the LFG and flaring of the captured LFG (M2); The electricity generated by the project is supplied to China South Power Grid (CSPG) which is dominated by coal-fired power stations (P6). Therefore, the project is applicable to (a) and (c). Please refer to section 3.4 of this joint PD&MR for details.
3	Specific applicability conditions for the different processes are provided in Table 2 of ACM0022 (Version 03.0).	The project utilizes the biogas from anaerobic digestion of fresh waste for power generation. The fresh waste of the project is mainly kitchen and catering waste from Guangzhou City. The production of this project activity is biodiesel and electricity, there is no non-biodegradable materials of waste by-products that may have market value. Thus, the project is applicable to the option “Anaerobic digestion” of the column “waste treatment option under the project activity” listed in Table 2 of ACM0022 (version 03.0). Please refer to table 3-2 for details of the applicability conditions specified in the

		methodological tool “Project and leakage emissions from anaerobic digesters”.
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In addition, the project meets the applicability conditions of the applied tools applied in the joint PD&MR as follows:

Table 3-2 Applicability of applied tools

Tool	Applicability	The project
Project and leakage emissions from anaerobic digesters (version 02.0)	The following sources of project emissions are accounted for in this tool: (a) CO ₂ emissions from consumption of electricity associated with the operation of the anaerobic digester; (b) CO ₂ emissions from consumption of fossil fuels associated with the operation of the anaerobic digester; (c) CH ₄ emissions from the digester (emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester); and (d) CH ₄ emissions from flaring of biogas.	Applicable. The sources (a), (c) and (d) of project emission are accounted for the project. (b) are not involved in the project boundary.
	The following sources of leakage emissions are accounted for in this tool: (a) CH ₄ and N ₂ O emission from composting of digestate; (b) CH ₄ emissions from the anaerobic decay of digestate disposed in a SWDS or subjected to anaerobic storage, such as in a stabilization pond.	Not applicable. (a) The project does not involve composting of digestate; (b) The digestate from anaerobic digestion in the project will be outward transported and incinerated directly in thermal power plant, not involving the anaerobic decay of digestate disposed in a SWDS or subjected to anaerobic storage. Thus, the leakage emission is zero.
	Emission sources associated with N ₂ O emissions from physical leakages from the digester, transportation of feed material and digestate or any other on-site transportation, piped distribution of the biogas, aerobic treatment of liquid	Applicable. These are minor emission sources for the project, and which all are neglected.

	digestate and land application of the digestate are neglected because these are minor emission sources or because they are accounted in the methodologies referring to this tool.	
Emissions from solid waste disposal sites (version 08.0)	The tool can be used to determine emissions for the following types of applications: (a) Application A: The CDM project activity mitigates methane emissions from a specific existing SWDS. Methane emissions are mitigated by capturing and flaring or combusting the methane (e.g. “ACM0001: Flaring or use of landfill gas”). The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for an ex ante estimation of emissions in the project design document (CDM-PDD). The emissions will then be monitored during the crediting period using the applicable approaches in the relevant methodologies (e.g. measuring the amount of methane captured from the SWDS); (b) Application B: The CDM project activity avoids or involves the disposal of waste at a SWDS. An example of this application of the tool is ACM0022, in which municipal solid waste (MSW) is treated with an alternative option, such as composting or anaerobic digestion, and is then prevented from being disposed of in a SWDS. The methane is generated from waste disposed or avoided from disposal during the crediting period. In these cases, the tool can be applied for both ex ante and ex post estimation of emissions. These project activities may apply the simplified approach detailed in 0 when calculating baseline emissions.	Applicable. The project is the condition of application B, that avoids or involves the disposal of waste at a SWDS. The project is applicable to the ACM0002 (Version 03.0), due to the kitchen and catering waste of the Guangzhou City are treated by anaerobic digestion in the project and is then prevented from being disposed of in a SWDS. The methane is generated from waste disposed or avoided from disposal during the crediting period. And in the joint PD&MR, the project owner chooses to apply this tool for both ex ante and ex post estimation of emissions other than simplified approach. Please refer to section 4 of the joint PD&MR for details.

	These two types of applications are referred to in the tool for determining parameters. In the case that: (a) different types of residual waste are disposed or prevented from disposal; or that (b) both MSW and residual waste(s) are prevented from disposal, then the tool should be applied separately to each residual waste and to the MSW.	The project is the condition of application B, that avoids or involves the disposal of waste at a SWDS. The project only involves the MSW which mainly includes kitchen and catering waste of the Guangzhou City, then tool should be applied separately to the MSW.
Tool to calculate the emission factor for an electricity system (version 07.0)	This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects)	Applicable. The project utilizes the methane from anaerobic digestion of fresh waste for power generation supplied to CSPG that dominated by fossil-fuel plants. Therefore, the tool is applied to estimate the OM, BM and /or CM when calculating baseline emissions for the project.
	Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, two sub-options under the step 2 of the tool are available to the project participants, i.e. option II a and option II b. If option II a is chosen, the conditions specified in “Appendix 1: Procedures related to off-grid power generation” should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation	In the host country as off-grid power generation is not significant. Therefore, emission factor for the project electricity system is calculated only for the grid power plants. Thus, this applicability criterion is satisfied.

	and not to other aspects such as transmission capacity.	
	In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.	Applicable. The project electricity system is located in a non-Annex I country.
	Under this tool, the value applied to the CO ₂ emission factor of biofuels is zero.	The project does not involve biofuels.
Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0)	If emissions are calculated for electricity consumption, the tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption: (a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer; (b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or (c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power	Applicable. For the project, the electricity consumption is from the grid which the project is connected. Thus, Scenario A is applicable.

	plant(s) and the grid.	
	This tool can be referred to in methodologies to provide procedures to monitor amount of electricity generated in the project scenario, only if one out of the following three project scenarios applies to the recipient of the electricity generated: (a) Scenario I: Electricity is supplied to the grid; (b) Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or (c) Scenario III: Electricity is supplied to the grid and consumers/electricity consuming facilities.	Applicable. For the project, the electricity is supplied to the grid. Thus, Scenario I is applicable.
	This tool is not applicable in cases where captive renewable power generation technologies are installed to provide electricity in the project activity, in the baseline scenario or to sources of leakage. The tool only accounts for CO₂ emissions.	The project does not involve captive renewable power generation technologies installed to provide electricity in the project activity, in the baseline scenario or to sources of leakage.
Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)	Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions.	Applicable. The volumetric flow of the gaseous stream and volumetric fraction of greenhouse gas CH₄ will be measured by the project.
	Methodologies where CO₂ is the particular and only gas of interest should continue to adopt material balances as the means of flow determination and may not adopt this tool as material balances are the cost effective way of monitoring flow of CO₂.	The biogas of the project produced by anaerobic digestion of fresh waste includes CH₄, CO₂, NH₃ etc, CO₂ is not the particular and only gas of interest by the project.
	The underlying methodology should specify: (a) The gaseous stream the tool should be applied to; (b) For which greenhouse gases the mass flow should be determined; (c) In which time intervals the flow of the gaseous stream should be measured; and	The methodology has specified (a) to (d). Such as, (a) The biogas of the project produced by anaerobic digestion of fresh waste which contains CH₄, CO₂, NH₃ etc, should apply this tool. (b) The greenhouse gas CH₄

	(d) Situations where the simplification offered for calculating the molecular mass of the gaseous stream (equations (3) or (17)) is not valid (such as the gaseous stream is predominantly composed of a gas other than N₂).	should be measured based on the volumetric flow of biogas, volumetric fraction and density of CH₄. (c) The flow of the gaseous stream should be measured on an hourly basis and then accumulated for the year y. (d) The project does not involve the application of equations (3) or (17).
Combined tool to identify the baseline scenario and demonstrate additionality (version 07.0)	The tool is applicable to all types of proposed project activities. However, in some cases, methodologies referring to this tool may require adjustments or additional explanations as per the guidance in the respective methodologies. This could include, inter alia, a listing of relevant alternative scenarios that should be considered in Step 1, any relevant types of barriers other than those presented in this tool and guidance on how common practice should be established.	Applicable. The project utilizes the methane from anaerobic digestion of fresh waste for power generation.
Common practice (version 03.1)	This methodological tool is applicable to project activities that apply the methodological tool “Tool for the demonstration and assessment of additionality”, the methodological tool “Combined tool to identify the baseline scenario and demonstrate additionality”, or baseline and monitoring methodologies that use the common practice test for the demonstration of additionality.	Applicable. Since the project activity is using the methodological tool “Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0), the tool is applicable.
	In case the applied approved baseline and monitoring methodology defines approaches for the conduction of the common practice test that are different from those described in this methodological tool, the requirements contained in the methodology shall prevail.	Applicable. The baseline and monitoring methodology refers to “Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0). It required that the latest version of the “Methodological tool: Common practice” available on the UNFCCC

		website shall be applied. Therefore, this tool is applicable.
Investment analysis (version 11.0)	This methodological tool is applicable to project activities that apply the methodological tool “Tool for the demonstration and assessment of additionality”, the methodological tool “Combined tool to identify the baseline scenario and demonstrate additionality”, the guidelines “Non-binding best practice examples to demonstrate additionality for SSC project activities”, or baseline and monitoring methodologies that use the investment analysis for the demonstration of additionality and/or the identification of the baseline scenario.	Applicable. The project activity applies the methodological tool “Tool for the demonstration and assessment of additionality” (version 07.0) that use the investment analysis for the demonstration of additionality and/or the identification of the baseline scenario. Therefore, this tool is applicable.
	In case the applied approved baseline and monitoring methodology contains requirements for the investment analysis that are different from those described in this methodological tool, the requirements contained in the methodology shall prevail.	The project activity applies the methodological tool “Tool for the demonstration and assessment of additionality” (version 07.0) which required that the latest version of the “Methodological tool: Investment analysis” available on the UNFCCC website shall be applied. Therefore, this tool is applicable.
“Project emissions from flaring” (version 04.0)	This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity	Applicable. The project activity includes the enclosed flare and the type of which has been documented in the joint PD&MR.
	This tool is applicable to the flaring of flammable greenhouse gases where: (a) Methane is the component with the highest concentration in the flammable residual gas; and (b) The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).	Applicable. The purpose of the project is to utilize biogas produced by anaerobic digestion, which consists mainly of methane, for electricity generation.

	The tool is not applicable to the use of auxiliary fuels and therefore the residual gas must have sufficient flammable gas present to sustain combustion. For the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare.	The project does not involve the use of auxiliary fuels. And the residual biogas has a methane content of over 50% and therefore has sufficient flammable gas present to sustain combustion. The project adopts enclosed flare, please refer to section 1.11 for the detailed information of the enclosed flare.
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3.3 Project Boundary

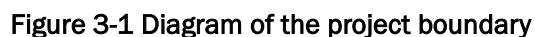
According to the methodology ACM0022 (version 03.0), the spatial extent of the project boundary is the SWDS where the waste is disposed of in the baseline, anaerobic lagoons or sludge pits treating organic wastewater in the baseline, and the site of the alternative waste treatment process(es). The boundary also includes on-site electricity and/or heat generation and use, on-site fuel use and the wastewater treatment plant used to treat the wastewater by-products of the alternative waste treatment process(es). The project boundary does not include facilities for waste collection and transport. In the case that the project provides electricity to a grid, then the spatial extent of the project boundary will also include those plants connected to the energy system to which the plant is connected. If upgraded biogas is fed to a natural gas distribution system, then the natural gas distribution system is also included in the boundary.

Therefore, for the project, the spatial extent of the project boundary is the SWDS where the waste is disposed of in the baseline, the anaerobic digestion system, the biogas power plant, and those plants connected to CSPG to which the plant is connected.

According to authoritative documents provided by China DNA⁹, CSPG covers Guangdong Province, Yunnan Province, Guizhou Province, Hainan Province, and Guangxi Zhuang Autonomous Region.

The project boundary is shown in Figure 3-1 below.

⁹ <https://www.mee.gov.cn/ywgz/ydqbh/wsqtz/202012/W020201229610353340851.pdf>



Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from heat generation	CO ₂	No	Excluded for simplification. This is conservative.
		CH ₄	No	
		N ₂ O	No	
	Emissions at the SWDS	CO ₂	No	CO ₂ emissions from the decomposition of fresh waste are not accounted for.
		CH ₄	Yes	Major emission source.
		N ₂ O	No	N ₂ O emissions are small compared to CH ₄ emissions from landfills. Exclusion of this gas is conservative.
	Emissions from anaerobic lagoons or sludge pits	CO ₂	No	The project does not involve baseline emissions from anaerobic lagoons or sludge pits
		CH ₄	No	
		N ₂ O	No	

Source		Gas	Included?	Justification/Explanation
	Emissions from electricity generation	CO ₂	Yes	Major source, electricity generation is included in the project activity and is sent to the grid or displaces fossil fuel fired electricity generation in the baseline.
		CH ₄	No	Excluded for simplification. This is conservative.
		N ₂ O	No	Excluded for simplification. This is conservative.
	Emissions from use of natural gas	CO ₂	No	The project does not involve baseline emissions from use of natural gas
		CH ₄	No	
		N ₂ O	No	
Project	Emissions from on-site fossil fuel consumption due to the project activity other than for electricity generation	CO ₂	No	Excluded for no fossil fuel is used by the project activity.
		CH ₄	No	Excluded for no fossil fuel is used by the project activity.
		N ₂ O	No	Excluded for no fossil fuel is used by the project activity.
	Emissions from on-site electricity use	CO ₂	Yes	May be an important emission source.
		CH ₄	No	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from the waste treatment processes	CO ₂	No	The project does not involve incineration, gasification or combustion of fossil based waste.
		CH ₄	Yes	CH ₄ leakage from the anaerobic digester and incomplete combustion in the flaring process are potential source of project emissions.
		N ₂ O	No	The project does not involve composting, incineration, syngas produced or RDF/SB

Source	Gas	Included?	Justification/Explanation
Emissions from wastewater treatment			combustion.
	CO ₂	No	CO ₂ emissions from the decomposition of fresh waste are not accounted.
	CH ₄	No	The project does not involve anaerobic treatment of wastewater.
	N ₂ O	No	Excluded for simplification. This emission source is assumed to be very small.

3.4 Baseline Scenario

According to the methodology ACM0022 (Version 03.0), using “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0) to identify the baseline scenario and demonstrate additionality.

According to tool 02, the project participants shall apply the following four Steps:

STEP 0. Demonstration that a proposed project activity is the first-of-its-kind;

STEP 1. Identification of alternative scenarios;

STEP 2. Barrier analysis;

STEP 3. Investment analysis (if applicable);

STEP 4. Common practice analysis.

Step 0: Demonstration whether the proposed project activity is the first-of-its-kind

The project is not the first-of-its-kind project.

Step 1: Identification of alternative scenarios

This Step serves to identify all alternative scenarios to the project activity(s) which can be the baseline scenario.

Step 1a: Define alternative scenarios to the proposed VCS project activity

Since the project only involves the treatment of fresh waste (anaerobic digestion) and the generation of electricity, and not claims the emission reduction from heat generation, the baseline scenario will be identified based on these two parts.

In identifying baseline alternatives for the treatment of the fresh waste, the following alternatives or combinations of these alternatives shall, inter alia, be considered:

Alternative scenarios provided by methodology ACM0022 (Version 03.0)		Realistic and credible?	Justification/explanation
M1	The project activity without being registered as a VCS project activity (i.e. any (combination) of the waste treatment options listed in Table 2 of methodology ACM0022).	Yes	Scenario M1 is the project activity undertaken without being registered as a VCS project activity. High investment and operational cost results in the investment barrier. M1 does not violate laws and regulations and therefore is an alternative scenario.
M2	Disposal of the fresh waste in a SWDS with a partial capture of the LFG and flaring of the captured LFG.	Yes	At present, there are no laws and regulations in our country that require landfills to recycle landfill gas. There is only "Technical code for municipal solid waste sanitary landfill" (CJJ17-2004) ¹⁰ , which requires landfills to be equipped with effective landfill gas from a safety perspective and shall take the initiative to adopt flaring treatment method. However, due to financial and/or technical difficulties, these regulations have not been widely implemented in China. According to the <i>Development Overview of China's Urban Domestic Waste Treatment Industry in 2014</i> ¹¹ , by the end of 2013, China had a total of 942 waste landfills, but only about 50 of them collected and utilized landfill gas or burned it by torch. Meanwhile, from the paper of "Gas generation and collection and utilization in landfill" in 2015 ¹² , most landfills in China are not equipped with gas collection devices, and the technology level is low, thus a large

¹⁰ <https://wenku.baidu.com/view/512fb0727c1cfad6185fa74e.html>

¹¹ <https://wenku.baidu.com/view/3aebdca9360cba1aa911da12.html>

¹² <https://iz.docin.com/p-1652165491.html>

			amount of gas is discharged in disorder. However, in the Guangzhou city, based on <i>Guangzhou municipal solid waste environmental pollution prevention information announcement</i> issued by Guangzhou Municipal Ecological Bureau on 14/05/2020¹³, there are five landfills with sufficient landfill capacity to treat MSW from Guangzhou City, only one landfill with a partial LFG capture system. Thus, it is demonstrated that sufficient landfill capacity would be available to dispose waste at a SWDS with a comparable annual waste acceptance rate and with the same operating lifetime as the project activity. And although most landfills in China are not equipped with gas collection devices, the scenario M2 is more conservative option to M3 in terms of the situation of the Guangzhou City. To be conservative, M2 is a realistic and credible alternative scenario.
M3	Disposal of the fresh waste in a SWDS without a LFG capture system.	No	As stated above, to be conservative, M3 is not a realistic and credible alternative scenario.
M4	Part of the fresh fraction of the solid waste is recycled and not disposed in the SWDS.	No	As stated above, sanitary landfill of domestic waste including fresh kitchen waste and catering waste is still the most common way of waste disposal at present. Thus, M4 is not a realistic and credible alternative scenario.
M5	Part of the fresh fraction of the solid waste is treated aerobically and not disposed in the SWDS.	No	According to FSR of the project, there is no such facility at the location of this project, therefore, M5 is not a realistic and credible alternative scenario.

