Project design document form for CDM project activities

(Version 08.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Sudokwon Landfill Gas Electricity Generation Project (50MW)
Version number of the PDD	Version_ 08.0
Completion date of the PDD	24/July/2017
Project participant(s)	Sudokwon Landfill site management Corporation (SLC) - DASCO Patners LLP - Ecoeye Co.,Ltd
Host Party	Republic of Korea
Applied methodology(ies) and, where applicable, applied standardized baseline(s)	- ACM0001 version 04 – "Consolidated baseline methodology for landfill gas project activities" - ACM0002 version 06– "Consolidated baseline methodology for grid-connected electricity generation from renewable sources.
Sectoral scope(s) linked to the applied methodology(ies)	Sectoral Scope : 01, 13
Estimated amount of annual average GHG emission reductions	1,210,342

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SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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As activities of transforming waste gas into resources, Sudokwon Landfill site Management Corporation (from here after SLC) have decided to install Landfill Gas (from here after LFG) power plant after reviewing a plan of medium/high energy content gas production and electric power generation in 2000. LFG collection potential rate is about 75%, generating capacity of this plant was determined as 50MW. This project activity involves this specific type of installation[1].

The main objectives of this project are (1) to destruct methane more efficiently (2) to reduce green house gas and (3) to construct clean generation system with renewable energy.

The Sudokwon Landfill is the largest dumping site in Korea, dealing with wastes from Seoul, Inchon and Kyonggi province. From 1992 to 2005 cumulative waste amounts 97,074 kilo tonnes and yearly average waste to 6,934 kilo tonnes.[2] The landfill site is composed of 4 sites. 1st site was reclaimed from 1992 to 2000 and 2nd site which succeeded 1st site has been reclaimed since 2000. 3rd and 4th site are plan to be reclaimed in the future. Central incineration station is composed of 6 units. 4 units was installed in 1996 as 1st phase and the other 2 units in 1998 as 2nd phase. Existing 6.5MW power plant was installed in 2001 and 3.38MW power plant in 2003.

In previous decade, most of the LFG was destroyed by central flaring facility and only the rest was destroyed by 6.5MW & 3.38MW power plant. In 2004, 87.2 % of LFG was flared and 11.9 % of LFG was used for generation. When 50MW power plant is installed, most of LFG will be destroyed by this facility and only the rest will be destroyed by 6.5MW & 3.38 MW power plant and central flaring facility. Also, existing temporary burners will be pulled down and a park will be installed at this location, which results in improvement of LFG collection rate.[3]

This project is composed of (1) expansion of the collection system and (2) construction of the 50MW LFG power plant using steam turbine which replaces the existing facilities. It is expected to reduce 12,103,416 tCO_2e green-house gases during 10 years, from 2007 to 2017.

This project will contribute to Sustainable Development as following;

- Reducing green house gas by eliminating CH_4 in LFG
- Replacing conventional fossil-fuel generation system with renewable energy technology
- Improving local environment (i.e. removing offensive odour) and removing elements threatening health of the residents
- Reducing the possibility of the explosion caused by LFG leakage

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[1] MoE, EMC, Jun 2000, Sudokwon Landfill Waste gas Resourcification Basic Plan

[2] Refer to Sudokwon Landfill Site Statistics Year Book (2005)

[3] The 9.88MW power plant had not been operated since 03/2007 due to the technical problem. Therefore, the rest of LFG which is not treated in 50MW power plant was destroyed by central flaring facility only. Regarding the stoppage of 9.88MW power plant, the request for review was made by CDM EB during 1st request for issuance. In accordance with the request for review of CDM EB, emission from the electricity generated by the existing 9.88MW power plant are regarded as baseline emissions and therefore should be deducted from emission reductions generated by the project activity. It has been applied from the first verification.
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A.2. Location of project activity

A.2.1. Host Party

>> Republic of Korea

A.2.2. Region/State/Province etc.

>> Incheon

A.2.3. City/Town/Community etc.

>> Seo-ku Baeksuk-dong

A.2.4. Physical/Geographical location

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The landfill site is located nearby Seoul, Incheon and Gyeonggi-do. It ranges the north latitude over 37 °33 '~ 37 °37' and the east longitude ove r 126°33'~ 126°40'. It is located 30km west of Seoul and constructed on reclaimed land. Yellow Sea is located in the south-west part of site and inland area does in the north-east part of site. Total area of Sudokwon landfill site is 9,025,000 m^2, the largest in Korea and is planned to be filled-up with waste from Sudokwon over 30 years. Landfill site is composed of 4 sites. 1st site has been filled-up with waste of Seoul and Sudokwon from 1992 to 2000, 2nd site is currently being filled-up and 3rd and 4th site are plan to be filled-up after 2013. In addition, environment management facilities are located nearby this site.

