

MOEJ/GEC JCM Feasibility Study (FS) 2014
Summary of the Final Report

“Recovery and Utilization of Biogas from Mixed-treatment of Waste and Septage”
(Implementing Entity: Kubota Corporation)

1. Overview of the Proposed JCM Project

Study partners	Nikken Sekkei Civil Engineering Ltd. - [Cosponsor] Study on waste, study on relevant laws The Japan Research Institute Ltd. - [Cosponsor] Development of JCM methodologies Kubota Environmental Service Co., Ltd. - [Subcontractor] Assisting evaluation of technologies implemented Hanoi Urban Environment Co.,Ltd. (hereinafter called “URENCO”) - [Principal project operator] Reporting to relevant organizations, study assistance Research Institute for Water Supply, Sewerage and Environment (“IWASSE”) - [Technical consultant] Technical advice, study assistance, etc.		
Project site	Cau Dien, Hanoi, Socialist Republic of Viet Nam		
Category of project	Waste and Biomass		
Description of project	The project intends to introduce a “methane fermentation system” at the CauDien institution which is an intermediate treatment facility in Hanoi City for the purpose of mixed treatment of the garbage (27t/day) contained in the municipal refuse which is collected and brought in to the same institution together with the septage sludge (50 m ³ /day). The collected biogas is replaced with the fossil fuel used at the medical waste treatment facility located in the same premise.		
Expected project implementer	Japan	KUBOTA	
	Host country	URENCO	
Initial investment	600,000 (thousand yen)	Date of groundbreaking	September, 2016
Annual maintenance cost	33,000 (thousand yen)	Construction period	12 months
Willingness to investment	Positive	Date of project commencement	September, 2017
Financial plan of project	As for financing, it is assumed [1] the capital requirement is fully funded by URENCO with budget to be applied for to Hanoi City or [2] the capital requirement is partially shared by KUBOTA by a method involving usage fee payment under a long-term agreement.		
GHG emission reductions	4,323 (tCO ₂ /year) *10 year average amount [1] Methane emission avoided 4,049 (tCO ₂ /year) [2] Internal fuel supply of light oil replaced 274 (tCO ₂ /day)		

2. Study Contents

(1) Project development and implementation

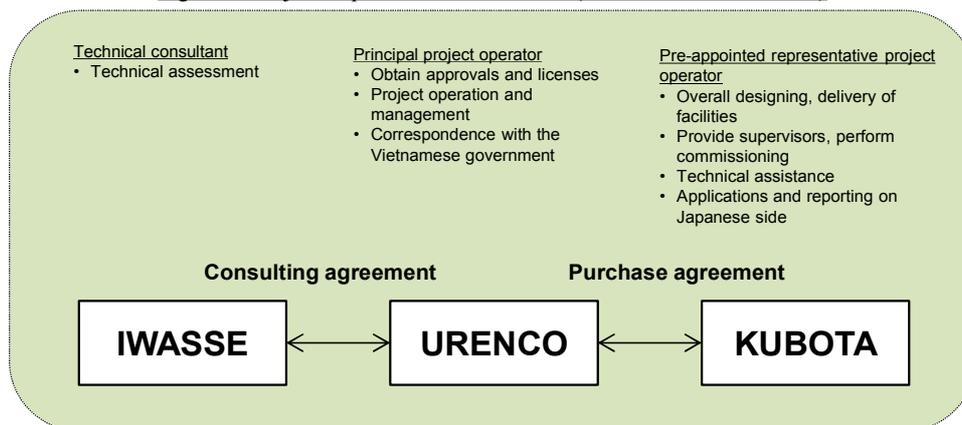
1) Project planning

The project intends to introduce a “methane fermentation system” at the CauDien institution which is an intermediate treatment facility in Hanoi City and is under study by URENCO, as the principal project operator, who controls the said institution. URENCO is a public corporation wholly owned by Hanoi City and is an organization responsible for controlling the waste materials created in the city.

The project system assumes implementation by an international consortium consisting of KUBOTA as a pre-appointed representative project operator together with URENCO in the JCM system and IWASSE as a technical consultant on Viet Nam side with their willingness for participation having been confirmed among the three parties.