¹³ <http://sthjj.gz.gov.cn/>

M6	Part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.	No	According to FSR of the project, there is no such facility at the location of this project, therefore, M6 is not a realistic and credible alternative scenario.
M7	Part of the organic fraction of the solid waste is gasified and not disposed in the SWDS.	No	According to FSR of the project, there is no such facility at the location of this project, therefore, M7 is not a realistic and credible alternative scenario.
M8	Part of the organic fraction of the solid waste is treated in an anaerobic digester and not disposed in the SWDS.	No	According to FSR of the project, before the implementation of the project, there is no such facility at the location of this project, therefore, M8 is not a realistic and credible alternative scenario.
M9	Part of the organic fraction of the solid waste is mechanically or thermally treated to produce RDF/SB and not disposed in the SWDS.	No	According to FSR of the project, there is no such facility at the location of this project, therefore, M9 is not a realistic and credible alternative scenario.

Electricity generation is an aspect of the project activity, then alternative scenarios for the generation of electricity shall also be identified. Alternative(s) shall include, inter alia:

Alternative scenarios provided by methodology ACM0022 (Version 03.0)		Realistic and credible?	Justification/explanation
P1	Electricity generated as an output of one of the waste treatment options listed in Table 2 of methodology ACM0022 (Version 03.0), not undertaken as a VCS project activity.	Yes	The project scenario is electricity generated as an output of biogas recovered from anaerobic digestion of fresh waste. Scenario P1 is the project activity undertaken without being registered as a VCS project activity. High investment and operational cost results in the investment barrier. P1 does not violate laws and regulations and therefore P1 is an alternative scenario.

P2	Use of an existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant.	No	The project is only involved power generation, not a cogeneration plant. Thus, P2 is not a realistic and credible alternative scenario.
P3	Existing or new construction of an on-site or off-site renewable based cogeneration plant.	No	The project is only involved power generation, not a cogeneration plant. Thus, P3 is not a realistic and credible alternative scenario.
P4	Existing or new construction of an on-site or off-site fossil fuel fired electricity plant.	No	According to Chinese power regulation ¹⁴ , the construction of coal-fired power plant with a capacity of 135MW or below is prohibited in the national grid coverage area. Therefore, construction of a power plant with the same capacity as the Project using coal, diesel oil or natural gas as fuel would be prohibited. Thus, P4 is not a realistic and credible alternative scenario.
P5	Existing or new construction of an on-site or off-site renewable based electricity plant.	No	Wind, solar photovoltaic, hydro, biomass and geothermal energy are feasible renewable energy sources that can be applied in CSPG. The wind resources¹⁵ of Guangdong Province is in the IV area of resource areas in China, namely relatively scarce areas, and the project is located in the provincial capital city area, which is not suitable for the construction of wind farms. The solar energy¹⁶ of Guangdong Province is in the III area of resource areas in China, however, where the project is located in the provincial capital city area, which is not suitable for the construction of and solar

¹⁴ http://www.gov.cn/gongbao/content/2002/content_61480.htm

¹⁵ <https://news.bjx.com.cn/html/20151015/671884.shtml>

¹⁶ https://www.sohu.com/a/293922336_468672

			plants. Although Guangdong Province is rich in water resources, the water resources of Guangzhou City, where the project is located, are at a low-medium level ¹⁷ compared with Yangtze and Yellow river basins, and the project is located in the provincial capital city area, which is not suitable for the construction of hydropower stations. Biomass energy in China is mainly distributed in the Anhui, Shandong, Jiangsu, Heilongjiang and Hubei ¹⁸, and the project is located in the provincial capital city area, the project site has no adequate biomass materials supplied for a biomass power. There are few high-temperature geothermal resources suitable for power generation in China, mainly distributed in southern Tibet, western Sichuan and western Yunnan¹⁹. Thus, P5 is not a realistic and credible alternative scenario.
P6	Electricity generation in existing and/or new grid-connected electricity plants.	Yes	P6 is the actual situation before the start of the project activities and meets the requirements of national regulations, so it is a feasible alternative.

Outcome of Step 1a: List of plausible alternative scenarios to the project activity

¹⁷ <http://swj.gz.gov.cn/>

¹⁸ https://wenku.baidu.com/view/475ac276940590c69ec3d5bbfd0a79563d1ed413.html?fixfr=OoXDKEm%252BwPnIIMw3W%252FQ%252F2A%253D%253D&fr=income4-wk_app_search_ctrX-searchhttps://wenku.baidu.com/view/475ac276940590c69ec3d5bbfd0a79563d1ed413.html?fixfr=OoXDKEm%252BwPnIIMw3W%252FQ%252F2A%253D%253D&fr=income4-wk_app_search_ctrX-search

¹⁹ <http://news.bjx.com.cn/html/20120313/347598.shtml>

According to the analysis above, M1 and M2 for the treatment of the fresh waste, P1 and P6 for electricity generation are feasible baseline scenarios.

Step 1b: Consistency with mandatory applicable laws and regulations

M1 and M2 for the treatment of the fresh waste, P1 and P6 for electricity generation are all consistent with mandatory applicable laws and regulations.

The baseline alternative options that are technically feasible and comply with all legal and regulatory requirements are listed below:

Scenario ID	Treatment of the fresh waste	Electricity generation
Combined alternative scenario 1 (M1+P1): This is the project activity not implemented as a VCS project. This scenario faces investment barriers, which will be discussed in section 3.5.	M1	P1
Combined alternative scenario 2 (M1+P6): This is a conflicted scenario for use of methane for electricity production conflicted with equivalent quantity of electricity supply from existing and/or new grid-connected electricity plants.	M1	P6
Combined alternative scenario 3 (M2+P1): This is a conflicted scenario, for the disposal of the fresh waste in a SWDS with a partial capture of the LFG and flaring of the captured LFG is conflicted with the fresh waste will be treated by way of anaerobic digestion, the two scenarios will not be existed at the same time.	M2	P1
Combined alternative scenario 4 (M2+P6): This is the continuation of business as usual. It remains as a possible baseline scenario alternative.	M2	P6

Outcome of Step 1b: List of alternative scenarios to the project activity that follow mandatory legislation and regulations considering the enforcement in the region or country and Board decisions on national and/or sectoral policies and regulations.

As above, the baseline alternative options that are technically feasible and comply with all legal

and regulatory requirements are combined alternative **Scenario 1 (M1+P1)** and **Scenario 4 (M2+P6)**.

Step 2: Barrier analysis

The project activity is not the first-of-its-kind project. The scenario 1 (M1+P1) and scenario 4 (M2+P6) are not prevented by any barrier. The remaining alternative scenario 1 (M1+P1) include the proposed project activity undertaken without being registered as a VCS project activity. As per "TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0), If more than one alternative scenario is not prevented by any barrier, and if the proposed project activity is not the first-of-its-kind, and the remaining alternative scenarios include the proposed project activity undertaken without being registered as a VCS project activity, then proceed to **Step 3 (Investment Analysis)**.

Outcome of Step 2

Proceed to **Step 3: Investment Analysis** below.

3.5 Additionality

According to the methodology ACM0022 (Version 03.0), using "TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0) to identify the baseline scenario and demonstrate additionality. Based on the above section 3.4, the **step 3** and **step 4** are listed as following.

Step 3: Investment Analysis

According to "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 07.0), the objective of Step 3 is to compare the economic or financial attractiveness of the alternative scenarios remaining after Step 2 by conducting an investment analysis. The latest approved version of the "Methodological tool: Investment analysis", shall be considered when applying this step.

The alternative scenarios of the project include:

Scenario 1 is fresh waste treated by anaerobic digestion for electricity generation, i.e, implement the project without VCS.

Scenario 4 is the business as usual scenario, fresh waste landfill in the landfill site does not create economic benefits, but no investment required for this scenario.

For **Scenario 4**, the choice between the Benchmark Analysis versus the Investment Comparison Analysis and Simple cost analysis is determined by whether the output can only be provided by the project proponent. And the project proponent applies Benchmark Analysis to conduct

Investment Analysis due to the output such as electricity and biodiesel can be provided by others.

According to the FSR provided by the project owner, the IRR is chosen as the financial indicators by the project.

The products of the project are biodiesel and electricity, and the corresponding percentage of biodiesel revenue in the total product revenue is about 68%. The main product biodiesel production belongs to Petroleum Processing and Petroleum Products Manufacturing according to *Economic Evaluation Method and Parameters for Construction Projects (Third Edition)* issued by National Development and Reform Commission (DRC) and Ministry of Construction; thus, the benchmark project IRR of Petroleum Processing and Petroleum Products Manufacturing is applicable to the project which is 12% (Before tax)²⁰. In addition, this benchmark is also applied in the investment analysis of the Feasibility Study Report (FSR) completed in November 2016. The project FSR was approved by Development and Reform Bureau of Guangzhou City. The project proponent decided to undertake the project as a VCS or CDM project on 15/09/2016 prior to the compiled date of the FSR.

Comparison of IRR for the project and the financial benchmark:

The main parameters for calculation of financial indicators are shown in the following table:

Table 3-3 Main parameters for financial analysis calculation

Item	Unit	Value	Source
Installed capacity	MW	10.45	FSR
Total investment	CNY	853,592,601	FSR
Total Static investment	CNY	820,724,878	FSR
Working capital	CNY	3,007,000	FSR
Plant load factor	%	85.34	FSR
Annual electricity generation	MWh/year	77,303	FSR
Power self-consumption ratio	%	20%	FSR
Annual electricity exported	MWh/year	61,842	FSR
Electricity Tariff (including VAT)	CNY/MWh	689	FSR
Biodiesel quantity	T	13,200	FSR
Biodiesel price (including VAT)	CNY/t	7,000	FSR

²⁰ P74 Table 2.13-2, *Economic Evaluation Method and Parameters for Construction Projects* issued by National Development and Reform Commission (DRC) and Ministry of Construction in 2006 (The third Edition).

Subsidy price		CNY/t	109	FSR
MSW quantity		T	673,200	FSR
Value added tax (VAT) for electricity and biodiesel		%	17	FSR
VAT refund for biodiesel		%	70	FSR
Urban maintenance and construction tax		% of VAT	7	FSR
Surtax for education		% of VAT	5	FSR
Income tax		%	25	FSR
Depreciation period		Year	25	FSR
Deductible equipment VAT		CNY	74,020,412	FSR
Fixed assets		CNY	746,704,466	FSR
Annual operation and management (O&M) cost	Total	CNY	119,705,508	FSR
	Annual maintenance cost	CNY	17,920,907	FSR
	Annual staff salary and welfare	CNY	26,174,400 ²¹	FSR
	Annual insurance	CNY	1,866,761	FSR
	Annual material fee	CNY	44,090,000 ²²	FSR
	Waste residue treatment fee	CNY	20,570,000 ²³	FSR
	Annual other cost	CNY	9,083,440	FSR

²¹ According to the Guangzhou Statistical Yearbook in 2016, based on the 95,315CNY/y and 112,095CNY/y of annual average wage respectively in Petrochemical Industry and Power Industry of Guangzhou city, the annual salary and welfare of the project is slightly lower than local annual average wage of Petrochemical Industry and Power Industry and which is conservative and reasonable due to the project is located in the outskirts of the Guangzhou city.

²² The unit price of raw material is about at range from 3,000 CNY/t to 5,000 CNY/t sourced from the preliminary survey of biodiesel production project in the FSR. Considering that case-by-case situation and conservative principles, the annual material fee of the project is reasonable. Additionally, the material fee of Shandong Province Jinjiang Biodiesel Production Project (UNFCCC Ref.8158) is 4,456 CNY/t biodiesel in the price range from 3,000 CNY/t to 5,000 CNY/t, and which furthermore demonstrate the reasonability.

²³ The waste residue treatment fee of 20,570,000 CNY is calculated by the 302,940 ton of solid and liquid waste and the 67.9 CNY/t of unit price. The 67.9 CNY/t of comprehensive unit price of waste residue treatment involved solid and liquid waste and its traffic expense is sourced from relevant price standard of Guangzhou Municipal Development and Reform Commission. And the waste residue quantity is estimated by empirical value of 45% ratio between input and output waste.

Construction period	Year	2	FSR
Operation period	Year	25	FSR
Expected VER Price	CNY/tCO ₂ e	20	Assumption

Table 3-4 below shows the difference between the project IRR, with and without the revenue from carbon.

Table 3-4 Comparison of financial indicators with and without the revenue from carbon

Item	Without the revenue from carbon	Benchmark rate	With the revenue from carbon
Project IRR (before tax)	7.87%	12%	8.79%

Sensitivity analysis

The sensitivity analysis is conducted to check whether, under reasonable deviations in five major financial parameters, the Project would remain financially unattractive, i.e. the Project IRR without the revenue from carbon would remain below the benchmark IRR. The four major financial parameters that significantly affect the Project IRR are:

- Total static investment
- Annual O&M cost
- Annual electricity generation and electricity tariff (Electricity revenue)
- Biodiesel quantity and biodiesel price (Biodiesel revenue)
- MSW quantity and subsidy price (Subsidy revenue)

The impacts of the above parameters on the Project IRR were analyzed. The results of sensitivity analysis of the five indicators are shown in Table 3-5 and Figure 3-2.

Table 3-5 Sensitivity analysis of Project IRR to different financial parameters

Hypothetic change	-10%	-5%	0	+5%	+10%
Total Static investment	9.32%	8.56%	7.87%	7.22%	6.63%
Annual O&M cost	9.47%	8.612%	7.87%	7.02%	6.15%

Electricity generation	7.34%	7.60%	7.87%	8.13%	8.38%
Electricity tariff	7.34%	7.60%	7.87%	8.13%	8.38%
Biodiesel quantity	6.65%	7.26%	7.87%	8.46%	9.05%
Biodiesel price	6.65%	7.26%	7.87%	8.46%	9.05%
MSW quantity	6.83%	7.35%	7.87%	8.37%	8.86%
Subsidy price	6.83%	7.35%	7.87%	8.37%	8.86%

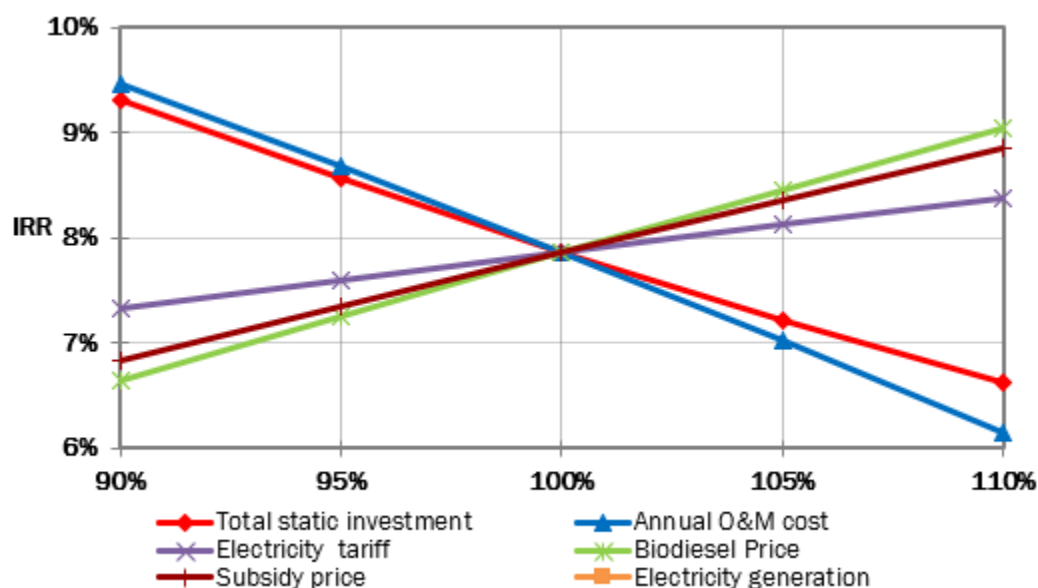


Figure 3-2 Sensitivity analysis of financial indicators of the Project

Table 3-6 below shows the necessary change in the five major parameters required for the Project IRR without VCUs revenue to reach the benchmark rate, ceteris paribus. All the speculated changes are clearly too large to be realistic.

Table 3-6 Critical Point Analysis

Hypothetic Project IRR	Benchmark Rate 12%
Total Static investment	-24.83%
Annual O&M cost	-26.92%

Electricity generation	+85.56%
Electricity tariff	+85.56%
Biodiesel quantity	+36.77%
Biodiesel price	+36.77%
MSW quantity	+43.91%
Subsidy price	+43.91%

Total static Investment

The Project IRR would reach the benchmark rate of 12% when the total static investment decreases by 24.83%. According to the investment details by the project owner, the actual investment of the project is almost same as the total static investment. Therefore, it is impossible that the total static investment can be reduced by 24.83% to make the IRR to cross the benchmark.

Annual O&M cost

The Project IRR would reach the benchmark when the Annual O&M cost decreases by 26.92%. Considering about the composition of the Annual O&M cost, the analysis focuses mainly on following items:

Material cost. Based on statistics released by *2018 National Bureau of Statistics of China*, producer price indices for purchasing goods are increasing in recent five years (108.1, 98.0, 93.9, 97.8 and 98.0) and therefore will not cause significant decrease. Therefore, there will not be decrease by 26.92% happened on material cost.

Salary and welfare. Based on statistics released by *2018 National Bureau of Statistics of China*, the index of wages keeps increasing in recent five years (110.0, 108.9, 110.1, 109.5 and 110.1). Therefore, there will not be decrease by 26.92% happened on salary and welfare.

Therefore, the IRR can't reach the benchmark by reducing annual O&M cost.

Annual electricity generation and electricity tariff (Electricity revenue)

The Project IRR would reach the benchmark rate of 12% when the electricity revenue increased by 85.56%. According to installed capacity, operation hours, electricity purchase contract of the project and sales receipts, the maximum electricity revenue is 45,139,146 CNY based on the actual fixed electricity tariff of 0.689 CNY/kwh (VAT) and the maximum annual exported

electricity of 65,514 MWh. And even if the biogas generators work at full load (i.e. for operating for 8760 hours), the actual exported electricity would be 72,463 MWh which is used for calculating the IRR as 8.76% which is much lower than benchmark. Therefore, it is unlikely that the electricity revenue would increase by 85.56%.