Figure 1 location of the Sudokwon Landfill site

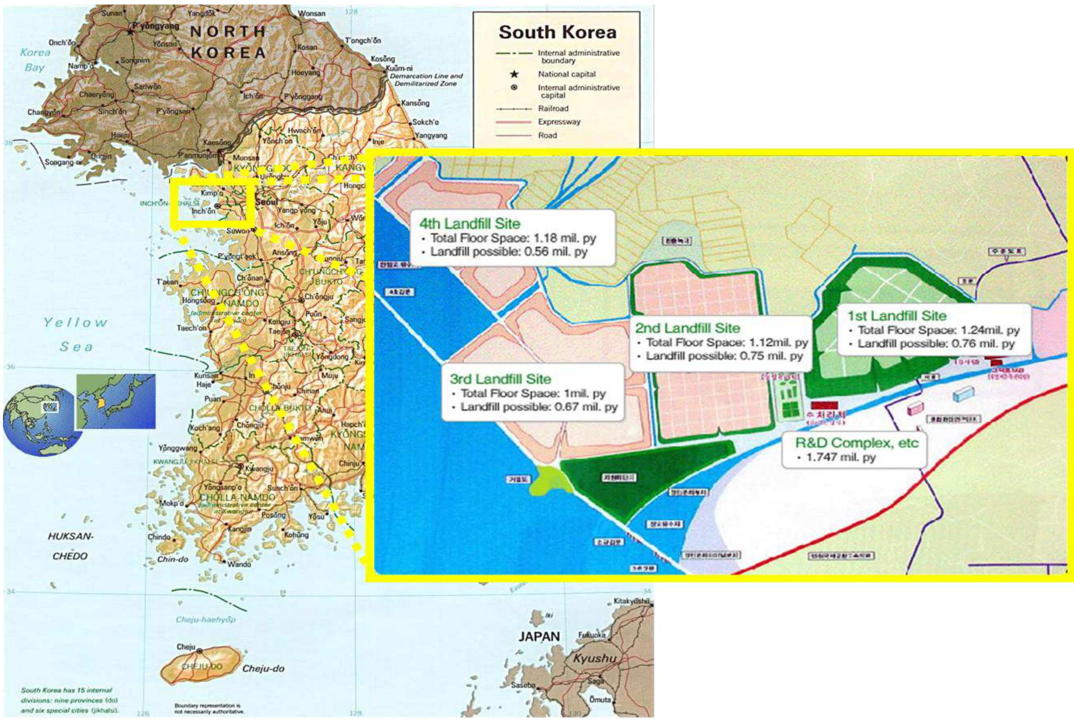

Table 1 Sudokwon Landfill Area, Capacity, and Period of Landfilling

	Site Area	Landfilling Area	Landfilling Capacity	Period of Landfilling
Site 1	4.10 mil ㎡	2.51 mil ㎡	64 mil ton	Feb 1992~ Oct 2000
Site 2	3.70 mil ㎡	2.48 mil ㎡	67 mil ton	Oct 2000 ~ Sep2010
Site 3	3.31 mil ㎡	2.21 mil ㎡	97 mil ton	After 2013
Site 4	3.90 mil ㎡	1.82 mil ㎡		
Others	4.89 mil ㎡	(Comprehensive Environment Management Facilities etc)		
Total	19.90 mil ㎡	9.02 mil ㎡	228 mil ton	

Source: Sudokwon Landfill Site Management Corp homepage (http://www.slc.or.kr), 2006

A.3. Technologies and/or measures

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Landfill Gas Collection System

Construction of 1st site for stabilization is completed in Dec. 2004, and LFG is collected by existing horizontal pipes and new vertical pipes. These vertical pipes are installed as additional facilities for 50MW power plant.

Reclamation of 2nd site is on progress and vertical pipes are installed on reclamation for maximizing LFG collection efficiency, which makes LFG from 2nd site increase.

In case of normal operation, LFG is plan to be used by 50MW power plant and in case of emergency maintenance it is flared by central flaring facility.

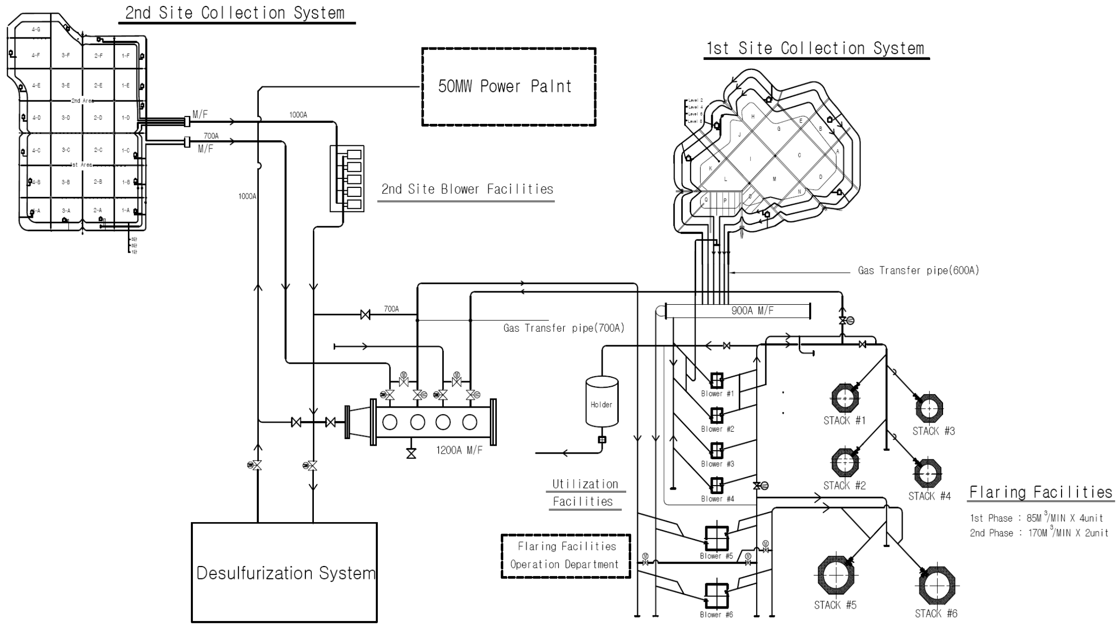
Major specification of collection system is as below.