[Figure 1] below shows the project implementation structure and sharing of roles. KUBOTA shall perform overall system designing/delivery of facilities, etc. based on a facility purchase agreement with URENCO. URENCO plans to entrust URENCO7, one of their subsidiaries (and the operator of the existing facilities) with facility operation as well as collecting and handling activities, which KUBOTA is expected to provide with operational supervision relative to facility maintenance.

Figure 1: Project implementation structure (international consortium)



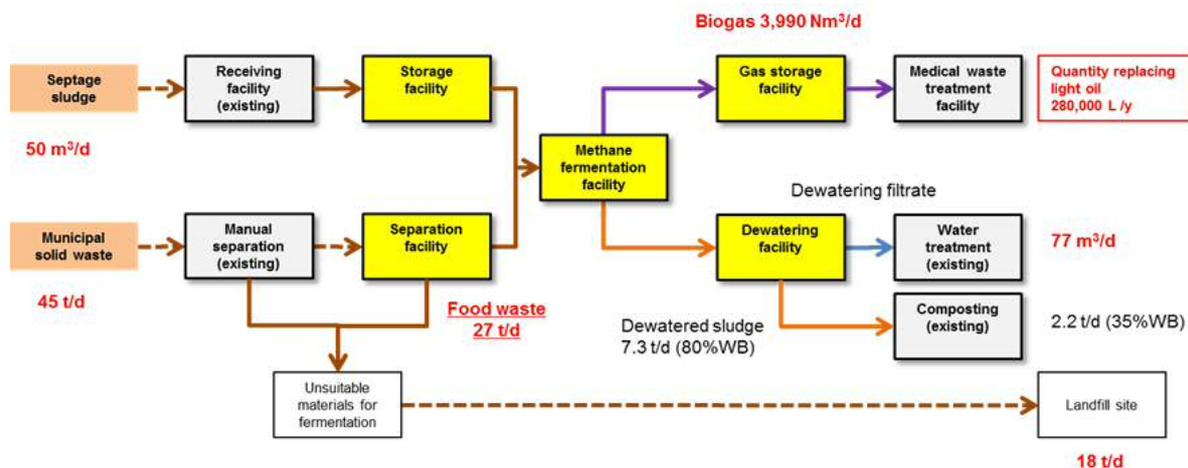
As to the schematic designing of the introduced system for the project plan, this study performs a field survey (survey on the existing facilities, sampling analyses on the waste materials, etc. laboratory testing to verify system applicability and survey on relevant laws, etc.) for the purpose of specifying [1] characteristics of the materials to be covered, [2] target values of performance/utilization of biogas and [3] design conditions.

[Figure 2] below shows the system flow of the introduced system and the material balance. The processing capacities are set at 45 t/day for the municipal solid waste and 50 m³/day for the septage and 27 t/day of garbage after excluding from the municipal solid waste the unsuitable materials for fermentation shall be covered for treatment. The planned facilities consist of [1] the storage facility for the septage sludge, [2] the separation facility for the garbage from the collected waste materials (combination of manual and mechanical separation), [3] the methane fermentation facility, [4] the biogas storage and supply facility and [5] the dewatering facility for the methane fermentation digestive fluid while it is assumed the existing facilities at the said business institution shall be utilized for receiving and separating the waste materials (manual separation yard), receiving the septage sludge, composting the dewatered sludge and treating the filtrate from sludge dewatering.

The destination for utilizing the recovered biogas is planned to be the steam boiler (new construction) at the hospital waste treatment facility controlled by URENCO in the same CauDien institution. At present, the hospital waste treatment at the institution is handled by operating the incineration facility which happens to fall in the renewal time due to aging after starting the common use in 1999. URENCO plans to renew the facility to an “evaporative sterilization processing facility (autoclave)” and start the common use within 2015, the new facility being introduced under the guidance of the Ministry of Natural Resources and Environment which has received an aid from the UNDP.

For the purpose of calculating the GHG reduction amount, however, the incinerating facility having operating results shall be used for setting up the pre-implementation premises for the project.