Biodiesel quantity and biodiesel price (Biodiesel revenue)

The Project IRR would reach the benchmark rate of 12% when the biodiesel revenue increased by 36.77%. The maximum biodiesel revenue will be 105,138,000 CNY based on the actual biodiesel price of 7,900 CNY/t (VAT) and the maximum biodiesel quantity of 13,200 t/y, which will increase by 12.86% but not exceed the 36.77%.

Although the biodiesel price increased 12.86%, the fluctuation will be at the small range by reason of relevant biodiesel policy stated that “relevant departments will continue to guide pilot cities to promote biodiesel consumption, stabilize the supply of raw materials for biodiesel enterprises, and promote high-quality development of the industry” issued by National Energy Administration²⁴. Thus, the stable supply of raw materials will lead to relatively stable biodiesel price in market. In addition, the actual quantity of the biodiesel in 2021 is 8,670 t which is 34.32% lower than the designed value.

Therefore, it is unlikely that the biodiesel revenue would increase by 36.77%.

MSW quantity and subsidy price (Subsidy revenue)

The Project IRR would reach the benchmark rate of 12% when the subsidy revenue increased by 43.91%. According to actual operation situation, the actual fixed subsidy price is 109 RMB/t from the BOT franchise agreement signed between project owner and Guangzhou Municipal Management Committee, and the actual annual MSW quantity is about 650,000 in 2021 which is lower than the designed value. Therefore, it is unlikely that the electricity revenue would increase by 43.91%.

Since January 2023, a deviation to the registered PD was identified for the project. A new pipeline with a biogas flow meter has been built connecting the project activity with the Grandtop Fushan project to purchase surplus biogas for power generation. The deviation changes the following aspects of the investment analysis:

Parameters	Value in the registered PD	Value due to this deviation	Justification
Total static Investment – Cash outflow	820,724,878 CNY	820,724,878 CNY	Construction of a new biogas pipeline requires additional project cost, however, in the re-calculation of project IRR, this value is considered

²⁴ http://www.nea.gov.cn/2021-09/27/c_1310212584.htm

			as 0, which is deemed conservative as project investment is cash outflow.
Annual O&M cost – Cash outflow	119,705,508 CNY	120,285,508 CNY	$120,285,508 \text{ CNY} = 119,705,508 \text{ CNY} + 580,000 \text{ CNY}$ Where, 580,000CNY is the incremental cost from biogas purchase, calculated from 2,000,000Nm³ and the price of 0.29 CNY/Nm³, both values are sourced from biogas purchase agreement. The price of 0.29 CNY/Nm³ has been crosschecked with the biogas purchase settlement note between the PP and Grandtop Fushan, consistency was identified. Incremental cost from the deviation only considers the biogas purchase cost, no other costs (such as incremental maintenance cost) are considered. This is deemed conservative as annual O&M cost is cash outflow.
Annual revenue from electricity generation (excluding VAT) – Cash inflow	36,418,067 CNY	39,143,968 CNY	$39,143,968 \text{ CNY} = 36,418,067 \text{ CNY} + 2,725,901 \text{ CNY}$ Where, 2,725,901CNY is the incremental revenue from electricity generated by purchased biogas
Expected annual biogas purchased	-	2,000,000 Nm ³	Based on the biogas purchase agreement (with a CH ₄ content of 55%), which is much higher than the actual purchased biogas (948,082 Nm ³) in 2023, therefore this value is deemed conservative.
Expected annual electricity exported	61,842 MWh	66,470.89 MWh	$66,470.89 \text{ MWh} = 61,842 \text{ MWh} + 4,628.89 \text{ MWh}$ Where, 4,628.89MWh of electricity is expected to be generated from purchased biogas, calculated as follows: $4,628.89 \text{ MWh} = 2,000,000 \text{ Nm}^3 \times 55\% \times 0.00071566 \times 0.0504 \times 42\% \times 1000 / 3.6$ Where, 55% - the CH₄ content of the biogas, 0.00071566 t/ Nm³ - density of CH₄, 0.0504 GJ/kg – NCV of CH₄, 42% - Highest efficiency of biogas generators, 3.6 – Conversion factor from GJ to MWh, The calculation of electricity generated from purchased biogas assumes all biogas generators operate at their highest efficiency of 42%, which will result in the theoretical maximum electricity generation. This is deemed conservative.
Updated Project IRR from the deviation	7.87%	8.17%	Based on the above analysis, the project IRR was updated from 7.87% to 8.17%, which is still below the benchmark of 12%.

			Furthermore, the sensitivity analysis for the updated project IRR shows that the project IRR fluctuates between 6.47% and 9.77%. The updated investment analysis shows that the project is still not financially attractive.
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Based on the Investment Analysis, the alternative that the project activity not undertaken as a VCS project activity is not financially attractive to the project owner, and it is thus not baseline scenario.

Only one alternative scenario (**Scenario 4**) is left.

Step 4: Common practice analysis

The proposed VCS project activity applies measures that are listed in the definitions section in the methodology tool “Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0), then proceed to **Step 4a**.

Step 4a: *The proposed VCS project activity(s) applies measure(s) that are listed in the definitions section in the methodological tool “Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0)*

The latest version of methodological tool “Common Practice (version 03.1)” is followed as below.

Sub-step 4a-1: *Calculate applicable capacity or output range as +/-50% of the total design capacity or output of the proposed project activity*

The total installation capacity of the Project is 10.45MW. Range of +/- 50% of the capacity is from 5.225 MW to 15.675 MW. Additionally, considering that the project is to utilize the biogas produced by anaerobic digestion of the fresh waste for power generation, the range +/- 50% of design processing capacity of 2,040 t/d is from 1,020 t/d to 3,060 t/d which also shall be applied.

Sub-step 4a-2: *Identify similar projects (both CDM and non-CDM) which fulfill all of the following conditions:*

(a) The projects are located in the applicable geographical area.

According to the methodological tool “Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0), the applicable geographical area should be the entire host country. However, considering the vastness of China, the geographical differences between provinces (such as geography, climate, natural resources, etc.) and socio-economic differences (such as regulatory framework, infrastructure, level of economic development, economic structure, science and technology level, financing capacity, electricity price level, etc.). Therefore, this project selects Guangdong Province as the appropriate geographic area.

(b) The projects apply the same measure as the project activity. Thus, only the project provided power generation based on methane from fresh waste treated by anaerobic digestion for power generation are chosen.

(c) The project uses the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity. Thus, only the projects use fresh waste are chosen.

(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant. Thus, only projects with electricity generation are chosen.

(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step sub-step 4a-1. Thus, only projects have a capacity of 5.225 MW to 15.675 MW and design processing capacity of 1,020 t/d to 3,060 t/d are chosen.

(f) The projects started commercial operation before the project design document is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the project activity. Thus, only the projects started commercial operation before 15/08/2017²⁵ are chosen.

Sub-step 4a-3: Within the projects identified in Sub-step 4a-2, identify those that are neither registered CDM/VCS/CCER project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all} .

Searching from publicly available sources^{26,27}, China's DNA website and UNFCCC website, there is no power generation projects utilized the methane from fresh waste treated by anaerobic digestion for power generation with capacity of 5.225 ~ 15.675 MW operated before 15/08/2017 in Guangdong Province. Thus, $N_{all}=0$.

Sub-step 4-4: Within similar projects identified in Sub-step 4-3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff} .

For the project, $N_{diff}=0$.

Sub-step 4-5: Calculate factor $F=1-N_{diff}/N_{all}$ representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the

²⁵ Source from equipment purchase contract

²⁶ <http://news.bjx.com.cn/zt.asp?topic=%CD%DF%CB%B9%B7%A2%B5%E7>

²⁷ China Electric Power Yearbook

measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

Since $N_{all} = 0$, $N_{diff}=0$, therefore, $N_{all} - N_{diff} = 0$, which is less than 0.

$$F = 1 - N_{diff} / N_{all} = 1.$$

According to common practice (version 03.1), the proposed project activity is a “common practice” within a sector in the applicable geographical area if the factor F is greater than 0.2 and $N_{all} - N_{diff}$ is greater than 3. However, the $N_{all} - N_{diff}$ is less than 3.

Thus, the Project activity is not a “common practice”.

Outcome of Step 4:

Based on the analysis above, the baseline scenario of the project is:

Combined alternative **scenario 4 (M2+P6)**: Disposal of the fresh waste in a SWDS with a partial capture of the LFG and flaring of the captured LFG; Electricity generation in existing and/or new grid-connected electricity plants.

Therefore, the proposed project is additional.

As above mentioned, the baseline scenario is **(M2+P6)**: Disposal of the fresh waste in a SWDS with a partial capture of the LFG and flaring of the captured LFG; Electricity generation in existing and/or new grid-connected electricity plants. The project is to utilize the biogas produced by anaerobic digestion for power generation.

According to the relevant applicable laws and regulations at the time of submission of registration, i.e. Renewable Energy Law of the People’s Republic of China which came into effect on 01/01/2006, Agenda for China’s 14th Five-Year Plan (2021-2025), there are no new national and/or sectoral policies that could affect the baseline scenario during the crediting period. Therefore, the project is surplus to regulatory requirements.

3.6 Methodology Deviations

As plant specific fuel consumption and electricity generation data are not publicly available in China, the Guidance caused by DNV’s request for deviation of Chinese project activities for the CDM baseline methodology AM0005 has been applied for calculating the build margin (BM) emission factor of this project activity. Please refer to section 4.1 of this report for details.

The deviation has no impact on conservativeness of the quantification of GHG emission reductions or removals.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

According to the methodology ACM0022 (version 03.0), baseline emissions are determined according to equation (1) and comprise the following sources:

- (a) Methane emissions from the SWDS in the absence of the project activity;
- (b) Methane emissions from the treatment of organic wastewater in the absence of the project activity;
- (c) Energy generated or electricity consumed by the grid in the absence of the project activity;
- (d) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = \sum_t (BE_{CH_4,t,y} + BE_{WW,y} + BE_{EN,t,y} + BE_{NG,t,y}) \times (1 - RATE_{compliance,t,y}) \quad (1)$$

With,

Where,

BE_y	= Baseline emissions in year y (t CO ₂ e)
$BE_{CH_4,t,y}$	= Baseline emissions of methane from the SWDS in year y (t CO ₂ e)
$BE_{WW,y}$	= Baseline methane emissions from anaerobic treatment of the wastewater in open anaerobic lagoons or of sludge in sludge pits in the absence of the project activity in year y (t CO ₂ e)
$BE_{EN,t,y}$	= Baseline emissions associated with energy generation in year y (t CO ₂)
$BE_{NG,t,y}$	= Baseline emissions associated with natural gas use in year y (t CO ₂)
$RATE_{compliance,t,y}$	= Rate of compliance of a requirement that mandates the use of alternative waste treatment option t in year y
T	= Type of alternative waste treatment option

For simplification, the type of alternative waste treatment option t is hitherto omitted.

The project is using methane from fresh waste by anaerobic digestion treatment for electricity

generation. It doesn't involve methane emissions from anaerobic treatment of the wastewater in open anaerobic lagoons or of sludge in sludge pits and emissions associated with natural gas use, thus, $BE_{WW,y}=0$, $BE_{NG,t,y}=0$.

In addition, In China, there is no regulation requiring kitchen and catering waste to be treated by anaerobic digestion. At present, landfill is still the main method to treat fresh waste. Thus, $RATE_{compliance,t,y}=0$ and is determined once for the first crediting period.

Therefore,

$$BE_y = BE_{CH_4,y} + BE_{EN,y} \quad (2)$$

Baseline emissions of methane from the SWDS ($BE_{CH_4,y}$)

$BE_{CH_4,SWDS,y}$ is determined using the methodological tool "Emissions from solid waste disposal sites" (version 08.0). The following guidance should be taken into account when applying the tool:

- (a) $W_{j,x}$ in the tool is the amount of organic fresh waste prevented from disposal in the baseline SWDS due to its treatment in any (combination) alternative waste treatment process;
- (b) Emission amounts are calculated using Application B in the tool (only fresh waste avoided from disposal after the start of the first crediting period shall be considered);
- (c) Sampling to determine the fractions of different waste types is necessary (note that for the case that the waste is combusted in the project activity, then the parameter $Q_{j,c,y}$ in this methodology is equivalent to the variable $W_{j,x}$ in the tool);
- (d) The tool instructs that f_y shall be determined based on historic data or contract or regulation requirements specifying the amount of methane that must be destroyed/used (if available). The following additional instruction applies:
 - (i) If the regulation requirements specify a percentage of the LFG that is required to be flared, the amount shall equal f_y ;
 - (ii) If the regulation requirements do not specify the amount or percentage of LFG that should be destroyed but require the installation of a capture system, without requiring the captured LFG to be flared then $f_y = 0$; and
 - (iii) If the requirement does not specify any amount or percentage of LFG that should be destroyed but require the installation of a system to capture and flare the LFG, then it is assumed $f_y = 0.2$.

The project is to utilize biogas produced from fresh waste by anaerobic digestion for power generation and avoid the disposal of only fresh waste at a SWDS. And the fresh waste is mainly mixed kitchen and catering waste of the Guangzhou City. Therefore, the **Application B** is applied,

and the fractions of different waste types is determined by sampling. And in the applied **Application B**, the methane is generated from waste disposed or avoided from disposal during the crediting period. In these cases, the tool can be applied for both ex ante and ex post estimation of emissions.

In China, the requirement does not specify any amount or percentage of LFG that should be destroyed but require the installation of a system to capture and flare the LFG, then it is assumed $f_y = 0.2$.

The $BE_{CH_4,SWDS,y}$ is calculated for both ex ante and ex post estimation of emissions as follows:

$$BE_{CH_4,SWDS,y} = \phi_y \times (1 - f_y) \times GWP_{CH_4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^y \sum_j (W_x \times \frac{\sum_{n=1}^{Z_x} P_{n,j,x}}{Z_x} \times DOC_j \times e^{-k_j \cdot (y-x)} \times (1 - e^{-k_j})) \quad (3)$$

Where:

$BE_{CH_4,SWDS,y}$	=Baseline methane emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year y (t CO ₂ e/yr)
X	=Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y)
y	=Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)
$DOC_{f,y}$	=Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction)
W_x	=Total amount of waste disposed in a SWDS in year x (t)
$P_{n,j,x}$	=Fraction of the waste type j in the sample n collected during the year x (weight fraction)
Z_x	=Number of samples collected during the year x
ϕ_y	=Model correction factor to account for model uncertainties for year y
f_y	=Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
GWP_{CH_4}	=Global Warming Potential of methane
OX	=Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)

F	=Fraction of methane in the SWDS gas (volume fraction)
MCF_y	=Methane correction factor for year y
DOC_j	=Fraction of degradable organic carbon in the waste type j (weight fraction)
n	=Samples collected in year x
k	=Decay rate for the waste type j (1 / yr)
j	=Type of residual waste or types of waste in the MSW, the project mainly involve kitchen and catering waste and please refer to Table 4-1 for details.

Baseline emissions from generation of energy

This procedure is distinguished depending on whether the baseline is the separate generation of electricity and heat or the combined generation of heat and electricity by cogeneration.

The project is using methane from fresh waste by anaerobic digestion treatment for electricity generation. Thus, baseline emissions from separate generation of electricity ($BE_{EC,y}$) is considered.

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

The project is to utilize the biogas produced by anaerobic digestion for power generation. The electricity generated by the project is supplied to China South Power Grid (CSPG) which is dominated by coal-fired power stations. This is the scenario that existed prior to the implementation of the project activity and is also the baseline scenario.

The baseline emissions associated with electricity generation in year y ($BE_{EC,y}$) shall be calculated using "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". When applying the tool:

- 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
- $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated by the alternative waste treatment process t and exported to the grid or displacing fossil fuel fired captive energy plant in year y ($EG_{t,y}$).

According to methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0),

$$BE_{EC,y} = \sum_k EC_{BL,k,y} \times EF_{EL,k,y} \times (1 + TDL_{k,y}) \quad (4)$$

Where:

$BE_{EC,y}$	=Baseline emissions from electricity consumption in year y (t CO ₂ /yr)
$EC_{BL,k,y}$	=Quantity of electricity that would be consumed by the baseline electricity consumer k in year y (MWh/yr)
$EF_{EL,k,y}$	=Emission factor for electricity generation for source k in year y (t CO ₂ /MWh)
$TDL_{k,y}$	=Average technical transmission and distribution losses for providing electricity to source k in year y
k	=Sources of electricity consumption in the baseline

Since 01-Jan-2023, the baseline emissions associated with electricity generation in year y ($BE_{EC,y}$) are calculated as follows:

$$BE_{EC,y} = \sum_k (EC_{BL,k,y} - EC_{purchased,y}) \times EF_{EL,k,y} \times (1 + TDL_{k,y}) \quad (5)$$

Where,

$EC_{purchased,y}$ = The electricity generated from purchased biogas (MWh), which is the theoretical maximum electricity generation from purchased biogas

The electricity generated from purchased biogas ($EC_{purchased,y}$) is calculated as follows:

$$EC_{purchased,y} = V_{purchased,y} \times V_{purchased,t,db} \times \rho_{CH_4,n} \times NCV_{CH_4} \times \varphi \div 3.6 \quad (6)$$

Where,

$V_{purchased,y}$	=	Quantity of purchased biogas in year y (m ³)
$V_{purchased,t,db}$	=	100% (m ³ gas CH ₄ /m ³ dry gas)
$\rho_{CH_4,n}$	=	0.71566 (kg/m ³)
NCV_{CH_4}	=	0.0504 (GJ/kg)
φ	=	42%, highest power generation efficiency of biogas generator, sourced from registered VCS-JPM
3.6	=	Unit conversion from GJ to MWh

Quantity of purchased biogas ($V_{purchased,y}$) is monitored by newly installed biogas flow meter. However, the PP did not install gas analyzer to monitor the volumetric fraction of CH₄ in the purchased biogas, it is conservatively assumed that the CH₄ content in the purchased biogas is 100%, since the value of purchased biogas is deducted from total ER and higher value of $V_{purchased,y}$ will result in lower ER of the project.

According to the tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0), the project belongs to the case of **Scenario A**, use as default values of 3% for baseline emission, i.e. $TDL_{k,y}=3\%$.