Table 2 Major specification of Sudokwon LFG Collection system

	Total	1st site				2nd site			
		Level 2	Level 4	Level 6	Level 8	Area 1		Area 2	
						Level 1	Level 3	Level 1	Level 3
Transferring pipe	35.0㎞	6.4㎞	6.2㎞	6.0㎞	-	3.1㎞	4.5㎞	3.6㎞	5.0㎞
Collection pipe (horizontal)	87ea	-	-	24ea	24ea	39ea	-		
Collection pipe (vertical)	1,088ea	-	2ea	2ea	385ea	-	326ea		373ea
Gas distribution pipes	75ea	-	-	31ea		-	20ea		24ea
Blowers	11sets	100HP×4set, 170HP×2set, 250HP×5set							

Source: Sudokwon Landfillsite LFG Electricity Generation project Management & Operation Manual 2017.2

Figure 2 50MW project LFG Collection and Decomposition facilities



Generating System

50MW Boiler is supplied and installed by Doosan Heavy Industry and steam turbine by MHI(Mitsubishi Heavy Industry).

Boiler has the process as following; flue gas is generated by combustion of CH_4 in combustor, this flue gas produces steam by heat-transfer to heating surface and is supplied to turbine. This boiler is semi-open, Drum, Natural draft and Forced draft type which has simple structure and is easy to operate. As a fuel, LPG is used for start-up and LFG for normal operation.

Major specification of boiler is as below

- Steam Flow : 106.2 ton/hr (@BMCR)
- Steam Pressure : 100 ㎏/㎠·g (@BMCR)
- Steam Temperature: 539 ℃
- Efficiency : 82.4 % @ HHV, ASME Condition

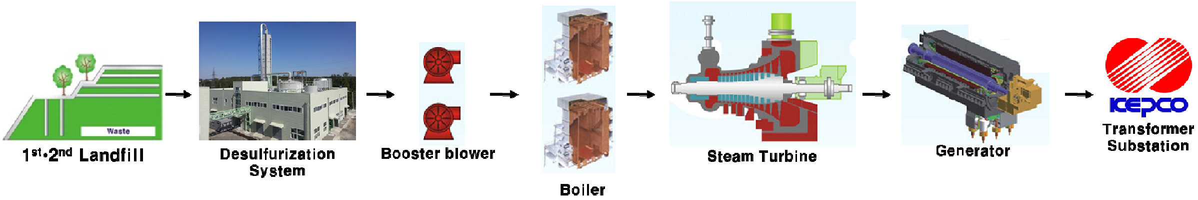
This project adopts steam turbine for following reasons; (1) Steam turbine produces pollutant less than other alternatives (i.e. gas engine, gas turbine, HRSG etc.) (2) it needs no pretreatment facilities (3) low quality LFG can be used (4) when generating capacity exceeds 10MW, it is economically more attractive than other alternatives.

Most of thermal energy of superheated steam supplied by boiler is converted to kinetic energy which operates generator, some of thermal energy is used for heating feed water and the rest are transferred to circulation system by condenser. Supplied turbine is single casing, non-reheating, recycling and condensing one.
Major specification of steam turbine is as below

- Power : 50,000 kW
- Steam Temperature and Pressure: 536 ℃, 95 ㎏/㎠·g
- Rotation per minute : 3,600 rpm
- Steam Flow: 184,300 ㎏/hr (@MGR)

- Heat Consumption: 2,201.4 ㎉/㎾ h (@MGR)