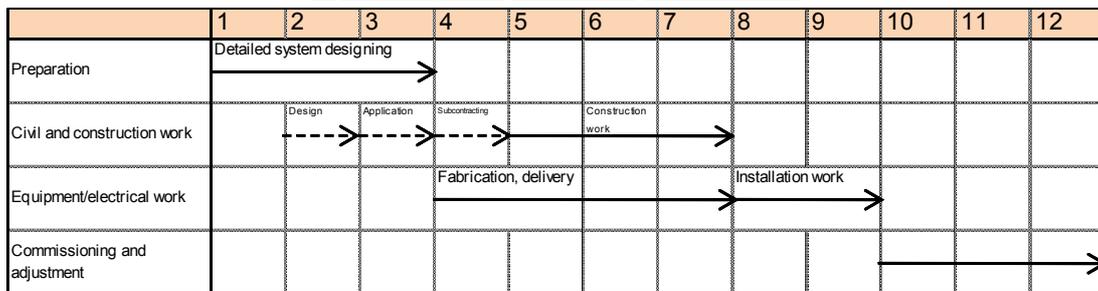
Figure 2: System flow of introduced facility



As for the site where the introduced facility is installed, acquisition of a new land, etc. is not necessary because some ground adjacent to the existing facilities including the hospital waste treatment facility will expectedly be made available (part of which is currently utilized as the storage yard for the compost). But, regarding actual implementation of the construction, an appropriate erection planning must be formulated and performed not to jeopardize the operational management of the existing facilities as well as for sufficiently ensuring safe control thereof.

The project implementation process schedule is shown in [Figure 3]. A 12 month period is required for obtaining the approval for construction start-up and concluding the contract through to the project completion, which consists of the planned 3 months for detailed system designing, 4 months for fabrication and delivery of the plant and equipment, 2 months for installation work and 3 months for commissioning and adjustment of the facilities. With regard to the equipment export from Japan, mainly machinery and instrumentation being assumed, will only be subject to ordinary customs procedures and delivery schedule to the site as they are regarded as ordinary facilities, etc.

Figure 3: Project implementation process schedule



[Table 1] shows the results of approximate calculation conducted by KUBOTA for estimating the initial investment for the introduced facility and the maintenance cost.

The initial costs for investment integrate those for constituent machinery exported from Japan and other adjacent countries and their transportation and custom duties and those for constituent machinery procured in Viet Nam and their local construction (including civil construction, equipment installation, piping and electrical work) as well as those for the detailed system designing and overhead costs, etc. all put together.

Table 1: Results of approximate calculation for estimating the initial investment for the introduced facility and the maintenance cost

(1 US\$ = 120 JPY)

Item	Content	Amount (US\$)
Initial investment cost	Facility cost, local construction cost	5,000,000
Annual maintenance cost	Electrical, chemicals and water supply cost, personnel cost, facility maintenance cost and MRV expenses, etc.	270,000/yesr

As for financing plan as a result of the discussion with URENCO, in addition to [1] the total financing by URENCO on the premise of the budget being applied to the Hanoi municipal government, a method is assumed where [2] KUBOTA shall share part of the construction cost and receive usage fee under a long-term agreement, but as URENCO is taking time for such decision making, the basic policy decision would be made by the end of the first half of 2015 as a target date. URENCO, in making its decision on investment from a waste disposal contractor’s standpoint is seemingly placing more emphasis on the consistency between the project plan and the master plan of Hanoi City for waste materials treatment rather than considering project viability such as the payout period of the investment as the judgment standard for contribution to the funding.

2) Permits and Licenses for the project development and implementation

As URENCO, the principal project operator, is a public corporation under the control of Hanoi City, it is required to obtain approvals from the Hanoi municipal government for budget application and implementation thereof. [Table 2] shows the approvals and licenses necessary for the implementation of the project and their schedule for acquisition. It is understood that implementation of the environmental impact assessment is subject to compliance with governmental ordinances, etc. which are required for enforcing the environmental protection law.

As the procedure for URENCO's facility purchase contract may vary depending on the financing method, further continuation of the discussions with URENCO may become necessary including coordination with the JCM.

Table 2: Project approvals and licenses

No.	Approval and licenses	Scheduled date of acquisition
1	Approval on preliminary feasibility study (pre-FS) for application of municipal budget	Submission by May, 2015
2	Approval on feasibility study (FS) for application of municipal budget	Submission by October, 2015
3	Environmental impact assessment	Submission by August, 2015
4	Budget approval by municipal council	June, 2015
5	Construction license	September, 2016
6	Pollution certificate, environmental certificate	September, 2017

3) Advantage of Japanese technology

The methane fermentation system to be introduced to the project should contribute not only to improving the inappropriate way of controlling waste materials prevalent in developing countries by treating/reducing the waste materials but also to substantially curtailing the GHG emissions by use of low-carbon technologies, the superiority of which can be summarized as follows.