Determination of the emission factor for electricity generation ($EF_{EL,k,y}$)

According to the tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”(version 03.0),for the project is in the case of **Scenario A**: Electricity consumption from the grid, the project participants choose **Option A1**: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the “Tool to calculate the emission factor for an electricity system” (version 07.0) ($EF_{EL,k,y} = EF_{grid,CM,y}$).

According to “Tool to calculate the emission factor for an electricity system” (version 07.0). The following six steps are applied to determine OM, BM, and CM used for calculating the project baseline emissions:

Step 1. Identify the relevant electricity systems

According to the Tool to calculate the emission factor for an electricity system (Version 07.0), project participants may delineate the project electricity system using any of the following options:

Option 1. A delineation of the project electricity system and connected electricity systems published by the DNA or the group of the DNAs of the host country(ies), In case a delineation is provided by a group of DNAs, the same delineation should be used by all the project participants applying the tool in these countries;

Option 2. A delineation of the project electricity system defined by the dispatch area of the dispatch centre responsible for scheduling and dispatching electricity generated by the project activity. Where the dispatch area is controlled by more than one dispatch centre, i.e. layered dispatch area, the higher level area shall be used as a delineation of the project electricity system (e.g. where regional dispatch centres are required to comply with dispatch orders of the national dispatch centre then area controlled by the national dispatch centre shall be used);

Option 3. A delineation of the project electricity system defined by more than one independent dispatch areas, e.g. multi-national power pools.

The Chinese DNA has published a delineation of the project electricity system and connected electricity systems, Option 1 is applied for the project. According to the delineations, the China

South Power Grid (CSPG) is identified as the relevant electric power system of the project, which includes Guangdong Province, Yunnan Province, Guizhou Province, Hainan Province, and Guangxi Zhuang Autonomous Region Power Grids.

Step 2. Choose whether to include off-grid power plants in the project electricity system (optional)

Project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.

Option II: Both grid power plants and off-grid power plants are included in the calculation

Based on China's real situation, only grid power plants are included in the calculation.

Step 3. Select a method to determine the operating margin (OM)

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

- (a) Simple OM, or
- (b) Simple adjusted OM, or
- (c) Dispatch data analysis OM, or
- (d) Average OM.

In China, specific data from the grid or each power plant is treated as business confidential and thus not public available. Therefore, method (b) and method (c) are not suitable for the project.

The Simple OM method (a) can only be applied when low-cost/must run resources²⁸ constitute less than 50% of total grid generation in average of the five most recent years. According to “2019 Baseline Emission Factors for Regional Power Grids in China”²⁹, for the CSPG the project

²⁸ Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.

²⁹ <https://www.mee.gov.cn/ywgz/ydqhbh/wsqtgz/202012/W020201229610353340851.pdf>

activity connected to, the average low-cost/must-run electric power resources generation accounts for the total grid total in recent five years is lower than 50%, which satisfied the applicability of the method (a), therefore, the simple OM method is chosen for the calculation of the OM emission factor $EF_{grid,OM,y}$.

As per the latest version of “Tool to calculate the emission factor for an electricity system” (version 07.0), one of the following methods should be chosen to calculate the simple OM emission factor:

- Ex ante option: If the ex-ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the joint PD&MR to the DOE for validation, or
- Ex post option: If the ex post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required calculating the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.

Here the ex ante option is selected, and the $EF_{grid,OM,y}$ is fixed during the crediting period.

Step 4. Calculate the operating margin emission factor according to the selected method

Based on the analysis of the step 3, the simple OM method is used to calculate the China South Power Grid (CSPG) OM emission factor in this step. The simple OM emission factor is calculated as the generation-weighted average CO₂ emissions per unit net electricity generation (tCO₂/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/ units.

The simple OM may be calculated by one of the following two options:

Option A: Based on the net electricity generation and a CO₂ emission factor of each power unit;
or

Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

For the project activity, the required data for the exercise of Option A is not available and those of Option B can be obtained from official sources, and off-grid power plants are not included in the calculation, therefore, Option B is chosen to calculate the operating margin emission factor:

For Option B, the Simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not including low-cost / must-run power plants / units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_y} \quad (7)$$

Where:

$EF_{grid,OMsimple,y}$	= Simple operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$FC_{i,y}$	= Amount of fuel type i consumed in the project electricity system in year y (mass or volume unit)
$NCV_{i,y}$	= Net calorific value (energy content) of fuel type i in year (GJ / mass or volume unit)
$EF_{CO2,i,y}$	= CO ₂ emission factor of fuel type i in year y (tCO ₂ /GJ)
EG_y	= Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year y (MWh)
I	= All fuel types combusted in power sources in the project electricity system in year y
Y	= The three most recent years for which data is available at the time of submission of the joint PD&MR to the DOE for validation.

If available, $NCV_{i,y}$ and $EF_{CO2,i,y}$ from the fuel supplier of the power plants in invoices may be used; or, regional or national average default values may be used. In this joint PD&MR, $NCV_{i,y}$ of different fuels are obtained from China Energy Statistical Yearbook. Emission factors ($EF_{CO2,i,y}$) of each type of fossil fuel come from IPCC 2006 default values.

The Simple OM Emission Factor ($EF_{grid,OMsimple,y}$) of the project is calculated on the basis of the fuel consumption data for electricity generation of the China South Power Grid (CSPG), not including those of low-operating cost and must-run power plants, such as wind power, hydropower and nuclear etc. These data are obtained from the China Electric Power Yearbook (2016~2018, published annually) and China Energy Statistical Yearbook (2016~2018). Based

on these data, the Simple OM Emission Factor ($EF_{grid,OMsimple,y}$) of the Central China Power Grid is calculated as 0.8042 tCO₂/MWh. Details of the calculations and the published data from the Chinese DNA³⁰, which uses official national statistics.

Step 5. Calculate the build margin (BM) emission factor

In terms of vintage of data, project participants can choose between one of the following two options:

Option 1: For the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of joint PD&MR submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2: For the first crediting period, the build margin emission factor shall be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

The joint PD&MR chooses Option 1, which requires the project participant to calculate the Build Margin Emission Factor $EF_{grid,BM,y}$, ex-ante based on the most recent information available on units already built for sample group m at the time of joint PD&MR submission.

The sample group of power units m used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5-units}$) and determine their annual electricity generation ($AEG_{SET-5-units}$, in MWh);

³⁰“2019 Baseline Emission Factors for Regional Power Grids in China”

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total} , in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20 per cent of AEG_{total} (if 20 per cent falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20 \text{ per cent}}$) and determine their annual electricity generation ($AEG_{SET_{\geq 20 \text{ per cent}}}$, in MWh);

(c) From $SET_{5\text{-units}}$ and $SET_{\geq 20 \text{ per cent}}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. Ignore steps (d), (e) and (f).

Under the current circumstances in China, the power plants consider the Build Margin data as important business data and will not have them published. Therefore, it is difficult to obtain the data of five power plants that have been put into operation most recently or the newly installed power plant capacity additions in the electricity system that comprise 20% of the system generation.

According to the instructions of China DNA, for the determination of the set of samples, a sample merging processing in some degree has been adopted due to that the power generation data, energy consumption data or thermal efficiency data of each plant cannot be consulted in the public statistical data. In this calculation, the newly-installed power units in the past years are classified by year, province and power generation technology, and the same type of newly-installed power units in the same province and in the same year are bundled as a "newly-installed power units".

The power generation of each "newly-installed power units" in the most recent year y is estimated based on its installed capacity and the number of power generation utilization hours in year y . The formula is as follows:

$$EG_{m,y} = CAP_m \times H_{m,y} \quad (8)$$

Where:

$EG_{m,y}$ =Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)

CAP_m =Installed capacity of electricity generated and delivered to the grid by power

unit m in year y (MW)

$H_{m,y}$ =The number of power utilization hours (h) of electricity generated and delivered to the grid by power unit m in year y . And it selects the average utilization hours of similar units in the province in which it is located in year y ;

Y =Most recent year for which data is available.

M =The sample group of power units.

The power unit m is selected from the “newly-installed power plants” in the most recent year y (For the calculation of the grid BM in 2019, the y is equal to 2017) to the “newly-installed power plants” in the earlier year, until the cumulative power generation reaches 20% of the total power generation in the year y ($y=2017$).

Since the newly-installed power units of the same type (k) in the same province (A) and the same year (t) are bundled into the “newly-installed power units”, the CAP_m is equal to the statistical data of recent installed capacity of a given unit type(k) in a given year(t) in a given province (A).

$$CAP_m = CAP_m|_{m=(A,t,k)} = CAP_{A,t,k} \quad (9)$$

Where:

CAP_m =Installed capacity of electricity generated and delivered to the grid by power unit m in year y (MW), and m is equivalent to an established combination of (A , t , k);

$CAP_{A,t,k}$ =Capacity of newly-installed power units of a given province (A), given year (t), and given unit type (k) (MW)

A =It is the various provincial regions covered by the regional power grid

T =It is the sampling year of the “newly-installed power units”. For the calculation of the grid BM in 2019, t is equal to 2017, 2016, ..., until the units that comprise at least 20 percent of the system generation in 2017.

K =It is the power generation technology classification of "newly-installed power units", which is divided into: hydro-power, coal-thermal power, gas-thermal power, oil-thermal power, Waste-thermal power plant, other thermal power³¹, nuclear power, wind power, solar power, and others³².

As per tool, the CO₂ emission factor of each power unit m ($EF_{EL,m,y}$) should be determined as per the tool in Step 4 section 6.4.1 for the simple OM, using Options A1, A2 or A3, using for y the

³¹ refers to waste heat and pressure, straw, bagasse, forest wood power generation.

³² refers to power generation such as geothermal energy and ocean energy.

most recent historical year for which electricity generation data is available, and using from the power units included in the build margin.

Because current statistics data cannot separate each power plant, for a power unit m , only data on electricity generation and the fuel types used is available. So, the option A2 is selected, the emission factor should be determined based on the CO₂ emission factor of the fuel type used and the efficiency of the power unit, as follows:

$$EF_{EL,m,y} = \frac{EF_{CO_2,m,i,y} \times 3.6}{\eta_{m,y}} \quad (10)$$

Where:

$EF_{EL,m,y}$ =CO₂ emission factor of power unit m in year y (tCO₂/MWh)

$EF_{CO_2,m,i,y}$ =Average CO₂ emission factor of fuel type i used in power unit m in year y (tCO₂/GJ)

$\eta_{m,y}$ =Average net energy conversion efficiency of power unit m in year y (ratio)

3.6 =Conversion coefficient of thermal work equivalent of electricity (GJ/MWh)

According to above formula (8), the unit electricity emission factor of the hydro-power, nuclear power, wind power, solar power, other thermal power³³, and others power generation technology³⁴ in the “newly-installed power units” samples are is zero. The emission factor per unit of electricity for power generation from coal, gas, oil and waste power is calculated based on above formula. Since the average net energy conversion efficiency of each sample($\eta_{m,y}$) cannot be obtained, the power supply thermal efficiency of the best commercialized technology of coal, gas, oil and waste power ($\eta_{Best,m,y}$) is better than $\eta_{m,y}$. It is conservative to use $\eta_{Best,m,y}$ for the calculation of $EF_{EL,m,y}$.

The Build Margin emissions factor is the generation-weighted average emission factor (tCO₂/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad (11)$$

Where

$EF_{grid,BM,y}$ =Build Margin CO₂ emission factor in year y (tCO₂/MWh)

³³ Other thermal power mainly refers to waste heat and pressure, straw, bagasse and forest power generation.

³⁴ Others power generation technology mainly refers to geothermal energy, ocean energy and other power generation.

$EG_{m,y}$	=Net quantity of electricity generated and delivered to the grid by power unit m in year y
$EF_{EL,m,y}$	=CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh)
M	=Power units included in the Build Margin
Y	=The most recent year for which data is available

Outcome of STEP5:

Based on the calculation in appendix 4, the Build Margin Emission Factor ($EF_{grid,BM,y}$) of the CSPG could be obtained to be 0.2135 tCO₂/MWh.

Step 6. Calculate the combined margin (CM) emission factor

As per the “tool to calculate the emission factor for an electricity system”, the combined margin emission factor ($EF_{grid,CM,y}$) is calculated based on one of the following methods:

- (a) Weighted average CM; or
- (b) Simplified CM.

The weighted average CM method (option A) should be used as the preferred option.

The simplified CM method (option b) can only be used if:

The project activity is located in: (i) a Least Developed Country (LDC); or in (ii) a country with less than 10 registered CDM projects at the starting date of validation; or (iii) a Small Island Developing States (SIDS); and

The data requirements for the application of step 5 above cannot be met.

The joint PD&MR choose option A.

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = \omega_{OM} \times EF_{grid,OM,y} + \omega_{BM} \times EF_{grid,BM,y} \quad (12)$$

Where,

$EF_{grid,BM,y}$	= Build margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{grid,OM,y}$	= Operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
ω_{OM}	= Weighting of operating margin emissions factor (per cent)
ω_{BM}	= Weighting of build margin emissions factor (per cent)

The combined margin emissions factor $EF_{grid,CM,y}$ should be calculated as the weighted average of the Operating Margin emission factor ($EF_{grid,OM,y}$) and the Build Margin emission factor ($EF_{grid,BM,y}$), where $\omega_{OM} = 0.5$ and $\omega_{BM} = 0.5$ for all other projects (owing to their intermittent and non-dispatchable nature) for the first crediting period and $\omega_{OM}=0.25$ and $\omega_{BM} = 0.75$ for the second and third crediting period.

For the project, the weight ω_{OM} and ω_{BM} are both 0.5 by default for the fixed crediting period. Thus, $EF_{grid,CM,y}=0.8042 \text{ tCO}_2/\text{MWh} * 0.5 + 0.2135 \text{ tCO}_2/\text{MWh} * 0.5 = 0.50885 \text{ (tCO}_2/\text{MWh)}$.

In summary, BE_y is ex ante determined as the following equations:

$$BE_y = BE_{CH4,y} + BE_{EC,y}$$

$$BE_{CH4,SWDS,y} = \phi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^y \sum_j (W_x \times \frac{\sum_{n=1}^{Z_x} P_{n,j,x}}{Z_x} \times DOC_j \times e^{-k_j \cdot (y-x)} \times (1 - e^{-k_j}))$$

$$BE_{EC,y} = \sum_k EC_{BL,k,y} \times EF_{EL,k,y} \times (1 + TDL_{k,y})$$

The necessary values to calculate BE_{CH4} are shown as Table 4-1.

Table 4-1 The necessary values to calculate BE_{CH4}

Parameter	Value		Data sources
ϕ_y	0.85		Emissions from solid waste disposal sites (version 08.0)
f_y	0.2		ACM0022 (Version 03.0)
GWP_{CH4}	28		IPCC Fifth Assessment Report (AR5)
OX	0.1		IPCC 2006 Guidelines for National Greenhouse Gas Inventories
F	0.5		IPCC 2006 Guidelines for National Greenhouse Gas Inventories
$DOC_{f,y}$	0.5		IPCC 2006 Guidelines for National Greenhouse Gas Inventories
MCF_y	1.0		IPCC 2006 Guidelines for National Greenhouse Gas Inventories, 1.0 for anaerobic managed solid waste disposal sites was applied for the project activity.
W_x	673,200		FSR
$P_{n,j,x}$ (Weight fraction of waste)	Wood	0.66%	FSR
	Paper	5.12%	
	Food	75%	
	Textile	3.26%	

type j in the fresh waste)	Garden and park waste	0	
	Others (plastic, glass, metal,etc)	15.96%	
	Total	100%	
DOC _j	Pulp, paper and cardboard	40%	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
	Textiles	24%	
	Food, food waste, beverages and tobacco	15%	
	Wood and wood products	43%	
	Garden, yard and park waste	20%	
	Rubber and leather	-	
	Plastic	-	
	Metal	-	
	Glass	-	
	Others	-	
k _j	Pulp, paper and cardboard	0.07	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
	Textiles	0.07	
	Food, food waste, beverages and tobacco	0.40	
	Wood and wood products	0.035	
	Garden, yard and park waste	0.17	
	Rubber and leather	-	
	Plastic	-	
	Metal	-	
	Glass	-	
	Others	-	
y	1-7		ACM0022 (Version 03.0)

The estimated methane amount in landfill gas in the 7 years calculated by the project according to the methodological tool “Emissions from solid waste disposal sites” (version 08.0) is higher than the methane amount destroyed by the project with the capacity of 10.45 MW based on the equation (6) of methodology AMS-III.G (Version 10.0). In the joint PD&MR, the equation (3) in section 4.1 of the joint PD&MR is applied to estimate the methane amount. The joint PD & MR refers to the parameters in the FSR: the installed capacity of 10.45 MW, annual operating hours (7,920 hours), the power generation efficiency (42%), power plant self-consumption rate (20%). Methane calorific value is 0.0504 TJ/tCH₄ as per ACM0001 version

19.0, to have a theoretical calculation that the prior calculation of annual average methane from destroyed is 13,927 tCH₄/year³⁵ for the capacity of 10.45 MW. The detailed theoretical installed capacity and methane destroyed as follows, details please refer to ER calculation spreadsheet.

The estimation of annual BE_{CH₄, SWDS, y}, EG_{t,y} (EC_{BL,k,y}) is shown as table 4-2.

Table 4-2 The estimation of BE_{CH₄, SWDS, y}, EG_{t,y} (EC_{BL,k,y})

Year	BE _{CH₄, SWDS, y} -BE _{CH₄,t, y} (CO ₂ e)	Q _{CH₄,y} (t)	Theoretical installed capacity (MW)	Actual installed capacity (MW)	Electricity generation (MWh)	EG _{t,y} = EC _{BL,k,y} (MWh)
01/04/2020~31/12/2020	113,279	4,046	3.99	10.45	23,809	19,047
01/01/2021~31/12/2021	227,822	8,137	6.71	10.45	47,831	38,266
01/01/2022~31/12/2022	306,541	10,948	8.59	10.45	64,361	51,489
01/01/2023~31/12/2023	361,118	12,897	9.9	10.45	75,850	60,679
01/01/2024~31/12/2024	399,394	14,264	10.82	10.45	81,034	64,827
01/01/2025~31/12/2025	426,632	15,237	11.47	10.45	81,893	65,514
01/01/2026~31/12/2026	446,367	15,942	11.95	10.45	81,893	65,514
01/01/2027~31/03/2027	111,162	3,970	11.95	10.45	20,193	16,154
Total	2,392,315	85,440	/	/	476,863	381,490

Therefore, BE_{EC,y} is ex ante estimated as the follows.