Figure 3 Steam Turbine and electricity grid system flow chart



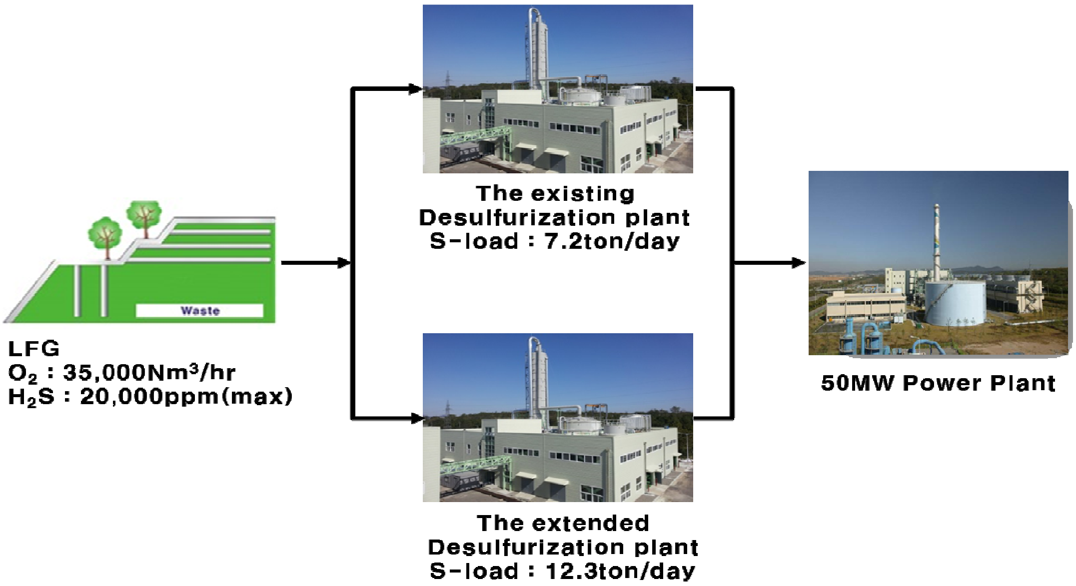
Major specification of transmission system is as below

- Spec. : 154kV 1 line, 240 ㎟
- Overhead transmission tower : 29 unit
- Overhead transmission line : 7.615km
- Connection point : KEPCO Kyeyang Substation

Ecoenergy, operator of 50MW power plant, planned to install the sulfurization system in 2010, due to government policy[4] which is regulation of total emission on SOx and Ecoenergy completed the desulfurization system in 2014. And The extended desulfurization construction has begun in 2015 and it is expected to operate from 2017.
The Desulfurization System is installed by PAQUES(Netherland), major specification of desulfurization system is as below

- Capacity : 35,000 Nm^3/ hr(Maximum 42,000 Nm^3/ hr)
- Inlet temperature of LFG : 15~65℃
- Inlet H_2S concentration : 12,000ppm(Maximum 20,000ppm)
- Outlet H_2S concentration : below 200ppm
- Efficiency : Average 98.3 %(Maximum 99.0%)

Figure 4 The Desulfurization System flow chart



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[4] Enforcement ordinance of Special Act on Seoul Metropolitan Air Quality Improvement (No. 236, enforced as of 1 July. 2007) http://www.law.go.kr/LSW/lsInfoP.do?lsiSeq=79525&ancYd=20070628&ancNo=00236&efYd=20070701&nwJoYnInfo=N&efGubun=Y&chrClsCd=010202#0000

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Korea (host)	Sudokwon Landfill site management Corporation (SLC)	No
(Annex1)	DASCO Partners LLP Ecoeye Co.,Ltd	No

A.5. Public funding of project activity

>> There is no public funding for this Project

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

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- ACM0001(version 04) : "Consolidated baseline methodology for landfill gas project activities"
- ACM0002(version 06) : "Consolidated baseline methodology for grid-connected electricity generation from renewable sources."

B.2. Applicability of methodology and standardized baseline

>>

ACM0001 is applicable to the following situations in regard to LFG activities where:

a) The captured gas is flared; or

b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are
claimed for displacing or avoiding energy from other sources; or

c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy from other sources.

The project activity corresponds to situation c) and is therefore applicable to ACM0001.

ACM0001 states that in area of c), the approved consolidated baseline methodology for grid-connected electricity generation from renewable sources can be applied (ACM0002).

ACM0002 is applicable to grid-connected renewable power generation project activities amongst others under the following conditions:

- Applies to grid connected electricity generation from landfill gas capture to the extent that it is combined
with the approved "Consolidated baseline methodology for landfill gas project activities" (ACM0001).

The project activity corresponds to the situation described above and is therefore applicable to ACM0002.