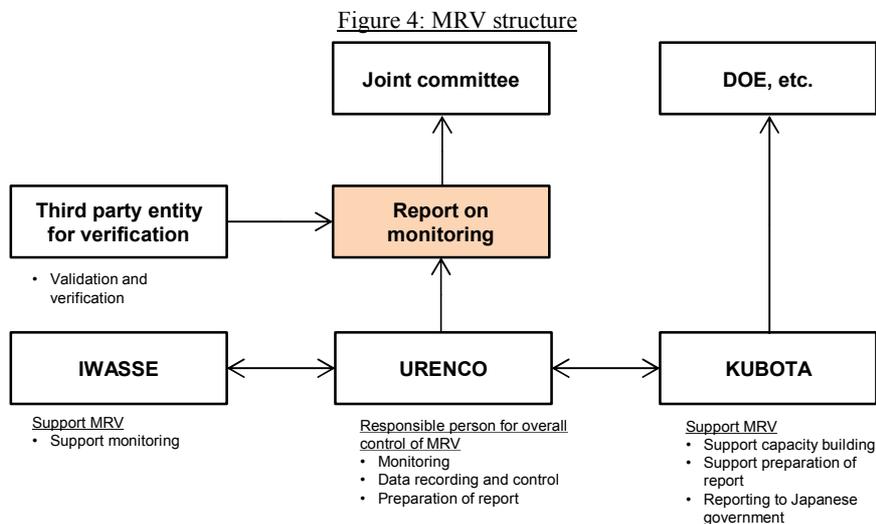
- The methane fermentation treatment method suitable for biomass with high moisture content such as garbage and septage sludge would enable collection and utilization of biogas to replace fossil fuels. (The current project envisages biogas replacing the light oil now used for incinerating the hospital waste.)
- As against the current status where the municipal refuse including garbage, etc. is reclaimed as landfill without separation and releases methane into the atmosphere, collection and utilization of biogas by means of the methane fermentation would make it possible to reduce the GHG emissions.
- The diffusion rate of sewage treatment in Viet Nam is rather low with the main treatment method for the domestic wastewater being the widely used septic tanks (simple and independent septic tanks to handle human waste only). The septage sludge created from cleaning the septic tanks is handled in an inappropriate way and discharged into the environment and such current status should be coped with by the methane fermentation method which can decompose, treat and stabilize the sludge in an appropriate way making it possible to reduce the GHG emissions.
- The mixed treatment of the garbage and septage sludge should help enhance de-polymerization effect of the low molecular compounds by solubilization and contribute to stabilizing the methane fermentation which realizes an effective collection of biogas. That is to say, the collection efficiency of biogas is thus enhanced.
- The fermentation liquor resulting from the methane fermentation can be used as recycled compost after dewatering leaving the ultimate residue being only the substances unsuitable for fermentation created during pre-treatment process prior to fermentation. Therefore, this contributes to reducing GHG emissions attributable to the transportation fuel used to transfer the materials to the final disposal site.

The competing technologies selectable among others for introduction by the host country in the absence of the support from the JCM can be assumed to be composting technologies. However, URENCO did introduce one composting technology back in 1993 and has carried over a problem of business management due to the quality of the compost and the demand instability and the overall evaluation of the project is not necessarily high.

Cases of other composting facilities introduced utilizing the sewage water sludge have been identified in other areas of Viet Nam, but actual cases of the compost being recycled to the agricultural land seem to be limited and even creating problems in the vicinity of the facilities requiring countermeasures for the offensive odor. As the superiority of the methane fermentation as compared to the composting technologies, collection of biogas and its utilization as energy can be pointed out. That is to say, the waste materials can be treated simultaneously while methane gas can be collected by decomposing organic materials which can be converted to heat or electricity enabling utilization of energy and thus can be an effective and very promising option for controlling waste materials particularly in urban areas, etc. where utilization of compost is rather limited.