Table 4-3 The estimation of BE_{EN,t,y} (BE_{EC,y})

Year	EG _{t,y} = EC _{BL,k,y} (MWh)	EF _{EL,k,y} = EF _{grid,CM,y} (tCO ₂ /MWh)	TDL _{k,y}	BE _{EN,t,y} = BE _{EC,y} (t CO ₂ e)
01/04/2020~31/12/2020	19,047	0.50885	3%	9,983
01/01/2021~31/12/2021	38,266	0.50885	3%	20,055
01/01/2022~31/12/2022	51,489	0.50885	3%	26,986

³⁵ The methane amount destroyed by the project with the capacity of 10.45 MW is calculated by the equation (6) of methodology AMS-III.G (Version 10.0). And the equation (6) is $F_{CH_4,PJ,y} = EG_y * 3600 / NCV_{CH_4} * EF_y = 10.45 MW * 7920 h * 3600 MJ / MWh * 0.0504 TJ * 42\% / tCH_4 * 10^{-6} = 13,927 tCH_4$

01/01/2023~31/12/2023	60,679	0.50885	3%	31,802
01/01/2024~31/12/2024	64,827	0.50885	3%	33,976
01/01/2025~31/12/2025	65,514	0.50885	3%	34,336
01/01/2026~31/12/2026	65,514	0.50885	3%	34,336
01/01/2027~31/03/2027	16,154	0.50885	3%	8,466
Total				199,940

Therefore, during this crediting period, BE_y is ex ante estimated as the following table.

Table 4-4 The ex-ante estimation of BE_y

Period	BE _{CH4, SWDS, y} = BE _{CH4, t, y} (CO ₂ e)	BE _{EN,t,y} = BE _{EC,y} (t CO ₂ e)	BE _y (t CO ₂ e)
01/04/2020~31/12/2020	113,279	9,983	123,262
01/01/2021~31/12/2021	227,822	20,055	247,876
01/01/2022~31/12/2022	306,541	26,986	333,526
01/01/2023~31/12/2023	361,118	31,802	392,920
01/01/2024~31/12/2024	399,394	33,976	433,369
01/01/2025~31/12/2025	426,632	34,336	460,967
01/01/2026~31/12/2026	446,367	34,336	480,703
01/01/2027~31/03/2027	111,162	8,466	119,628
Total	2,392,315	199,940	2,592,251

4.2 Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{COMP,y} + PE_{AD,y} + PE_{GAS,y} + PE_{RDF_SB,y} + PE_{INC,y} \quad (13)$$

Where:

$$PE_y = \text{Project emissions in year } y \text{ (t CO}_2\text{e)}$$

$PE_{COMP,y}$	=	Project emissions from composting or co-composting in year y (t CO ₂ e)
$PE_{AD,y}$	=	Project emissions from anaerobic digestion and biogas combustion in year y (t CO ₂ e)
$PE_{GAS,y}$	=	Project emissions from gasification in year y (t CO ₂ e)
$PE_{RDF_SB,y}$	=	Project emissions associated with RDF/SB in year y (t CO ₂ e)
$PE_{INC,y}$	=	Project emissions from incineration in year y (t CO ₂ e)

The project only involves the project emissions from anaerobic digestion and biogas combustion, not involved in the emissions from composting or co-composting, gasification, RDF/SB and incineration, thus,

$$PE_y = PE_{AD,y} \quad (14)$$

Project emissions from anaerobic digestion ($PE_{AD,y}$)

$PE_{AD,y}$ is calculated according to the methodological tool “Project and leakage emissions from anaerobic digesters”. When estimating the parameters $PE_{EC,y}$ and $PE_{FC,y}$ in the tool, the sources of electricity and fossil fuel consumption shall include processing, upgrading and compressing the biogas into the natural gas network (if this is part of the project activity).

According to the methodological tool “Project and leakage emissions from anaerobic digesters” (version 02.0), the project emissions associated with the anaerobic digester ($PE_{AD,y}$) are determined as follows:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{flare,y} \quad (15)$$

Where:

$PE_{AD,y}$	=	Project emissions associated with the anaerobic digester in year y (t CO ₂ e)
$PE_{EC,y}$	=	Project emissions from electricity consumption associated with the anaerobic digester in year y (t CO ₂ e)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption associated with the anaerobic digester in year y (t CO ₂ e)
$PE_{CH_4,y}$	=	Project emissions of methane from the anaerobic digester in year y (t CO ₂ e)
$PE_{flare,y}$	=	Project emissions from flaring of biogas in year y (t CO ₂ e)

According to the methodological tool “Project and leakage emissions from anaerobic digesters” (version 02.0), these parameters are determined through the steps outlined below.

Step 1: Determination of the quantity of methane produced in the digester ($Q_{CH_4,y}$)

There are two different procedures to determine the quantity of methane produced in the digester in year y ($Q_{CH_4,y}$). For large scale projects only Option 1 shall be used. For small scale projects, project participants may choose between Option 1 or Option 2.

The joint PD&MR uses option 1 to determine the quantity of methane produced in the digester in year y ($Q_{CH_4,y}$).

Option 1: Procedure using monitored data

$Q_{CH_4,y}$ shall be measured using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0). When applying the tool, the following applies:

- (a) The gaseous stream to which the tool is applied is the biogas collected from the digester;
- (b) CH_4 is the greenhouse gas i for which the mass flow should be determined; and
- (c) The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y . Please note that units need to be converted to tons, when applying the results in this tool.

Since the flow meter of this project is installed at the back end of desulfurization and dehydration process, the monitored flow rate and methane content of the biogas after dehydration treatment and filtration are all in the dry base state, therefore, **Option A** in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) is applied to determine the parameter of $Q_{CH_4,y}$.

Option A

Flow measurement on a dry basis is not doable for a wet gaseous stream. In order to determine that the biogas is in a dry state, there are two ways to do this:

- (a) Measure the moisture content of the gaseous stream ($C_{H_2O,t,db,n}$) and demonstrate that this is less or equal to $0.05 \text{ kg H}_2\text{O}/\text{m}^3$ dry gas; or
- (b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

According to the FSR of the project, the temperature of the gaseous stream after desulfurization and cooling dehydration process is about 15°C , which is less than 60°C . On a dry basis, the mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,n} \quad (16)$$

With:

$$\rho_{i,n} = \frac{P_n \times MM_i}{R_u \times T_n} \quad (17)$$

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)
$\rho_{i,n}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m ³ gas i), methane in the gaseous stream is under the normal conditions.
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)
i	=	i is methane in the biogas

Thus,

$$Q_{CH_4,y} = \frac{F_{i,t} \times h}{1000} \quad (17)$$

Where:

$Q_{CH_4,y}$	=	Quantity of methane produced in the digester in year y (t CH ₄)
$F_{i,t}$	=	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
h	=	The total operation hours of the project (h)
i	=	i is methane in the biogas

$Q_{CH_4,y}$ is ex ante determined based on the parameters $BE_{CH_4,SWDS,y}$ and GWP_{CH_4} in the joint PD&MR and will be monitored ex post in the verification period.

Step 2: Determination of project emissions from electricity consumption ($PE_{EC,y}$)

The project participants choose **option 1** in the methodological tool “Project and leakage emissions from anaerobic digesters” (version 02.0) to calculate $PE_{EC,y}$:

Option 1: Procedure using monitored data

$PE_{EC,y}$ shall be calculated using the “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0), where the project emission source j referred to in the tool is the total electricity consumption associated with the anaerobic digestion facility.

According to “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0), project emissions from consumption of electricity are calculated as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \quad (18)$$

Where:

$PE_{EC,y}$	=	Project emissions from electricity consumption in year y (t CO ₂ / yr)
$EC_{PJ,j,y}$	=	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$EF_{EL,j,y}$	=	Emission factor for electricity generation for source j in year y (t CO ₂ /MWh)
$TDL_{j,y}$	=	Average technical transmission and distribution losses for providing electricity to source j in year y
j	=	Sources of electricity consumption in the project

As stated above, according to the tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”(version 03.0), for the project is in the case of **Scenario A**: Electricity consumption from the grid, the project participants choose **Option A1**: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the “Tool to calculate the emission factor for an electricity system” (version 07.0) ($EF_{EL,j,y} = EF_{grid,CM,y}$). And using default values of 3% for project emission, i.e , $TDL_{j,y} = 3\%$ since electricity consumption by all project electricity consumption sources is smaller than the electricity consumption of all baseline electricity consumption sources.

$EC_{PJ,j,y}$ is ex ante determined as 0 in the joint PD&MR and will be monitored ex post in the verification period.

Step 3: Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$)

The anaerobic digester facility of the project will not use fossil fuels, thus,

$$PE_{FC,y} = 0$$

Step 4: Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)

Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester. These emissions are calculated using a default emission factor ($EF_{CH4,default}$), as follows:

$$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4} \quad (19)$$

Where:

$PE_{CH_4,y}$	=	Project emissions of methane from the anaerobic digester in year y (t CO ₂ e)
$Q_{CH_4,y}$	=	Quantity of methane produced in the anaerobic digester in year y (t CH ₄)
$EF_{CH_4,default}$	=	Default emission factor for the fraction of CH ₄ produced that leaks from the anaerobic digester (fraction)
GWP_{CH_4}	=	Global warming potential of CH ₄ (tCO ₂ /tCH ₄)

Step 5: Determination of project emissions from flaring of biogas ($PE_{flare,y}$)

If the project activity includes flaring of biogas, then project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the “Project emissions from flaring” (Version 04.0). The following applies:

- (a) For small scale projects, project participants may adopt a default value for the fraction of methane in the biogas ($f_{CH_4,default}$) in applying the tool; and
- (b) The tool provides default factors for the flare efficiency, which can be used for large or small scale projects as described in the tool.

According to the tool, the project emissions calculation procedure is given in the following steps:

- (a) **STEP 5.1:** Determination of the methane mass flow of the residual gas;
- (b) **STEP 5.2:** Determination of the flare efficiency;
- (c) **STEP 5.3:** Calculation of project emissions from flaring.

Step 5.1: Determination of the methane mass flow in the residual gas

Since the biogas collected from the digester will be stored in the gas tank which installed at the back end of desulfurization and dehydration process, the biogas will be deliver to generators for generating electricity and the remaining biogas will be flaring if the gas tank malfunctions or its storage capacity is full.

The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” shall be used to determine the following parameter $F_{CH_4,RG,m}$. And monitored flow rate and methane content of the residual gas are all on a dry basis, therefore, **Option A** in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) is applied to determine the parameter of $F_{CH_4,RG,m}$.

According to **Option A** in the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0), the calculation equation of mass flow of residual gas is listed directly as follows,

$$F_{CH_4,RG,m} = V_{RG,t,db} \times v_{RG,t,db} \times \rho_{RG,n} \times \frac{h}{1000} \quad (20)$$

With:

$$\rho_{RG,n} = \frac{P_n \times MM_i}{R_u \times T_n} \quad (21)$$

Where:

- $F_{CH_4, RG, m}$ = Mass flow of greenhouse gas i in the residual gaseous stream in time interval t (kg gas/m)
- $V_{RG, t, db}$ = Volumetric flow of the gaseous stream in time interval t on a dry basis (m³ dry gas/h)
- $v_{RG, t, db}$ = 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) , i =Residual gas (RG), $v_{RG, t, db} = v_{i, t, db}$
- $\rho_{RG, n}$ = Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m³ gas i), i =Residual gas (RG)
- P_n = Absolute pressure of the gaseous stream in time interval t (Pa)
- MM_i = Molecular mass of greenhouse gas i (kg/kmol), i =Residual gas (RG)
- R_u = Universal ideal gases constant (Pa.m³ /kmol.K)
- T_n = Temperature of the gaseous stream in time interval t (K)
- h = The total operation hours of the flare (hours)

$F_{CH_4, RG, m}$ is ex ante determined based on the parameters $BE_{CH_4, SWDS, y}$ minus theoretical methane destroyed by generators which is calculated by theoretical and actual installed capacity, Net calorific value of methane, power generation efficiency and GWP_{CH_4} in the joint PD&MR.

And $F_{CH_4, RG, m}$ will be monitored ex post in the verification period.

Step 5.2: Determination of flare efficiency

According to the FSR, the flare of the project is enclosed flare. In the case of enclosed flares, project participants may choose between the following two options to determine the flare efficiency for minute m ($\eta_{flare, m}$) and shall document in the joint PD&MR which option is selected:

- (a) Option A: Apply a default value for flare efficiency;
- (b) Option B: Measure the flare efficiency.

And Option A: Apply a default value for flare efficiency is chose.

Option A: Default value

The flare efficiency for the minute m ($\eta_{flare, m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating:

(a) The temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m ; and

(b) The flame is detected in minute m ($Flame_m$).

According to the technical agreement of the flare on site, the flare of the project is enclosed flare and which meets the above conditions (a) and (b), thus, **Option A:** Apply a default value for flare efficiency is applicable. Thus, $\eta_{flare,m} = 90\%$

Step 5.3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute m in year y , based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3} \quad (22)$$

Where:

$PE_{flare,y}$ = Project emissions from flaring of the residual gas in year y (tCO₂e)

GWP_{CH4} = Global warming potential of methane valid for the commitment period (tCO₂e/tCH₄)

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

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

Since 01-Jan-2023, the project emissions from flaring are calculated as follows due to project deviation in order to ensure conservative calculation of project emissions:

$$PE_{flare,y} = GWP_{CH4} \times (V_{t,db} \times v_{RG,t,db} \times \rho_{RG,n} \times h + V_{purchased,y} \times V_{purchased,t,db} \times \rho_{RG,n}) \times (1 - \eta_{flare,m}) \times 10^{-3} \quad (23)$$

In summary, PE_y is ex ante determined as the following equations:

$$PE_y = PE_{AD,y} = PE_{EC,y} + PE_{CH4,y} + PE_{flare,y}$$

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

$$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4} = \frac{V_{t,db} \times v_{t,db} \times \rho_{t,n} \times h}{1000} \times EF_{CH4,default} \times GWP_{CH4}$$

$$\begin{aligned} PE_{flare,y} &= GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3} \\ &= GWP_{CH4} \times \frac{V_{RG,t,db} \times v_{RG,t,db} \times \rho_{RG,n} \times h}{1000} \times (1 - \eta_{flare,m}) \times 10^{-3} \end{aligned}$$

$$V_{RG,t,db}=V_{i,t,db}$$

As per the section 4.1 in this joint PD&MR, a theoretical calculation that the prior calculation of methane from destroyed is 13,927³⁶ tCH₄/year for the capacity of 10.45 MW. The biogas will be deliver to generators for generating electricity and the remaining biogas will be flaring if the gas tank malfunctions or its storage capacity is full. The detailed theoretical installed capacity and methane destroyed, and residual methane flared as follows, details please refer to ER calculation spreadsheet.

The estimation of annual methane flared is shown as table 4-5.

Table 4-5 The estimation of Q_{CH₄,y} and F_{CH₄,RG, m}

Year	BE _{CH₄, SWDS, y} = BE _{CH₄, y} (CO ₂ e)	Q _{CH₄,y} (t)	Theoretical installed capacity (MW)	Actual installed capacity (MW)	F _{CH₄, RG, m} (t)
01/04/2020~31/12/2020	113,279	4,046	3.99	10.45	0
01/01/2021~31/12/2021	227,822	8,137	6.71	10.45	0
01/01/2022~31/12/2022	306,541	10,948	8.59	10.45	0
01/01/2023~31/12/2023	361,118	12,897	9.9	10.45	0
01/01/2024~31/12/2024	399,394	14,264	10.82	10.45	484
01/01/2025~31/12/2025	426,632	15,237	11.47	10.45	1,310
01/01/2026~31/12/2026	446,367	15,942	11.95	10.45	2,015
01/01/2027~31/03/2027	111,162	3,970	11.95	10.45	536
Total	2,392,315	85,440	/	/	4,344

Therefore, PE_{CH₄, y} and PE_{flare, y} is ex ante estimated as the follows.

Table 4-6 The estimation of PE_{CH₄, y}

Year	Q _{CH₄,y} (t CH ₄)	EF _{CH₄,default}	GWP _{CH₄}	PE _{CH₄,y} (tCO ₂ e)
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³⁶ The methane amount destroyed by the project with the capacity of 10.45 MW is calculated by the equation (6) of methodology AMS-III.G (Version 10.0). And the equation (6) is F_{CH₄,PJ,y}=EG_y*3600/NCV_{CH₄}*EF_y=10.45MW*7920h*3600MJ/MWh*0.0504TJ*42%/tCH₄*10⁻⁶=13,927 tCH₄

01/04/2020~31/12/2020	4,046	0.028	28	3,173
01/01/2021~31/12/2021	8,137	0.028	28	6,379
01/01/2022~31/12/2022	10,948	0.028	28	8,584
01/01/2023~31/12/2023	12,897	0.028	28	10,112
01/01/2024~31/12/2024	14,264	0.028	28	11,184
01/01/2025~31/12/2025	15,237	0.028	28	11,946
01/01/2026~31/12/2026	15,942	0.028	28	12,499
01/01/2027~31/03/2027	3,970	0.028	28	3,113
Total				66,989

Table 4-7 The estimation of $PE_{flare,y}$

Year	$F_{CH_4, RG, m}$ (t)	$\eta_{flare,h}$	GWP_{CH_4}	$PE_{flare,y}$ (tCO _{2e})
01/04/2020~31/12/2020	0	90%	28	0
01/01/2021~31/12/2021	0	90%	28	0
01/01/2022~31/12/2022	0	90%	28	0
01/01/2023~31/12/2023	0	90%	28	0
01/01/2024~31/12/2024	484	90%	28	1,355
01/01/2025~31/12/2025	1,310	90%	28	3,667
01/01/2026~31/12/2026	2,015	90%	28	5,642
01/01/2027~31/03/2027	536	90%	28	1,501
Total				12,165

Therefore, during this crediting period, PE_y is ex ante estimated as the following table.