B.3. Project boundary

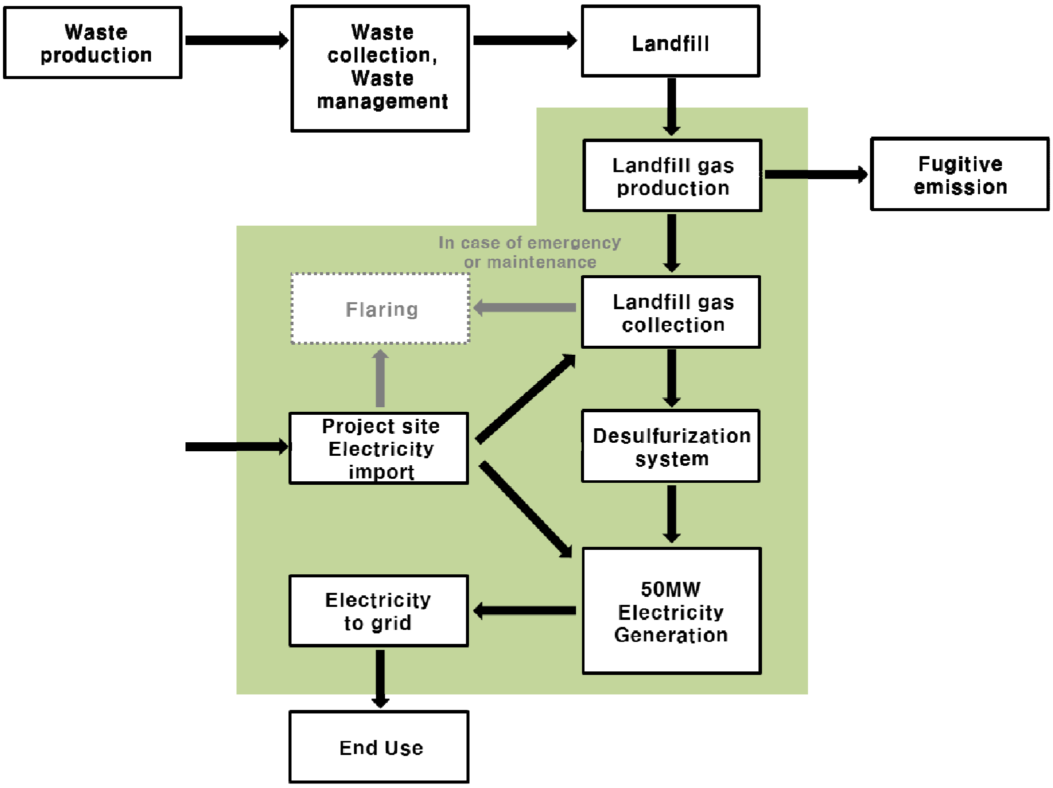
In case of normal operation, LFG is plan to be used by 50MW power plant mainly and in case of emergency or maintenance it is flared by central flaring facility. 50MW LFG power plant is designed to consider estimated LFG emission amount from 1st and 2nd site of SLC. So, when 50MW power plant is operated, most of LFG from these sites will be covered by this huge LFG

power plant. But in case of emergency or maintenance rest of LFG will be flared by central flaring facility. Additionally, the desulfurization facility is expected to operate in 2013.

The spatial extent of the project boundary includes landfill site, gas collection and decomposition systems. For accuracy, decomposition system boundary include not only 50MW LFG power plant as main facility of methane decomposition, but also existing facilities as spare facilities.

Electric Grid system also include, because generated electricity from LFG Power plant will be connected to KEPCO (Korea Electric Power Corporation) grid system.

Figure 5 project boundary



Emission sources and gases that are included in the project boundary are listed in the below table:

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from landfill site	CO_2	*No*	Excluded for carbon neutral emissions
		CH_4	*Yes*	Major emission sources
		N_2O	*No*	Excluded for simplification
	Emissions from power grid	CO_2	*Yes*	Major emission sources
		CH_4	*No*	Excluded for simplification
		N_2O	*No*	Excluded for simplification
Project scenario	Emissions from landfill site	CO_2	*No*	Excluded for carbon neutral emissions
		CH_4	*No*	Excluded for not included in baseline scenario
		N_2O	*No*	Excluded for simplification
	Emissions from project activities	CO_2	*Yes*	Total amount of LPG for 50MW LFG power station start-up
		CH_4	*No*	Excluded for simplification
		N_2O	*No*	Excluded for simplification

B.4. Establishment and description of baseline scenario

>> Although there is provision for LFG treatment facility equipment in regulation of Ministry of Environment[5]. It is not forcible regulation on LFG only concentrated on security factor and there are still many barriers and no implementation on the whole landfill in Republic of Korea. According “Landfill site Management Status” from MoE[6], there are total 232 landfill sites at the middle of 2006. Only a few sites (18 sites) have operated simple control facilities avoiding explosion of methane aggregation, the other sites have been status of atmospheric release of LFG gas.

The active collection and flaring of LFG is not mandatory at Sudokwon Landfill Corporation(SLC), but SLC have operated LFG treatment facilities; central flaring facility (since 1997) and 6.5MW and 3.38MW gas engine power plants (each since 2001, 2003) as voluntary act before the provision of LFG treatment facility equipment was stipulated.

In a conservative manner, baseline scenario is defined as to continue the current situation, landfill gas will be captured and destroyed with existing gas collection and flaring facilities. This scenario applies to calculate Adjustment Factor (AF).[7] Further details are described in section B.6

B.5. Demonstration of additionality

>> The ACM0001 methodology requires the use of the “Tool for the demonstration and assessment of additionality” to demonstrate and assess additionality.
The “Tool for the demonstration and assessment of additionality” (Made in EB 16th meeting, Revised 28 November, 2005) is applied as follows.

Step 0. Preliminary screening based on the starting date of the project activity[8]

According to Project Basic Plan (Jun.2000), it is mentioned that baseline / emission reduction amount estimation, financial analysis with carbon credit, contract etc[9]. This is the evidence that 50MW LFG power plant project was considered as CDM. But the actual methane destruction crediting period is expected to start on 15th December, 2006; by then, Step 0 is not applicable.[10]

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5 Table 7. waste treatment facility standard(Last revised on 11. Aug. 2004.) In waste control enforcement regulations(ministry of environment enforcement decree No. 179) regulate that if gas is generated during reclamation of organic waste, incineration facility (i.e. flaring, generating system) should be equipped.