4) MRV structure

As a result of discussions with URENCO regarding the MRV structure required by the JCM structure, the structure and the role sharing assumed at this time are shown in [Figure 4] below. It is planned URENCO shall have overall control of the MRV structure, conduct monitoring and preparation of reports, etc., entrust a third party entity with verification thereof and summarize the outcome. The candidate for the third party entity for verification shall be selected from the implementing agencies approved by the Japan-Viet Nam joint committee who have experience in examining and verifying the CDM validation. KUBOTA and IWASSE shall support these activities as necessary and reporting to the Japanese government shall be conducted by KUBOTA.



The required monitoring parameters and methods thereof are shown in [Table 3] in accordance with the methodology as proposed by this study.

For collection and analysis of the monitoring data, part of the existing facilities shall be utilized and automatic measuring instruments shall also be introduced to ensure continuous measurement and recording which shall be controlled by a person in charge of operation at URENCO7. The types of measuring instruments shall be selected on condition that they have good track record in Japan and are being calibrated by the certifying bodies in the host country.

As for the OJT (capacity building program) on MRV, it is assumed KUBOTA shall be responsible for the technical training along with the operational education/training on the facility operation and maintenance and

the practical routine for measuring and monitoring shall be acquired by URENCO7 through the OJT and so managed thereby. Also, for the purpose of ensuring a reliable performance of monitoring, it is assumed KUBOTA shall conduct periodical verification of the status of performance by checking the operational data, etc. under the facility maintenance agreement to be concluded with URENCO.

Table 3: Monitoring item and its method

No.	Monitoring parameters	Coverage	Measuring method
1	Amount of garbage input to anaerobic digester	Anaerobic digester	Flowmeter (constant)
2	Amount of septage input to anaerobic digester	Anaerobic digester	Flowmeter (constant)
3	Amount of heat generated by the project activity	Heat generating facility	Calorimeter (constant)
4	Amount of electricity generated by the project activity	Electricity generating facility	Wattmeter (constant)
5	Amount of electricity consumption of project activities	Substation facility	Wattmeter (constant)
6	Ratios of methane collected at landfill and allotted to flaring/combustion/utilization	Final disposal site	Hearing from proprietors/ public administration
7	Percentage of moisture in septage	Analytical laboratory	Sampling analysis
8	(Where quantity of garbage charged into anaerobic digester cannot be measured) Quantity of delivered waste	Waste collection/ receiving facility	Truck scale (total inspection)
9	(Where amount of heat supplied by heat recovery system cannot be measured) Quantity and concentration of biogas supplied by project facility	Biogas supply facility	Gas flowmeter/densitometer (constant)

5) Environmental integrity and Sustainable development in host country

As it is assumed the superiority of the Japanese technologies contributes to “improving the inappropriate waste management for garbage and septage”, an issue Viet Nam, the host country is subjected to and thus brings about environmentally favorable impacts, the implementation of the project can be regarded as a business model for diffusing the methane fermentation system made in Japan in Viet Nam (sales promotion). For ensuring such favorable impacts, it is important to secure organic waste materials which are used as the raw materials as well as establishing a business management structure which is capable of maintaining the facilities under an appropriate maintenance plan, which necessitates establishing a management structure and selecting the responsible official performing the management through close communication with URENCO for the purpose of determining the business implementation plan.

In addition, the following effects can be brought about expectedly as to the contribution to the sustainable development.

- Providing an “effective and inexpensive intermediate treatment technology” consistent with the regional characteristics of Viet Nam in the light of improved waste management and reduction of solid waste.
- Life extension of the final disposal site can be achieved by volume reduction treatment of waste.
- Environmental protection and public health are ensured by reducing inappropriate treatment of septage sludge.
- Investment payout is realized by the benefit of biogas produced by methane fermentation.
- The fermentation liquor resulting from the methane fermentation can be made into compost by dewatering contributing to realizing a recycling-oriented social shaping. (Compared to compositing garbage alone, the mixed treatment of waste and septage sludge effectively helps create high quality compost by decreasing salt content, etc.)
- Facility improvement and maintenance should favorably enhance personnel employment, etc.

6) Toward project realization (planned schedule and possible obstacles to be overcome)

This study has so far verified the sufficient feasibility of introducing the “methane fermentation system” to CauDien institution which is an intermediate treatment facility in Hanoi City but on the other hand further issues yet to be studied and verified have been identified such as [1] the financing method by URENCO is yet to be determined and [2] uncertainties still exist in the approval and licensing procedure including application for budget, etc. These issues shall continue to be studied in more details with URENCO even after completion of this study.