Table 4-8 The ex-ante estimation of PE_y

Year	$PE_{EC,y}$ (tCO _{2e})	$PE_{CH_4,y}$ (tCO _{2e})	$PE_{flare,y}$ (tCO _{2e})	PE_y (tCO _{2e})
01/04/2020~31/12/2020	0	3,173	0	3,173
01/01/2021~31/12/2021	0	6,379	0	6,379

01/01/2022~31/12/2022	0	8,584	0	8,584
01/01/2023~31/12/2023	0	10,112	0	10,112
01/01/2024~31/12/2024	0	11,184	1,355	12,538
01/01/2025~31/12/2025	0	11,946	3,667	15,613
01/01/2026~31/12/2026	0	12,499	5,642	18,141
01/01/2027~31/03/2027	0	3,113	1,501	4,614
Total	0	66,989	12,165	79,154

4.3 Leakage

According to the ACM0022 (Version 03.0), leakage emissions are associated with composting/co-composting, anaerobic digestion and the use of RDF/SB that is exported outside the project boundary. Leakage emissions are determined as follows:

$$LE_y = LE_{COMP,y} + LE_{AD,y} + LE_{RDF_SB,y} \quad (24)$$

Where:

- LE_y = Leakage emissions in the year y (t CO₂e)
- $LE_{COMP,y}$ = Leakage emissions from composting or co-composting in year y (t CO₂e)
- $LE_{AD,y}$ = Leakage emissions from anaerobic digester in year y (t CO₂e)
- $LE_{RDF_SB,y}$ = Leakage emissions associated with RDF/SB in year y (t CO₂e)

And the waste by-products of the project do not involve compost or co-compost and the use of RDF/SB outside the project boundary. Leakage emissions associated with anaerobic digestion of waste ($LE_{AD,y}$) are calculated according to “TOOL14: Project and leakage emissions from anaerobic digesters” (Version 02.0).

According to the tool, the leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) depend on how the digestate is managed. They include emissions associated with storage and composting of the digestate and are determined as follows.

$$LE_{AD,y} = LE_{storage,y} + LE_{comp,y} \quad (25)$$

Where:

- $LE_{AD,y}$ = Leakage emissions associated with the anaerobic digester in year y

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y (t CO₂e)

$LE_{comp,y}$ = Leakage emissions associated with composting digestate in year y (t CO₂e)

Step 1: Determination of leakage emissions associated with storage of digestate ($LE_{storage,y}$)

This step applies in the case that the digestate is stored under the following anaerobic conditions:

- (a) In an un-aerated lagoon that has a depth of more than one meter; or
- (b) In a SWDS, including stockpiles that are considered a SWDS as per the definitions section.

Since the solid digestate will be outward transported and incinerated directly in thermal power plant and will not be stored under anaerobic conditions and the wastewater will be treated aerobically by wastewater treatment plant nearby, thus $LE_{storage,y} = 0$.

Step 2: Determination of leakage emissions associate with composting digestate ($LE_{comp,y}$)

$LE_{comp,y}$ shall be calculated using the methodological tool 13 “Project and leakage emissions from composting”. According to the tool, leakage emissions from composting ($LE_{comp,y}$) shall be accounted for if compost is subjected to anaerobic storage or disposed of in a SWDS.

However, tool 13 is not applicable due to the project does not involve digestate compost. Thus $LE_{comp,y} = 0$.

In conclusion, leakage emission is zero, $LE_y = LE_{storage,y} + LE_{comp,y} = 0$.

4.4 Estimated Net GHG Emission Reductions and Removals

As described in section 4.1, 4.2 and 4.3 above, for the first crediting period from 01/04/2020 to 31/03/2027,

$$BE_y = 2,592,251 \text{ tCO}_2\text{e};$$

$$PE_y = 79,154 \text{ tCO}_2\text{e};$$

$$LE_y = 0 \text{ tCO}_2\text{e};$$

$$ER_y = BE_y - PE_y - LE_y = 2,513,097 \text{ tCO}_2\text{e}$$

Therefore, during the first crediting period, the total ex ante estimated emission reduction is 2,513,097 tCO₂e, the average annual emission reduction is 359,014 tCO₂e.

The detail information can be obtained as below:

Year	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
01/04/2020~31/12/2020	123,262	3,173	0	120,089
01/01/2021~31/12/2021	247,876	6,379	0	241,497
01/01/2022~31/12/2022	333,526	8,584	0	324,942
01/01/2023~31/12/2023	392,920	10,112	0	382,808
01/01/2024~31/12/2024	433,369	12,538	0	420,831
01/01/2025~31/12/2025	460,967	15,613	0	445,354
01/01/2026~31/12/2026	480,703	18,141	0	462,562
01/01/2027~31/03/2027	119,628	4,614	0	115,015
Total	2,592,251	79,154	0	2,513,097
Average annual ERs	370,322	11,308	0	359,014

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	GWP _{CH₄}
Data unit	t CO ₂ e/t CH ₄
Description	Global warming potential of CH ₄
Source of data	IPCC
Value applied	28

Justification of choice of data or description of measurement methods and procedures applied	Default value of 28 from IPCC Fifth Assessment Report (AR5). Shall be updated according to any future COP/MOP decisions.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	NCV _{CH4}
Data unit	TJ/t CH ₄
Description	Net calorific value of methane at reference conditions
Source of data	Technical literature, ACM0001 version 19.0
Value applied	0.0504
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$\eta_{P,flare,m}$
Data unit	Dimensionless
Description	Flare efficiency in minute m
Source of data	"Project emissions from flaring" (Version 04.0)
Value applied	90%
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	ϕ_y											
Data unit	-											
Description	Model correction factor to account for model uncertainties for year y											
Source of data	“Emissions from solid waste disposal sites” (version 08.0)											
Value applied	0.85 <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>				Humid/wet conditions	Dry conditions	Application A	0.75	0.75	Application B	0.85	0.80
	Humid/wet conditions	Dry conditions										
Application A	0.75	0.75										
Application B	0.85	0.80										
Justification of choice of data or description of measurement methods and procedures applied	Default value suggested in the tool. The project selects Option 1: Use a default value to determine ϕ_y in the tool “Emissions from solid waste disposal sites” (version 08.0), and the project belongs to the situation of Application B, additionally, the climate is wet conditions based on the 23°C of average temperature of Guangzhou city and 1,722mm ³⁷ of annual mean precipitation,. thus 0.85 is chosen for ϕ_y .											
Purpose of Data	Calculation of baseline emissions											
Comments	-											

Data / Parameter	OX
Data unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied	0.1
Justification of choice of data or description of measurement methods and procedures applied	The landfill is covered with plastic film or soil, for conservative 0.1 was chosen.

³⁷ FSR

Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	F
Data unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	Using IPCC 2006 Guidelines default value
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	DOC _{f,y}
Data unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	Using IPCC 2006 Guidelines default value
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	MCF _y
------------------	------------------

Data unit	-
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied	1.0
Justification of choice of data or description of measurement methods and procedures applied	The nearly landfill of the project is controlled, including the following activities: (i) cover material; (ii) mechanical compacting; (iii) levelling of the waste. Therefore, 1.0 for anaerobic managed solid waste disposal sites is recommended by “Emissions from solid waste disposal sites (Version 08.0).”
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	DOC _j														
Data unit	-														
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)														
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)														
Value applied	Apply the following values for the different waste types j for MSW: <table border="1"> <thead> <tr> <th>Waste classification</th><th>DOC_j (% wet waste)</th></tr> </thead> <tbody> <tr> <td>Wood and wood product</td><td>43</td></tr> <tr> <td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr> <tr> <td>Food, food waste, beverage and tobacco (other than sludge)</td><td>15</td></tr> <tr> <td>Textiles</td><td>24</td></tr> <tr> <td>Gardens, yard and park was</td><td>20</td></tr> <tr> <td>Glass, metal and other inert waste</td><td>0</td></tr> </tbody> </table>	Waste classification	DOC _j (% wet waste)	Wood and wood product	43	Pulp, paper and cardboard (other than sludge)	40	Food, food waste, beverage and tobacco (other than sludge)	15	Textiles	24	Gardens, yard and park was	20	Glass, metal and other inert waste	0
Waste classification	DOC _j (% wet waste)														
Wood and wood product	43														
Pulp, paper and cardboard (other than sludge)	40														
Food, food waste, beverage and tobacco (other than sludge)	15														
Textiles	24														
Gardens, yard and park was	20														
Glass, metal and other inert waste	0														
Justification of choice of data or description of measurement methods and procedures applied	Using IPCC 2006 Guidelines default value														
Purpose of Data	Calculation of baseline emissions														
Comments	-														

Data / Parameter	k _j					
Data unit	1/yr					
Description	Decay rate for the waste type j					
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)					
Value applied	Apply the following default values for the different waste types j:					
	Waste type <i>j</i>		Boreal and Temperate(MAT≤ 20°C)		Tropical (MAT>20°C)	
			Dry (MAP/PET<1)	Wet (MAP/PET>1)	Dry (MAP <1000 mm)	Wet (MAP >1000 mm)
	Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0.06	0.045	0.07
		Wood, wood products and straw	0.02	0.03	0.025	0.035
	Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
	Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	0.40
	Note: 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.					

Justification of choice of data or description of measurement methods and procedures applied	The average temperature of Guangzhou city is 23 °C . The annual mean precipitation is 1,722mm ³⁸ , thus, the climate is classed as: Tropical (MAT>20°C), Wet (MAP >1000mm), and the value of k_j for this climate is applied for the project.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$EF_{grid,OM,y}$
Data unit	t CO ₂ /MWh
Description	Operating margin CO ₂ emission factor in year y
Source of data	"2019 Baseline Emission Factors for Regional Power Grids in China" published by DNA of China
Value applied	0.8042
Justification of choice of data or description of measurement methods and procedures applied	Official and authoritative statistic data.
Purpose of Data	Calculation of baseline emissions and project emissions
Comments	According to section 4.1, the ex ante option is selected to calculate $EF_{grid, OM,y}$ and fixed in the crediting period.

Data / Parameter	$EF_{grid,BM,y}$
Data unit	t CO ₂ /MWh
Description	Build margin CO ₂ emission factor in year y
Source of data	"2019 Baseline Emission Factors for Regional Power Grids in China" published by DNA of China
Value applied	0.2135
Justification of choice of data or description of measurement methods and procedures applied	Official and authoritative statistic data.

³⁸ FSR

Purpose of Data	Calculation of baseline emissions and project emissions
Comments	According to section 4.1, the ex ante option is selected to calculate $EF_{grid,BM,y}$ and fixed in the crediting period.
Data / Parameter	$EF_{grid,CM,y}$
Data unit	t CO ₂ /MWh
Description	Combined margin emission factor for the grid in year y
Source of data	Calculated based on “Tool to calculate the emission factor for an electricity system”
Value applied	0.50885
Justification of choice of data or description of measurement methods and procedures applied	$EF_{grid,CM,y}$ is calculated based on $EF_{grid,OM,y}$ and $EF_{grid,BM,y}$ as per the latest version of “Tool to calculate the emission factor for an electricity system” (version 07.0).
Purpose of Data	Calculation of baseline emissions and project emissions
Comments	According to section 4.1, For the project, the weight ω_{OM} and ω_{BM} are both 0.5 by default for the fixed crediting period. Thus, $EF_{grid,CM,y}=0.8042 \text{ tCO}_2/\text{MWh} * 0.5 + 0.2135 \text{ tCO}_2/\text{MWh} * 0.5 = 0.50885 \text{ tCO}_2/\text{MWh}$. The ex ante option is selected to calculate $EF_{grid, OM,y}$ and $EF_{grid,BM,y}$ and fixed in the crediting period, thus the $EF_{grid,CM,y}$ is fixed during the crediting period.

Data / Parameter	$EF_{CH4,default}$
Data unit	t CH ₄ leaked / t CH ₄ produced
Description	Default emission factor for the fraction of CH ₄ produced that leaks from the anaerobic digester
Source of data	IPCC (2006), Flesch et al. (2011) and Kurup (2003)
Value applied	0.028
Justification of choice of data or description of measurement methods and procedures applied	The digester with steel and gas tank and monolithic construction are installed by the project proponent
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	$f_{CH_4, default}$
Data unit	$m^3 CH_4 / m^3$ biogas corrected to reference conditions
Description	Default value for the fraction of methane in the biogas
Source of data	The default value was derived based on reported values from registered projects and research papers (Davidsson, 2007)
Value applied	0.6
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of project emissions
Comments	Use this value for Option 2 of the step “Determination of the quantity of methane produced in the digester”

Data / Parameter	R_u
Data unit	$Pa \cdot m^3 / kmol \cdot K$
Description	Universal ideal gases constant
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0)
Value applied	8,314
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	MM_i
------------------	--------

Data unit	kg/kmol
Description	Molecular mass of greenhouse gas CH ₄
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0)
Value applied	16.04
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	P _n
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0)
Value applied	101,325 Pa
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	T _n
Data unit	K
Description	Temperature at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0)

Value applied	273.15
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	$\rho_{i,n}$ & $\rho_{RG,n}$
Data unit	Kg gas i/m ³ gas I, i=RG=CH ₄
Description	Density of greenhouse gas CH ₄ in the gaseous stream at normal conditions
Source of data	Calculated in the section 4 of joint PD&MR as per the latest version of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0)
Value applied	0.71566
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	Applicable to Option A, $\rho_{i,n} = \rho_{RG,n} = 101,325\text{Pa} \times 16.04\text{kg/kmol} / (8314\text{Pa} \cdot \text{m}^3/\text{kmol} \cdot \text{K} \times 273.15\text{K}) = 0.71566 \text{ kg gas i/m}^3 \text{ gas i}$

Data / Parameter	TDL _{j,y} and TDL _{k,y}
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j or k in year y
Source of data	Methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0)
Value applied	TDL _{j,y} : 3% TDL _{k,y} : 3%

Justification of choice of data or description of measurement methods and procedures applied	According to the tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0), the project belongs to the case of Scenario A, use as default values of 3% for project emission since electricity consumption by all project electricity consumption sources is smaller than the electricity consumption of all baseline electricity consumption sources, and 3% for baseline emissions.
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	$RATE_{compliance,t,y}$
Data unit	Fraction
Description	Rate of compliance with a regulatory requirement to implement the alternative waste treatment t implemented in the project activity
Source of data	Ministry of Ecological Environment ³⁹
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	There is no regulatory requirement that mandates the use of anaerobic digestion to treat fresh waste according to the most recent information available from website of Ministry of Ecological Environment. Thus, $RATE_{compliance,t,y} = 0$.
Purpose of data	Calculation of baseline emissions
Comments	Calculated based on the number of instances of compliance identified at the time of the investment decision and updated once for every subsequent crediting period

5.2 Data and Parameters Monitored

Data / Parameter	f_y
Data unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y

³⁹ <http://www.mee.gov.cn/>

Source of data	ACM0022 (Version 03.0)
Description of measurement methods and procedures to be applied	According to the ACM0022 (Version 03.0), If the requirement does not specify any amount or percentage of LFG that should be destroyed but require the installation of a system to capture and flare the LFG, then it is assumed $f_y = 0.2$. In China, the requirement does not specify any amount or percentage of LFG that should be destroyed but require the installation of a system to capture and flare the LFG, then it is assumed $f_y = 0.2$.
Frequency of monitoring/recording	For application B: Annually
Value applied	0.2
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	There is only "Technical code for municipal solid waste sanitary landfill" (CJJ17-2004), which requires landfills to be equipped with effective landfill gas from a safety perspective and shall take the initiative to adopt flaring treatment method. However, due to financial and/or technical difficulties, these regulations have not been widely implemented in China. According to the Development Overview of China's Urban Domestic Waste Treatment Industry in 2014, by the end of 2013, China had a total of 942 waste landfills, but only about 50 of them collected and utilized landfill gas or burned it by torch. Meanwhile, from the paper of "Gas generation and collection and utilization in landfill" in 2015, most landfills in China are not equipped with gas collection devices, and the technology level is low, thus a large amount of gas is discharged in disorder. And although most landfills in China are not equipped with gas collection devices, the scenario M2 is more conservative option to M3. Please refer to section 3.4 for details.
Data / Parameter	W_x
Data unit	t

Description	Total amount of waste disposed in a SWDS in year x
Source of data	Measurements by project participants
Description of measurement methods and procedures to be applied	Measure on wet basis
Frequency of monitoring/recording	Continuously, aggregated at least annually for year x Recording monthly, aggregated annually
Value applied	The ex-ante value please refer to table 4-1, and the parameter will be monitored in the monitoring period.
Monitoring equipment	Weighbridge installed at the gate of the project site
QA/QC procedures to be applied	The project proponent will monitor the weight of the MSW regularly. The weighbridge will be calibrated annually.
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	For application B

Data / Parameter	$P_{n,j,x}$
Data unit	-
Description	Weight fraction of the waste type j in the sample n collected during the year x
Source of data	Sample measurements by project participants
Description of measurement methods and procedures to be applied	Sample the waste composition, using the waste types j, as provided in the table for DOC_j and k_j , and weigh each waste fraction (measure on wet basis)
Frequency of monitoring/recording	Minimum of three samples every three months
Value applied	The ex-ante value please refer to table 4-1, and the parameter will be monitored in the monitoring period.
Monitoring equipment	-
QA/QC procedures to be	-

applied	
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	For application B
Data / Parameter	Z_x
Data unit	-
Description	Number of samples collected during the year x
Source of data	Project participants
Description of measurement methods and procedures to be applied	Minimum of three samples every three months
Frequency of monitoring/recording	Continuously, aggregated annually
Value applied	-
Monitoring equipment	-
QA/QC procedures to be applied	The sample size and sampling technique must ensure the sample is representative. The samples will be measured by the project owner as per relevant standard.
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	For Application B and if the waste includes more than one waste type j

Data / Parameter	$EC_{BL,k,y}$
Data unit	MWh
Description	Quantity of electricity that would be consumed by the baseline electricity consumption source k in year y
Source of data	Electricity meter
Description of measurement methods	Electricity meter(s) and monthly recorded. All electronic data and paper documents will be archived for two

and procedures to be applied	years following the end of the crediting period.
Frequency of monitoring/recording	Monitoring continuously and recording monthly
Value applied	The ex-ante value please refer to section 4.1, and the parameter will be monitored in the monitoring period.
Monitoring equipment	Two bidirectional electricity meters M1(main meter) and M2 (backup meter) with accuracy of 0.5S are installed in the high voltage switch room of the project site.
QA/QC procedures to be applied	The data will be cross checked with sale receipts. The electricity meter(s) will be periodically checked and maintained. Calibration will be carried out annually to ensure normal operation.
Purpose of data	Calculation of baseline emissions.
Calculation method	-
Comments	$EC_{BL,k,y}$ is equivalent to the net amount of electricity generated by the alternative waste treatment process t and exported to the grid or displacing fossil fuel fired captive energy plant in year y ($EG_{t,y}$), which is the electricity exported by the project activity.