6 This data is available in Korean from MoE Homepage
http://www.me.go.kr/dev/info/info_view.jsp?code=A6&dept=&key=&search=&search_regdate_s=&search_regdate_e=&inpymd=20060712100804

7 Regarding the stoppage of 9.88MW power plant, the request for review was made by CDM EB during 1st request for issuance. In accordance with the request for review of CDM EB, emission from the electricity generated by the existing 9.88MW power plant are regarded as baseline emissions and therefore should deducted from emission reductions generated by the project activity. It has been applied from the first verification.

http://cdm.unfccc.int/UserManagement/FileStorage/CSVDHT7LAQW60Z8B5MKI4YN9RFPO2G

8 The Marrakesh Accords and decision 18/CP.9 provide guidance on the eligibility of a proposed CDM project activity which started before decision. By Providing evidence that the starting date of the CDM project activity falls 1 Jan. 2000 and the date of the registration of a first CDM project activity, CDM project activities can get CER

9 Ministry of Environment, Environment Management Corporation, Jun 2000, Sudokwon Landfill Waste gas Resourcification Basic Plant, pp 453-518, “Chap 8. feasibility study for CDM”

10 According to Tool for demonstration and assessment of additionality (Version 02) CDM project activities for registration before 31 Dec. 2005 may claim for a crediting period starting before the date or registration if it provide evidence that incentive from the CDM was seriously considered in the decision to proceed with the project activity.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Alternatives to the project activity consistent with current laws and regulations are defined through the following sub-steps:

Sub-step 1a. Define alternatives to the project activity:

The table below presents an analysis of different alternatives to the project activity along with a discussion of probable outcome.

Alternatives to Project Activity	Probability of Scenario
Landfill gas recovery not implemented (continuation of the current situation)	Probable: The landfill operator could continue the current business as usual practice of flaring and pilot electricity generation with landfill gas from the waste management operations.
Low or High grade gas production	Not Probable: There is no industry to which gas could be supplied in the vicinity of the landfill. A connection to the natural gas grid is difficult because the amount of heat is low
50MW Electricity generation from the methane component of the extracted landfill gas	Not probable: The landfill operator would invest in a landfill gas collection system of high effectiveness and in LFG power generation equipment (the proposed project activity), but the activity would not be undertaken as a CDM activity. The technical expertise and financial resources in Republic of Korea are not available to initiate electrical generation. Utilization systems are more capital-intensive than landfill gas capture and flaring systems, requiring significantly more investment.

The above analysis shows that the only reasonable alternative to the project activity is the continued uncontrolled release of landfill gas to the atmosphere as part of the "business-as-usual" scenario at both Sites. As a result, the project activity is the only viable alternative to address the reduction of greenhouse gas emissions at the Sites.

Sub-step 1b. Enforcement of applicable laws and regulations:

Each of the above alternatives complies with the applicable laws and regulations in Republic of Korea.[11] The active collection and flaring of LFG is not mandatory at the Sudokwon landfill, and therefore, the Sites are currently in compliance with all environmental regulations with respect to air emissions.

According to the EB 22nd meeting Report, Annex 3, 'Type E-' policy have been implemented since the adoption by the COP of the CDM M&P (decision 17/CP.7, 11 Nov 2001) need not be taken into account in developing a base scenario. This analysis is performed without regarding the 'Alternative Energy Development Promotion Act[12]' amended on March, 2002.

Step 2. Investment analysis

According to the "Tool for the demonstration and assessment of additionality version 2" (UNFCCC, 28 November 2005), an investment analysis or barrier analysis is required. For the

11 Table 7. waste treatment facility standard(Last revised on 11. Aug. 2004.) In waste control enforcement regulations(ministry of environment enforcement decree No. 179) regulate that if gas is generated during reclamation of organic waste, incineration facility (i.e. flaring, generating system) should be equipped.

12 'Alternative Energy Development Promotion Act': Alternative Energy Development Promotion Act amended in March, 2002, the Ministry of Commerce, Industry and Energy (MOCIE) of Korean Government issued the Public Notice No. 2003-61 on Oct 9, 2003 and its amendment No. 2004-04 on Oct 19,2004 which compensates the renewable energy electricity generation projects for the difference between the standard price applicable for the electricity generated using the alternative energy and the system marginal price of the grid promote such kinds of electricity generation

investment analysis, "if the CDM project activity generates no financial or economic benefits other than CDM related income, then apply the benchmark analysis (Option III)". Option III of Sub-step 2b is thus applied. In this case, the most likely alternative to the project is simply not to involve investments of a similar scale to the project. Therefore benchmark analysis will be applied.

Sub-step 2b.Option III – Apply benchmark analysis

The likelihood of project development, as opposed to the continuation of current activities (i.e. no collection and combustion of landfill gas) will be determined by comparing its IRR with the benchmark of interest rates available to a local investor, i.e. those provided by local banks (Company Bond) or government bonds in the Host Country, which range from, respectively, 5.21% and 4.76% based on May 2006.(LIBOR rate: 5.091~5.404)

Sub-step 2c. Calculation and comparison of financial indicators[13]

The Table below shows the financial analysis for the project activity. As shown, the project IRR (without carbon) is 0.9%, lower than the interest rates provided by local banks and even government bonds in the Host Country, which makes the project financially unattractive and unviable.