(2) JCM methodology development

1) Eligibility criteria

The eligibility criteria for the JCM methodology(ies) are as follows.

Table 4: Eligibility criteria

Criteria 1	Anaerobic digesters and system that is fuelled by the biogas are to be installed.
Criteria 2	The materials to be fed into the anaerobic digesters are garbage that would be disposed at a landfill site and septage that would not be properly treated in the absence of the project activity.
Criteria 3	The project secures the materials of the project activity and has a proper maintenance system that outlines a maintenance plan and equipment for monitoring activities.
Criteria 4	Anaerobic digester for wet mesophilic fermentation (30 to 38 degree Celsius) or wet thermophilic fermentation (50 to 55 degree Celsius) is to be installed.
Criteria 5	Biogas recovery rate is not less than 40 Nm3 per a tonne of garbage.
Criteria 6	Track record of installing anaerobic digester, which is used in the project activity is satisfied with the both criteria below. [1] More than two (2) projects to treat garbage or mix of garbage and septage (amount of those are more than 10 tonne per day) [2] More than two (2) projects of which fermentation method is equivalent to the one of the project.

The policy for establishing the above eligibility criteria is described as follows.

Table 5: Policy for establishing eligibility criteria

	Grounds for setup
Criteria 1	To identify the target technology covered by this methodology. As for effective utilization method for biogas, the individual project covered by this study assumes an autoclave (evaporative sterilization processing of hospital waste), but in anticipation of the same methodology being applied to similar projects in Viet Nam, it is provided that use of biogas shall not be limited to thermal utilization alone.
Criteria 2	To specify the raw materials put into the anaerobic digester which is introduced to the project.
Criteria 3	To ensure reduction of GHG emission by realizing continued maintenance of the project.
Criteria 4	To identify the target technology covered by this methodology. The individual project covered by this study plans to assume introducing a wet thermophilic (50°C–55°C) anaerobic digester but in anticipation of the same methodology being applied to similar projects in Viet Nam, it is provided that a wet mesophilic (30°C–38°C) system can be designated as the JCM project.
Criteria 5	To make the GHG emission reduction effective through project activities.
Criteria 6	To make the GHG emission reduction ensured through project activities.

2) Calculation of GHG emissions (including reference and project emissions)

In this study the methodology was developed with reference to UNFCCC's Approved consolidated methodology, ACM0022 (Version 1.0.0), Small-scale methodologies, AMS-III.AO (Version 1.0), AMS-I.C (Version 20.0) and Methodology Tool, "Emissions from solid waste disposal sites (Version 06.0.1). Also, attention has been paid to ensuring consistency with the methodology under development relative to the similar precedent project in Viet Nam.

In Hanoi City, the area covered by this project, the collected garbage are reclaimed in the landfill without any intermediate treatment and the septage sludge collected from households is disposed of in an inappropriate manner. This is reality of the situation regarding the municipal solid waste treatment and it is anticipated this situation should remain unchanged for some time for economic reasons.

Therefore, this study has considered methodologies with an established reference scenario i.e. "Should this project be not implemented, the garbage and septage sludge should continue to be disposed of by the above-mentioned methods releasing methane gas into the atmosphere as it is". However, as a result of the field survey, it has been known that the septage sludge has very high moisture content and very little degradable organic carbon content and, therefore, the subsequent methodology have eliminated it from GHG source coverage (but as mentioned above, its moisture content shall continue to be monitored).

(Calculation method for reference emissions) The calculation method for the reference emissions is shown below.

$$RE_y = RE_{CH_4,SWDS,y} + (EG_{thermal,y} / \eta_{thermal}) * EF_{FF,CO_2} + RE_{EC,y} \times EF_{e,y}$$