Data / Parameter	$EC_{PJ,j,y}$
Data unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data	Electricity meter
Description of measurement methods and procedures to be applied	Electricity meter(s) and monthly recorded. All electronic data and paper documents will be archived for two years following the end of the crediting period.
Frequency of monitoring/recording	Monitoring continuously and recording monthly
Value applied	0
Monitoring equipment	Two bidirectional electricity meters M1(main meter) and M2 (backup meter) with accuracy of 0.5S are installed in the high voltage switch room of the project site
QA/QC procedures to be	The data will be cross checked with purchase receipts. The

applied	electricity meter(s) will be periodically checked and maintained. Calibration will be carried out annually to ensure normal operation.
Purpose of data	Calculation of project emissions.
Calculation method	-
Comments	-
Data / Parameter	$Q_{CH_4, y}$
Data unit	t CH ₄ /y
Description	Quantity of methane produced in the digester in year y
Source of data	Calculated
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	-
Value applied	The ex-ante value please refer to section 4.2, and the parameter will be calculated based on ex-ante parameter $p_{i,n}$, the monitored parameters $V_{t,db,n}$, $v_{i,t,db}$ and operation hours in the monitoring period.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions.
Calculation method	-
Comments	-

Data / Parameter	$V_{t,db,n}$
Data unit	m ³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis at normal conditions
Source of data	Measured by a flow meter continuously and converted automatically by the recovery monitoring system

Description of measurement methods and procedures to be applied	The parameters of $V_{t,db,n}$ is measured by a flow meter continuously, which will be converted automatically into standard value $V_{t,db,n}$ (at the normal condition of 0 °C and 101,325 Pa) by the recovery monitoring system
Frequency of monitoring/recording	Monitoring continuously and recording monthly
Value applied	The data will be monitored ex post in the monitoring period. In the estimated net GHG emission reduction phase, the amount of biogas is estimated and calculated as per section 4, please refer to ER calculation sheet for details.
Monitoring equipment	Flow meter
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory for all projects applying large scale methodology(ies). Calibration will be carried out once every two years according to manufacturer's specifications.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	This parameter will be monitored in Option A

Data / Parameter	$F_{CH4,RG,m}$
Data unit	t CH ₄
Description	Mass flow of methane in the residual gas in the minute m
Source of data	Calculated
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	-
Value applied	The ex-ante value please refer to section 4.2, and the parameter will be calculated based on ex-ante parameter $\rho_{RG,n}$ and monitored parameters $V_{RG,t,db}$, $v_{i,t,db}$ and flare hours in the monitoring period.
Monitoring equipment	-

QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions.
Calculation method	-
Comments	-

Data / Parameter	$V_{RG,t,db}$
Data unit	m ³ dry gas/h
Description	Volumetric flow of the residue gas in time interval t on a dry basis at normal conditions
Source of data	Measured by a flow meter continuously and converted automatically by the recovery monitoring system
Description of measurement methods and procedures to be applied	The parameters of $V_{t,db,n}$ is measured by a flow meter continuously, which will be converted automatically into standard value $V_{t,db,n}$ (at the normal condition of 0 °C and 101,325 Pa) by the recovery monitoring system
Frequency of monitoring/recording	Monitoring continuously and recording monthly
Value applied	The data will be monitored ex post in the monitoring period. In the estimated net GHG emission reduction phase, the amount of biogas is estimated and calculated as per section 4, please refer to ER calculation sheet for details.
Monitoring equipment	Flow meter
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory for all projects applying large scale methodology(ies). Calibration will be carried out once every two years according to manufacturer's specifications.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	This parameter will be monitored in Option A

Data / Parameter	$v_{i,t,db} (v_{RG,t,db})$
Data unit	m ³ gas CH ₄ /m ³ dry gas

Description	Volumetric fraction of greenhouse gas CH ₄ in a time interval t on a dry basis
Source of data	Measured by continuous gas analyzer
Description of measurement methods and procedures to be applied	Continuous gas analyzer operating on dry basis. Volumetric flow measurement should always refer to the actual pressure and temperature.
Frequency of monitoring/recording	Monitoring continuously and recording monthly
Value applied	-
Monitoring equipment	gas analyzer
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory for all projects applying large scale methodology(ies). Calibration will be carried out annually according to the relevant national regulation.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	The value of both $v_{i,t,db}$ and $v_{RG,t,db}$ is same since the biogas from the same gas tank.

Data / Parameter	Operation hours (to calculate $Q_{CH_4,y}$) Operation hours (to calculate $F_{CH_4,RG,m}$)
Data unit	Hours
Description	The total operation hours of the project (to calculate $Q_{CH_4,y}$) The total operation hours of the flare (to calculate $F_{CH_4,RG,m}$)
Source of data	Project participants
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Monitoring hourly and recording monthly
Value applied	The data will be monitored ex post in the monitoring period. In the estimated net GHG emission reduction phase, $F_{CH_4,RG,m}$ and $Q_{CH_4,y}$

	are estimated and calculated as per section 4.2, please refer to ER calculation sheet for details.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions.
Calculation method	-
Comments	-

Data / Parameter	$V_{\text{purchased},y}$
Data unit	m^3
Description	Volume of the purchased biogas
Source of data	Measured by a flow meter continuously and converted automatically by the recovery monitoring system
Description of measurement methods and procedures to be applied	Measured by a flow meter continuously, which can be converted automatically into standard value $V_{\text{purchased},y}$ (at the normal condition of 0°C and $101,325\text{ Pa}$) by the recovery monitoring system
Frequency of monitoring/recording	Monitoring continuously and recording monthly
Value applied	2,000,000 (ex-ante)
Monitoring equipment	Flow meter installed in January of 2023
QA/QC procedures to be applied	Crosschecked by the settlement notes between the project owner and Grandtop Fushan Environmental Protection Energy Co., Ltd. Calibration should be carried out once every two years according to manufacturer's specifications
Purpose of data	Calculation of baseline emissions and project emissions
Calculation method	-
Comments	This parameter is measured only for period beyond 01-Jan-2023

5.3 Monitoring Plan

The monitoring plan presented in this joint PD&MR assures that real, measurable, long-term GHG emission reductions can be monitored, recorded and reported. It is a crucial procedure to identify the final VCUs of the project. This monitoring plan will be implemented by the project owner during the project operation period. The details of the monitoring plan are specified as follows:

(A) Data and parameters to be monitored

Data and parameters to be monitored are listed below shows the positions of the monitoring instruments and the corresponding parameters monitored can refer to section 5.3:

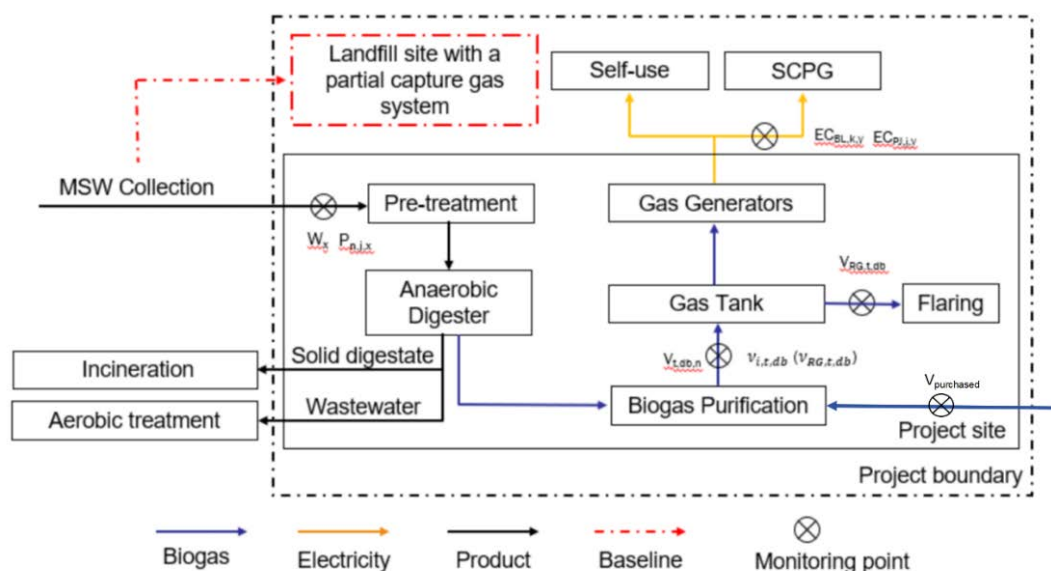


Figure 5-1 Project monitoring diagram

(B) Management Structure

The project owner organizes a specific VCS team in project development department to be responsible for data collection, supervision and witness the whole process of data measuring and recording. A VCS manager is appointed to take full responsibility for the overall monitoring of the project. The monitoring and measurement of extracted gas, electricity generation and consumption etc. are carried out by a few designated monitoring officers. In addition, the project developer appoints internal verifiers who is responsible for internal check of the measurement, collection of relevant receipts, and the calculation of the emission reductions. A

monitoring and management manual of the project that identifies detailed duties and responsibilities of the relevant parties is developed and served as the basis of the project monitoring. Figure 5-2 shows the operation and management structure of the project.

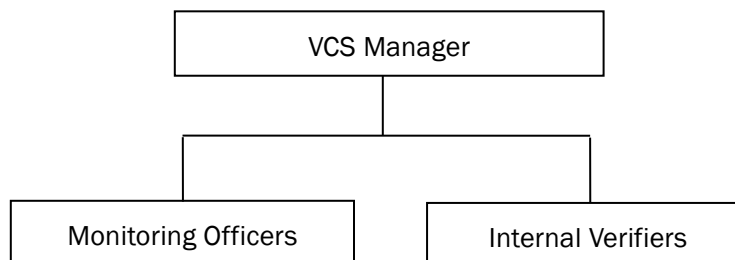


Figure 5-2 Operation and management structure of the project

(C) Data collection

Monitoring officers are responsible for data collection. Designated teams will read and collect the monitored data regularly. The computer system will automatically monitor and record relevant meter data. The relevant production data records will serve as the main data source for emission reductions calculation. All data files, relevant purchase and sales receipts will be collected by a designated monitoring officer, who will prepare backup in time and archive all documents properly.

(D) QA&QC

All metering equipment for monitoring will be chosen in accordance with VCS requirements and will be calibrated regularly for accuracy by qualified party according to the national regulations. The flow meter will be calibrated every two years as per Verification Regulation of Thermal Mass Gas Flowmeters (JJG 1132) or other national regulations. The weighbridge, electricity meters and gas analyzer will be calibrated annually according to the corresponding national regulations which are listed in below table.

Metering equipment	National regulations
Weighbridge	Verification Regulation for Digital Indication Weighing Instruments (JJG539) or others
Electricity meters	Verification Regulation of Electrical Meters for Measuring Alternating-current Electrical Energy (JJG596) or Technical Administrative Code of Electric Energy Metering (DL/T448) or others
Gas analyzer	Verification Regulation of Alarmer Detectors of Combustible Gas (JJG693) or others

To assist in future verifications, the project owner will preserve the calibration records, along

with the data files of project monitoring.

Error check routines will be established on site and at the point of data storage to detect data measuring/transmission failures as well as malfunctions. In the case of malfunction of the meters, the meter supplier will provide technical support to engage the problem promptly and emission reductions during the corresponding period will be calculated conservatively.

The installation of the electricity metering equipment will fulfill the requirements of the relevant national standard. The accuracy of the electricity meter is not lower than 0.5S. The accuracy of flow meters and gas analyzers will fulfill the relevant national standard. All the meters will be checked and maintained periodically. All metering equipment will be calibrated regularly for accuracy by qualified party according to the national regulations.

(E) Data file management

All monitoring data will be electronically filed by the end of each month and the electronic data files will be archived in both disk copy and printed hard copy. Other documents in paper e.g. maps, forms and environment assessment reports will be preserved as well. All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the crediting period. The project owner will provide original records and documents if necessary.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Data / Parameter	f _y	
Data unit	-	
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y	
Value applied:	Year	Value
	01/04/2020~31/12/2020	0.2

	01/01/2021~31/12/2021	0.2
Comments	According to the ACM0022 (Version 03.0), If the requirement does not specify any amount or percentage of LFG that should be destroyed but require the installation of a system to capture and flare the LFG, then it is assumed $f_y = 0.2$. In Guangdong province, the requirement does not specify any amount or percentage of LFG that should be destroyed but require the installation of a system to capture and flare the LFG, then it is assumed $f_y = 0.2$. There is only "Technical code for municipal solid waste sanitary landfill" (CJJ17-2004), which requires landfills to be equipped with effective landfill gas from a safety perspective and shall take the initiative to adopt flaring treatment method. However, due to financial and/or technical difficulties, these regulations have not been widely implemented in China. According to the Development Overview of China's Urban Domestic Waste Treatment Industry in 2014, by the end of 2013, China had a total of 942 waste landfills, but only about 50 of them collected and utilized landfill gas or burned it by torch. Meanwhile, from the paper of "Gas generation and collection and utilization in landfill" in 2015, most landfills in China are not equipped with gas collection devices, and the technology level is low, thus a large amount of gas is discharged in disorder. And although most landfills in China are not equipped with gas collection devices, the scenario M2 is more conservative option to M3. Please refer to section 3.4 for details.	

Data / Parameter	W_x	
Data unit	t	
Description	Total amount of waste disposed in a SWDS in year x	
Value applied:	Year	Value
	01/04/2020~31/12/2020	482,551.85
	01/01/2021~31/12/2021	654,072.84

Comments	For application B	
	In this monitoring period, the weighbridge is monitoring continuously and aggregated at least annually, and then recording monthly, aggregated annually.	
	The key information of the weighbridge installed at the gate of the project site is shown as below:	
	Monitoring equipment	Weighbridge
	Type	SCS-100/D2008
	Serial No	21050314BD
	Accuracy	III
	Calibration date	09/02/2020 02/02/2021
	Validity date	08/02/2021 01/02/2022

Data / Parameter	$P_{n,j,x}$	
Data unit	-	
Description	Weight fraction of the waste type j in the sample n collected during the year x	
Value applied:	The annual data is calculated based on the number of samples and each corresponding weight fraction of waste composition.	
	In this monitoring period, least three samples were collected by project owner every three months and which were measured according to the relevant standard. Please refer to ER spreadsheet for every sample data during this monitoring period.	
	Year	2020 2021
	Food	77.63% 77.80%
	Paper	6.28% 5.89%
	Garden and park waste	0.00% 0.00%
	Wood	0.00% 0.00%
	Others (Glass, plastic, metal, etc)	12.77% 12.70%
	Textile	3.32% 3.61%
Comments	-	

Data / Parameter	Z_x	
Data unit	-	
Description	Number of samples collected during the year x	
Value applied:	Year	Value
	01/04/2020~31/12/2020	16
	01/01/2021~31/12/2021	17
Comments	For Application B In this monitoring period, the number of samples collected is three at least every three months which is in line with the requirement of the methodology tool.	

Data / Parameter	EC _{BL,k,y}	
Data unit	MWh	
Description	Quantity of electricity that would be consumed by the baseline electricity consumption source k in year y	
Value applied:	Please refer to ER spreadsheet for monthly data.	
	Year	Value
	01/04/2020~31/12/2020	16,077.60
	01/01/2021~31/12/2021	23,276.00
Comments	EC _{BL,k,y} is equivalent to the net amount of electricity generated by the alternative waste treatment process t and exported to the grid or displacing fossil fuel fired captive energy plant in year y (EG _{t,y}), which is the electricity exported by the project activity.	
	In this monitoring period, the electricity is monitored continuously by electricity meter and the recorded at 24:00 on the last day of every month by remote reading system.	
	The key information of the electricity meters is shown as below:	
	Monitoring equipment	Electricity meter
Type	DSSD71	DSSD71
Serial No	001800010302	001800010306
Accuracy	0.5S	0.5S
Calibration date	05/02/2020 02/02/2021	05/02/2020 02/02/2021

	Validity date	04/02/2021	04/02/2021
		01/02/2022	01/02/2022

Data / Parameter	$EC_{PJ,j,y}$		
Data unit	MWh		
Description	Quantity of electricity consumed by the project electricity consumption source j in year y		
Value applied:	Please refer to ER spreadsheet for monthly data.		
Comments	Year		Value
	01/04/2020~31/12/2020		378.282
	01/01/2021~31/12/2021		2,574.692
	In this monitoring period, the electricity is monitored continuously by electricity meter and the recorded at 24:00 on the last day of every month by remote reading system.		
	The key information of the electricity meters is shown as below:		
	Monitoring equipment	Electricity meter	
	Type	DSSD71	DSSD71
	Serial No	001800010302	001800010306
	Accuracy	0.5S	0.5S
	Calibration date	05/02/2020 02/02/2021	05/02/2020 02/02/2021
	Validity date	04/02/2021 01/02/2022	04/02/2021 01/02/2022

Data / Parameter	$Q_{CH4,y}$		
Data unit	t CH ₄ /y		
Description	Quantity of methane produced in the digester in year y		
Value applied:	Please refer to ER spreadsheet for monthly data.		
	Year		Value
	01/04/2020~31/12/2020		8,534

	01/01/2021~31/12/2021	9,623
Comments	-	

Data / Parameter	$V_{t,db,n}$
Data unit	m ³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis at normal conditions

Value applied:

In this monitoring period, volumetric flow of the biogas is monitored continuously on a dry basis at normal conditions and the average value is recorded and calculated on a monthly basis.