	With Carbon	**Without Carbon**
Net Present Value IRR Discount rate	-6,160 5.9% 7%	-32,501 0.9% 7%

Sub-step 2d. Sensitivity analysis[14]

A sensitivity analysis was conducted by altering the following parameters:
- Increase in project revenue (price of electricity sold to the grid)
- Reduction in project capital and running cost(Operational and Maintenance costs)

Those parameters were selected as being the most likely to fluctuate over time. Financial analyses were performed altering each of these parameters by 10 %, and assessing the impact on the project IRR (see Table below). As it is shown, the project IRR remains lower than the interest rates or local banks and the Net Present Value (at 12% discount rate) is still negative even in the case where these parameters change in favor of the project.

Content	**IRR (%)**	**NPV(US$)**
Original (scenario without carbon)	0.9%	-32,501
10% Increase Electric Generation	2.9%	-22,157
10% Decrease Electric Generation	-1.3%	-42,845
10% Increase Electric Sales Price	2.9%	-22,157
10% Decrease Electric Sales Price	-1.3%	-42,845

13 Only applicable to options II and III
14 Only applicable to options II and III

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:

With the exception of small electricity generation pilot-scale undertakings, there are currently no LFG management projects operated in Korea. There are, however, several LFG management projects being filed under CDM with the local Government.

Sub-step 4b. Discuss any similar options that are occurring:

Implementation of landfill gas electricity generation systems in Korea currently under development are reliant on revenues generated from the CER exchange mechanism under the CDM. Thus, these projects face similar barriers to implementation as the project activity.

Landfill	Capacity	Type	Start date
Sudokwon	6.5MW 3.38MW 50MW	Gas Engine Gas Engine Steam Turbine	’01. Dec ’03. Mar ’06. Dec
Busan	5MW	Gas Engine	’01. Jul
Pohang	2MW	Gas Engine	‘02. May
Daegu	1.5MW 130 N m^3/min Middle grade gas production	Gas Engine	‘05
Daejeon	3.4 MW	Gas Engine	‘03. Jul
Kunsan	1MW	Gas Engine	‘02. Dec
Gwangju	2MW	Gas Engine	‘03. Dec
Jeju	2MW	Gas Engine	‘03. Apr
Cheongju	1MW	Gas Engine	‘04. Feb
Yosu	1MW	Gas Engine	‘04. Aug
Masan	1.5MW	Gas Engine	‘05

Source: Korea Energy Management Corp homepage (http:// racer.kemco.or.kr), 2006

Step 5. Impact of CDM registration

Once the proposed project activity is registered under CDM, the project will be entitled to proceed with the trade and/or exchange of the generated Certified Emission Reductions (CERs) in the open market. The sale of CERs to interested parties will generate a revenue source that will leverage the project Internal Rate of Return (IRR) to a point considered to be attractive by its investors in a way that the project will become economically feasible. Therefore, the CDM registration will facilitate and allow the implementation of the proposed project activity and ensure its financial viability. As a consequence, real reductions in anthropogenic greenhouse gas emissions will be realized.

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B.6. Emission reductions

B.6.1. Explanation of methodological choices

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The following formulae will be used to estimate emission reductions for the project activity

$$\mathbf{ER_y = (MD_{project,y} - MD_{reg,y}) \times GWP_{CH4} + EL_y \times CEF_{electricity,y} - ET_y \times CEF_{thermal,y}}$$

- ER_y are the emission reductions, measured in tCO_2e
- $MD_{project,y}$ is the amount of methane actually destroyed/combusted during time period t, measured in tCH_4
- $MD_{reg,y}$ is the amount of methane that would have been destroyed/combusted during time period t in the absence of the project activity, measured in tCH_4
- GWP_{CH4} is the approved Global Warming Potential value for methane, 21 tCO_2e/tCH_4
- EL_y is net quantity of electricity displaced during a given period t, measured in MWh
- $CEF_{electricity,y}$ is the CO_2 emissions intensity of the electricity displaced, measured in tCO_2e/MWh
- ET_y is Quantity of thermal energy displaced during the year in TJ/y
- $CEF_{thermal,y}$ is the CO_2 emissions intensity of the thermal energy displaced in tCO_2e/TJ

It is noted that while the term from thermal energy have been included to be consistent with the overall formulation stated in ACM0001, thermal energy generation is not a component of the proposed project activity.