RE_y	Reference CO ₂ emissions during the period of year y (tCO ₂ /y)
$RE_{CH_4,SWDS,y}$	Reference emission occurring in year y generated from waste disposal at a SWDS during a time period ending in year y (tCO ₂ /y)
$EG_{thermal,y}$	The net quantity of steam/heat supplied by the project activity during the year y (TJ)
$\eta_{thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity
EF_{FF,CO_2}	CO ₂ emissions factor of the fossil fuel that would have been used in the reference plant (tCO ₂ /TJ)
$RE_{EC,y}$	The quantity of net electricity generation that is produced by the project activity in year y (MWh/y)
$EF_{e,y}$	CO ₂ emissions factor of electricity in year y (tCO ₂ /MWh)
y	Years of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)

$$RE_{CH_4,SWDS,y} =$$

$$\phi_y \times (1 - f_y) \times GWP_{CH_4} \times (1 - OX) \times 16/12 \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^y W_{j,x} \times DOC_j \times e^{-kj(y-x)} \times (1 - e^{-kj})$$

ϕ_y	Model correction factor 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)
16/12	Ratio of molar mass of carbon against methane
F	Fraction of methane in the SWDS gas (volume fraction)
$DOC_{f,y}$	Fraction of degradable organic carbon (DOC) that decomposes under specific conditions occurring in the SWDS for year y(weight fraction)
MCF_y	Methane correction factor for year y
$W_{j,x}$	Amount of organic waste type j disposed or prevented from disposal in the SWDS in the year x (t)
DOC_j	Fraction of degradable organic carbon (by weight) in the organic waste type j(weight fraction)
k_j	Decay rate for the organic waste type j(1/year)
j	Type of residual organic waste or types of organic waste in the MSW
x	Years in the time period in which organic waste is landfilled, extending from the first year in the time period (x=1) to year y(x=y)

(Calculation method for project emissions) The calculation method for the project emissions is shown below.

$$PE_y = PEC_y * EF_{e,y}$$

PE_y	Project emissions in the year y(tCO_2)
PEC_y	Project electricity consumption by applicable equipment (MWh/y)
$EF_{e,y}$	CO_2 emissions factor of electricity in year y (tCO_2 /MWh)

3) Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed below.

Table 6: Parameters fixed *ex ante*

No.	Parameter	Description of data	Value	Source
1	$EF_{e,y}$	CO2 emissions factor of electricity (tCO ₂ /MWh)	0.5408	Ministry of Natural Resources and Environment, Viet Nam
2	EF_{FFCO_2}	CO2 emission factor of the fossil fuel that would have been used in the reference plant (tCO ₂ / TJ)	72.6	IPCC2006 guidelines
3	$\eta_{thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity	1.0	Default value
4	ϕ_y	Model correction factor account for model uncertainties	0.85	Methodological Tool "Emissions from solid waste disposal sites" (version 06.0.1)
5	GWP_{CH_4}	Global Warming Potential of methane	21	IPCC2006 guidelines
6	f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere	0	Measures Value no less than regulatory value set by the government of Viet Nam
7	OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)	0.1	IPCC2006 guidelines
8	F	Fraction of methane in the SWDS gas (volume fraction)	0.5	IPCC2006 guidelines
9	DOC_f	Fraction of degradable organic carbon (DOC) that decomposes under specific conditions occurring in the SWDS (weight fraction)	0.5	IPCC2006 guidelines
10	MCF	Methane correction factor	1.0	IPCC2006 guidelines
11	DOC_j	Fraction of degradable organic carbon (by weight) in the organic waste type j (weight fraction)	15%	Default value
12	K_j	Decay rate for the organic waste type j (1/year)	0.17	Default value
13	j	Composition of organic waste type j (weight fraction)	100%	Default value

Among the above, the composition of degradable organic carbon (DOC_j) of the organic waste, the default value of the decay rate (K_j) have been selected from the values indicated by the GHG emission listing guideline IPC20006 (see listing below) so that the reference emission can be derived in a conservative manner.

Table 7: Composition of degradable organic carbon and decay rate of waste indicated by IPC2006 guideline

11	DOC _j	Fraction of degradable organic carbon (by weight) in the organic waste type j (weight fraction)	Wood and wooden product 43% Paper 40% Food waste 15% Fabric 24% Garden and park waste 20% Inorganic matters such as glass and plastic 0%
12	K _j	Decay rate for the organic waste type j (1/year)	Wood and wooden product 0.035 Food waste 0.4 Paper and fiber 0.07 Others, organic waste other than food 0.17 IPCC (Tropical (MAT > 20°C) Wet, MAP > 1000 mm)