Period	Value
01/04/2020~30/04/2020	2,695
01/05/2020~31/05/2020	3,333
01/06/2020~30/06/2020	3,542
01/07/2020~31/07/2020	3,417
01/08/2020~31/08/2020	3,417
01/09/2020~30/09/2020	2,193
01/10/2020~31/10/2020	2,286
01/11/2020~30/11/2020	2,917
01/12/2020~31/12/2020	2,580
01/01/2021~31/01/2021	2,500
01/02/2021~28/02/2021	2,871
01/03/2021~31/03/2021	2,649
01/04/2021~30/04/2021	2,417
01/05/2021~31/05/2021	1,917
01/06/2021~30/06/2021	2,375
01/07/2021~31/07/2021	3,231
01/08/2021~31/08/2021	3,083
01/09/2021~30/09/2021	2,661
01/10/2021~31/10/2021	2,610
01/11/2021~30/11/2021	2,292
01/12/2021~31/12/2021	1,789

Comments	This parameter is monitored in Option A	
	In this monitoring period, volumetric flow of the biogas is monitored continuously on a dry basis at normal conditions and the average value is recorded and calculated on a monthly basis.	
	The key information of the flow meter installed at inlet of the gas tank is shown as below:	
	Monitoring equipment	Flow meter
	Type	ZD7200MT5HEX
	Serial No	2106L3546001
	Accuracy	± 1.5%
	Calibration date	02/02/2020
	Validity date	01/02/2022

Data / Parameter	F _{CH₄,RG,m}	
Data unit	t CH ₄	
Description	Mass flow of greenhouse gas i in the in the residual gaseous stream in time interval t	
Value applied:	Please refer to ER spreadsheet for monthly data.	
	Year	Value
	01/04/2020~31/12/2020	3,119
	01/01/2021~31/12/2021	1,241
Comments	-	

Data / Parameter	V _{RG,t,db}	
Data unit	m ³ dry gas/h	
Description	Volumetric flow of the residue gas in time interval t on a dry basis at normal conditions	
Value applied:	In this monitoring period, volumetric flow of the remaining biogas is monitored continuously on a dry basis at normal conditions and the average value is recorded and calculated on a monthly basis.	

	Period	Value
	01/04/2020~30/04/2020	2,003
	01/05/2020~31/05/2020	1,688
	01/06/2020~30/06/2020	2,001
	01/07/2020~31/07/2020	2,001
	01/08/2020~31/08/2020	2,000
	01/09/2020~30/09/2020	2,108
	01/10/2020~31/10/2020	1,621
	01/11/2020~30/11/2020	2,202
	01/12/2020~31/12/2020	2,001
	01/01/2021~31/01/2021	1,528
	01/02/2021~28/02/2021	1,621
	01/03/2021~31/03/2021	1,625
	01/04/2021~30/04/2021	1,620
	01/05/2021~31/05/2021	2,108
	01/06/2021~30/06/2021	2,100
	01/07/2021~31/07/2021	1,765
	01/08/2021~31/08/2021	2,098
	01/09/2021~30/09/2021	1,688
	01/10/2021~31/10/2021	1,766
	01/11/2021~30/11/2021	2,000
	01/12/2021~31/12/2021	2,100
Comments	This parameter is monitored in Option A	
	In this monitoring period, volumetric flow of the remaining biogas is monitored continuously on a dry basis at normal conditions and the average value is recorded and calculated on a monthly basis.	
	The key information of the flow meter installed at inlet of the flare is shown as below:	
	Monitoring equipment	Flow meter
	Type	JF63N2
	Serial No	18101502
	Accuracy	0.5

	Calibration date	02/02/2020
	Validity date	01/02/2022

Data / Parameter	$v_{i,t,db}$ ($v_{RG,t,db}$)																																						
Data unit	m ³ gas CH ₄ /m ³ dry gas																																						
Description	Volumetric fraction of greenhouse gas CH ₄ in a time interval t on a dry basis																																						
Value applied:	In this monitoring period, volumetric fraction of the CH₄ in biogas is monitored continuously on a dry basis and recorded monthly. <table> <tr> <th>Period</th><th>Value</th></tr> <tr><td>01/04/2020~30/04/2020</td><td>63.69</td></tr> <tr><td>01/05/2020~31/05/2020</td><td>62.14</td></tr> <tr><td>01/06/2020~30/06/2020</td><td>61.54</td></tr> <tr><td>01/07/2020~31/07/2020</td><td>59.47</td></tr> <tr><td>01/08/2020~31/08/2020</td><td>61.87</td></tr> <tr><td>01/09/2020~30/09/2020</td><td>60.75</td></tr> <tr><td>01/10/2020~31/10/2020</td><td>59.88</td></tr> <tr><td>01/11/2020~30/11/2020</td><td>63.51</td></tr> <tr><td>01/12/2020~31/12/2020</td><td>61.56</td></tr> <tr><td>01/01/2021~31/01/2021</td><td>59.41</td></tr> <tr><td>01/02/2021⁴⁰~28/02/2021</td><td>62.9</td></tr> <tr><td>01/03/2021~31/03/2021</td><td>62.27</td></tr> <tr><td>01/04/2021~30/04/2021</td><td>60.9</td></tr> <tr><td>01/05/2021~31/05/2021</td><td>62.39</td></tr> <tr><td>01/06/2021~30/06/2021</td><td>61.24</td></tr> <tr><td>01/07/2021~31/07/2021</td><td>61.64</td></tr> <tr><td>01/08/2021~31/08/2021</td><td>63.08</td></tr> <tr><td>01/09/2021~30/09/2021</td><td>60.96</td></tr> </table>	Period	Value	01/04/2020~30/04/2020	63.69	01/05/2020~31/05/2020	62.14	01/06/2020~30/06/2020	61.54	01/07/2020~31/07/2020	59.47	01/08/2020~31/08/2020	61.87	01/09/2020~30/09/2020	60.75	01/10/2020~31/10/2020	59.88	01/11/2020~30/11/2020	63.51	01/12/2020~31/12/2020	61.56	01/01/2021~31/01/2021	59.41	01/02/2021 ⁴⁰ ~28/02/2021	62.9	01/03/2021~31/03/2021	62.27	01/04/2021~30/04/2021	60.9	01/05/2021~31/05/2021	62.39	01/06/2021~30/06/2021	61.24	01/07/2021~31/07/2021	61.64	01/08/2021~31/08/2021	63.08	01/09/2021~30/09/2021	60.96
Period	Value																																						
01/04/2020~30/04/2020	63.69																																						
01/05/2020~31/05/2020	62.14																																						
01/06/2020~30/06/2020	61.54																																						
01/07/2020~31/07/2020	59.47																																						
01/08/2020~31/08/2020	61.87																																						
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01/12/2020~31/12/2020	61.56																																						
01/01/2021~31/01/2021	59.41																																						
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01/06/2021~30/06/2021	61.24																																						
01/07/2021~31/07/2021	61.64																																						
01/08/2021~31/08/2021	63.08																																						
01/09/2021~30/09/2021	60.96																																						

⁴⁰ From 01/02/2021 onwards, the original monthly data of volumetric fraction of the CH₄ in biogas during period from is multiplied by (1+2.5%) in order to be conservative in this monitoring period. Please refer to footnote 41 for details.

	01/10/2021~31/10/2021	65.11
	01/11/2021~30/11/2021	63.11
	01/12/2021~31/12/2021	60.91
Comments	The value of both $v_{i,t,db}$ and $v_{RG,t,db}$ is same since the biogas from the same gas tank. In this monitoring period, volumetric fraction of the CH₄ in biogas is monitored continuously on a dry basis and recorded monthly. The key information of the gas analyzer installed at inlet of gas tank is shown as below:	
	Monitoring equipment	Gas analyzer
	Type	UE50
	Serial No	62387/2
	Accuracy	±2.5%
	Calibration date ⁴¹	02/02/2020 30/12/2021
	Validity date	01/02/2022 29/12/2022

Data / Parameter	Operation hours (to calculate $Q_{CH_4, y}$) Operation hours (to calculate $F_{CH_4, RG, m}$)				
Data unit	Hours				
Description	The total operation hours of the project (to calculate $Q_{CH_4, y}$) The total operation hours of the flare (to calculate $F_{CH_4, RG, m}$)				
Value applied:	In this monitoring period, operation hours of the project plant and flare are monitored continuously and recorded monthly by on-line production system. Please refer to ER spreadsheet for monthly data. <table> <tr> <td>Year</td><td>Operation hours (to calculate $Q_{CH_4, y}$)</td><td>Operation hours (to calculate</td></tr> </table>		Year	Operation hours (to calculate $Q_{CH_4, y}$)	Operation hours (to calculate
Year	Operation hours (to calculate $Q_{CH_4, y}$)	Operation hours (to calculate			

⁴¹ The calibration frequency of gas analyzer is recommended to be once every two years according to manufacturer's specifications. However, as a result of the calibration period shall not exceed 1 year as per "Verification Regulation of Alarmer Detectors of Combustible Gas (JJG693)", gas analyzer is out of calibration from 02/02/2021 to 29/12/2021 in this monitoring period. For conservativeness, the monthly volumetric fraction of the CH₄ in biogas during uncalibrated period should be corrected and calculated based on the accuracy of 2.5% in the calculation of project emission, which means the original monthly data of volumetric fraction of the CH₄ in biogas during period from 01/02/2021 to 31/12/2021 is multiplied by (1+2.5%).

			F _{CH4, RG, m})
	01/04/2020~31/12/2020	6,600	3,614
	01/01/2021~31/12/2021	8,760	1,501
Comments	-		

6.2 Baseline Emissions

According to the methodology ACM0022 (version 03.0), baseline emissions are determined based on the section 4.1. The BE_y is ex-post determined as the following equations:

$$\begin{aligned}
 BE_y &= BE_{CH_4,y} + BE_{EC,y} \\
 &= \phi_y \times (1 - f_y) \times GWP_{CH_4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^y \sum_j (W_x \times \frac{\sum_{n=1}^{Z_x} P_{n,j,x}}{Z_x} \times \\
 &\quad DOC_j \times e^{-k_j \cdot (y-x)} \times (1 - e^{-k_j}) + \sum_k EC_{BL,k,y} \times EF_{EL,k,y} \times (1 + TDL_{k,y})
 \end{aligned}$$

The fixed value $(\phi_y \times (1 - f_y) \times GWP_{CH_4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y)$ is calculated as 5.712 according to the ex-ante parameters in section 4.1.

$\sum_{x=1}^y \sum_j (W_x \times \frac{\sum_{n=1}^{Z_x} P_{n,j,x}}{Z_x} \times DOC_j \times e^{-k_j \cdot (y-x)} \times (1 - e^{-k_j}))$ is calculated based on the monitored data and parameters of section 5.1 and 6.1, which is ex post calculated value during this monitoring period as the follows.

Table 6-1 The ex-post calculation of $\sum_{x=1}^y \sum_j (W_x \times \frac{\sum_{n=1}^{Z_x} P_{n,j,x}}{Z_x} \times DOC_j \times e^{-k_j \cdot (y-x)} \times (1 - e^{-k_j}))$

Period	Food (t)	Paper (t)	Garden and park waste (t)	Wood (t)	Others (t)	Textile (t)	Total
01/04/2020~31/12/2020	18,525	820	0	0	0	260	19,604
01/01/2020~31/12/2021	16,868	971	0	0	0	357	18,197

BE_{CH4} is ex post calculated value during this monitoring period as the follows. Please refer to ER calculation spreadsheet for monthly data.

Table 6-2 The ex post calculation of $BE_{CH_4,y}$

Period	$BE_{CH_4,y}$ (t CO ₂ e)
01/04/2020~31/12/2020	111,980
01/01/2020~31/12/2021	215,921
Total	327,901

Therefore, $BE_{EC,y}$ is ex post calculated value during this monitoring period as the follows.

Table 6-3 The calculation of $BE_{EN,t,y}$ ($BE_{EC,y}$)

Period	$EC_{BL,k,y}$ (MWh)	$EF_{EL,k,y}$ (tCO ₂ /MWh)	$TDL_{k,y}$	$BE_{EN,t,y}$ ($BE_{EC,y}$) (t CO ₂ e)
01/04/2020~31/12/2020	16,077.600	0.50885	3%	8,426
01/01/2020~31/12/2021	23,276.000	0.50885	3%	12,199
Total	39,353.600	/	/	20,625

Therefore, during this monitoring period from 01/04/2020 to 31/12/2021, BE_y is ex post calculated value as the following table.

Table 6-4 The ex-post calculation of BE_y

Period	$BE_{EN,t,y}$ ($BE_{EC,y}$) (t CO ₂ e)	$BE_{CH_4,y}$ (t CO ₂ e)	BE_y (t CO ₂ e)
01/04/2020~31/12/2020	8,426	111,980	120,406
01/01/2020~31/12/2021	12,199	215,921	228,120
Total	20,625	327,901	348,526

Thus, the total baseline emission of the project is 348,526 t CO₂e during this monitoring period from 01/04/2020 to 31/12/2021.

6.3 Project Emissions

According to the methodology ACM0022 (version 03.0), baseline emissions are determined based on the section 4.2. The PE_y is ex-post determined as the following equations:

$$PE_y = PE_{AD,y} = PE_{EC,y} + PE_{CH_4,y} + PE_{flare,y}$$

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

$$PE_{CH_4,y} = Q_{CH_4,y} \times EF_{CH_4,default} \times GWP_{CH_4} = \frac{V_{t,db} \times v_{t,db} \times \rho_{in} \times h}{1000} \times EF_{CH_4,default} \times GWP_{CH_4}$$

$$PE_{flare,y} = GWP_{CH_4} \times \sum_{m=1}^{525600} F_{CH_4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3}$$

$$= GWP_{CH_4} \times V_{t,db} \times v_{RG,t,db} \times \rho_{RG,n} \times h \times (1 - \eta_{flare,m}) \times 10^{-3}$$

Therefore, $PE_{EC,y}$ is ex post calculated value during this monitoring period as the follows. Please refer to ER calculation spreadsheet for monthly data.

Table 6-5 The calculation of $PE_{EC,y}$

Period	$EC_{PJ,j,y}$ (MWh)	$EF_{EL,j,y} = EF_{grid,CM,y}$ (tCO ₂ /MWh)	$TDL_{j,y}$	$PE_{EC,y}$ (t CO ₂ e)
01/04/2020~31/12/2020	378.282	0.50885	3%	199
01/01/2020~31/12/2021	2,574.692	0.50885	3%	1,350
Total	2,952.974	0.50885	3%	1,549

Based on the monitored data and parameters of section 5.1 and 6.1, $PE_{flare,y}$ and $PE_{CH_4,y}$ are ex post calculated value during this monitoring period as the follows. $Q_{CH_4,y}$ and $F_{CH_4,RG,m}$ is calculated by above formula based on the monitored parameters in section 6.1.

Please refer to ER calculation spreadsheet for monthly data and detailed calculation.

Table 6-6 The calculation of $PE_{CH_4,y}$

Period	$Q_{CH_4,y}$ (t CH ₄)	$EF_{CH_4,default}$ (t CH ₄ leaked / t CH ₄ produced)	GWP_{CH_4} (tCO ₂ /tCH ₄)	$PE_{CH_4,y}$ (t CO ₂ e)
01/04/2020~31/12/2020	8,534	0.028	28	6,691
01/01/2020~31/12/2021	9,842	0.028	28	7,717

Total	18,376	/	/	14,408
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Table 6-7 The calculation of $PE_{flare,y}$

Period	$F_{CH_4,RG,m}$ (t CH ₄)	$\eta_{flare,m}$ (%)	GWP_{CH_4} (tCO ₂ /tCH ₄)	$PE_{flare,y}$ (t CO ₂ e)
01/04/2020~31/12/2020	3,119	90	28	9
01/01/2020~31/12/2021	1,271	90	28	4
Total	4,390	/	/	13

Therefore, during this monitoring period from 01/04/2020 to 31/12/2021, PE_y is ex post calculated value as the following table.

Table 6-8 The ex-post calculation of PE_y

Period	$PE_{EC,y}$ (t CO ₂ e)	$PE_{flare,y}$ (t CO ₂ e)	$PE_{CH_4,y}$ (t CO ₂ e)	PE_y (t CO ₂ e)
01/04/2020~31/12/2020	199	9	6,691	6,899
01/01/2020~31/12/2021	1,350	4	7,717	9,071
Total	1,549	13	14,408	15,970

Thus, during this monitoring period from 01/04/2020 to 31/12/2021, the total project emission of the project is 15,970 t CO₂e.

6.4 Leakage

According to the ACM0022 (Version 03.0), leakage emissions are associated with composting/co-composting, anaerobic digestion and the use of RDF/SB that is exported outside the project boundary.

And the waste by-products of the project do not involve compost or co-compost and the use of RDF/SB outside the project boundary. Leakage emissions associated with anaerobic digestion of waste ($LE_{AD,y}$) are calculated according to “TOOL14: Project and leakage emissions from anaerobic digesters” (Version 02.0).

According to the tool, the leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) depend on how the digestate is managed. They include emissions associated with storage and composting of the digestate. Since the solid digestate is outward transported and incinerated directly in thermal power plant and not be stored under anaerobic conditions and the wastewater is treated aerobically by wastewater treatment plant nearby during this monitoring period, leakage emission is zero, $LE_y = 0$.

6.5 Net GHG Emission Reductions and Removals

As described in section 6.2, 6.3 and 6.4 above, in this monitoring period from 01/04/2020 to 31/12/2021,

$$BE_y = 348,526 \text{ tCO}_2\text{e};$$

$$PE_y = 15,970 \text{ tCO}_2\text{e};$$

$$LE_y = 0 \text{ tCO}_2\text{e};$$

$$ER_y = BE_y - PE_y - LE_y = 332,556 \text{ tCO}_2\text{e}$$

This monitoring period is from 01/04/2020 to 31/12/2021 (Both days included), with totally 640 days. Based on the annual estimated emission reductions, the amount of emission reductions for this monitoring period would be 361,586 tCO₂e. The actual emission reductions in this monitoring period (640 days) are 332,556 tCO₂e, which is 8.03% lower than the estimation and at the normal fluctuation range. Thus, net GHG emission reduction during this monitoring period is considered to be reasonable. The detail information can be obtained as below:

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)
01/04/2020~31/12/2020	120,406	6,899	0	113,507
01/01/2020~31/12/2021	228,120	9,071	0	219,049
Total	348,526	15,970	0	332,556