Considering that there is no regulatory or contractual requirement determining MD_{reg}, an adjustment factor (AF) is used in the Sudokwon Landfill project:

$$\mathbf{MD_{reg,y} = MD_{project,y} \times AF}$$

The methane destroyed by the project activity during a given time period can be determined by the following: monitoring the quantity of methane actually flared and LFG used to generate electricity and to produce thermal energy. For the proposed project activity, $MD_{thermal}$ = 0, as there is no thermal energy generation component of the project and central flaring facility is just for emergency and maintenance case. As a result, the total actual quantity of methane captured and destroyed will be metered ex post once the project activity is operated, and:

$$\mathbf{MD_{project,y} = MD_{electricity,y} + MD_{flare,y}}$$

$$\mathbf{MD_{project,y} = (LFG_{electricity,y} \times w_{CH4} \times D_{CH4}) + (LFG_{flare,y} \times w_{CH4} \times D_{CH4} \times FE)}$$

- $MD_{electricity,y}$ is the quantity of methane destroyed by combustion in electricity generation facility in a given time period t, measured in tCH_4
- $MD_{flare,y}$ is the quantity of methane destroyed by flaring facility in a given time period t, measured in tCH_4
- $LFG_{electricity,y}$ is average flow of LFG fed into electricity generator during specified monitoring period y, measured in cubic meters(m^3)
- w_{CH4} is the average methane fraction of the landfill gas as measured during the given time period t and expressed as a fraction of CH_4 volume per LFG volume(m^3 CH_4/m^3 of LFG)

- $D_{CH4,y}$ is the methane density, expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3 CH_4), and measured at STP(0 degree Celsius and 1.013 bar), which is 0.0007168 tCH_4/m^3 CH_4(as per consolidated methodology ACM0001)
- $LFG_{flare,y}$ is average flow of LFG fed into flaring system during specified monitoring period y, measured in cubic meters(m^3)
- FE : flare/combustion efficiency(%)

The CO_2 emissions intensity of the electricity displaced (EF) is calculated as a combined margin, consisting of the combination of operating margin (OM) and build margin (BM) factors according to the following three steps as per approved methodology ACM0002:

Step1 - Calculation of the Operating Margin emission factor (OM)

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$

- $F_{i,j,y}$ is the amount of fuel (mass or volume) i consumed by relevant sources i in year(s) y,
- j refers to the power sources delivering electricity to the grid not including low-operating cost and must run plants, including imports to the grid,
- $COEF_{i,j}$ is the CO_2 emission coefficient of fuel (tCO_2/mass or volume) taking into account the carbon content of the fuels used by the relevant power sources j and the percent oxidation of the fuel in year(s) y, and
- $GEN_{i,j}$ is the electricity(MWh) delivered to the grid by source j.

Step2 – Calculation of the Build Margin (BM)

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

- $F_{i,j,y,}$ $COEF_{i,j}$ and $GEN_{i,j}$ are analogous to the variables described for the simple OM method above for plants m.

Step3 – Calculation of the baseline emission factor

$$EF_y = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y}$$

- w_{OM} and w_{BM} is weights by default, are 50%(=0.50)

B.6.2. Data and parameters fixed ex ante

Data / Parameter	GWP_{CH4}
Unit	tCO_{2e}/tCH_4
Description	Global Warming Potential for CH_4
Source of data	IPCC
Value(s) applied	25

Choice of data or Measurement methods and procedures	21 for the first commitment period. 25 for the second commitment period.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	**AF**
Unit	%
Description	Adjustment Factor
Source of data	Sudokwon Landfill Corporation statistics
Value(s) applied	61.15%
Choice of data or Measurement methods and procedures	In conservative manner, AF calculated as actual maximum LFG Collection rate on baseline divided Estimated LFG Collection rate on project activity (42.80% / 70.00%)
Purpose of data	Calculation of baseline emissions
Additional comment	More details described in section B.6.3.

Data / Parameter	**EF**
Unit	tCO_2/MWh
Description	CO_2 emission factor of the grid
Source of data	KEPCO Electric Statistics
Value(s) applied	0.5666 tCO_2/MWh
Choice of data or Measurement methods and procedures	Calculated according to methodology ACM0002 (ver.6). Used data for the year 2003, 2004 and 2005 which are the most recent data available at the time of the validation.
Purpose of data	Calculation of baseline emissions
Additional comment	More details described in annex 3

Data / Parameter	$\mathbf{EF_{OM}}$
Unit	tCO_2/MWh
Description	CO_2 Operating Margin emission factor of the grid
Source of data	KEPCO Electric Statistics
Value(s) applied	0.7652 tCO_2/MWh
Choice of data or Measurement methods and procedures	Calculated according to methodology ACM0002 (ver.6).
Purpose of data	Calculation of baseline emissions

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Additional comment	More details described in annex 3

Data / Parameter	**EF_{BM}**
Unit	tCO_2/MWh
Description	CO_2 emission factor of the grid
Source of data	KEPCO Electric Statistics
Value(s) applied	0.3679 tCO_2/MWh
Choice of data or Measurement methods and procedures	Calculated according to methodology ACM0002 (ver.6).
Purpose of data	Calculation of baseline emissions
Additional comment	More details described in annex 3

Data / Parameter	**$BE_{9.88MW}$**
Unit	tCO_2
Description	Baseline emissions from 9.88MW power plant
Source of data	Calculated
Value(s) applied	122.27 tCO_2/day
Choice of data or Measurement methods and procedures	Calculated through ex-ante calculation method in section B.6.3
Purpose of data	Calculation of baseline emissions
Additional comment	The maximum theoretical value from 9.88MW power plants is calculated as 122.27 tCO_2/day(9.88MW x 91% x 8760 hours/yr x 1yr/365 days x0.5666 tCO_2/MW) according to the technical specification of the facilities

B.6.3. Ex ante calculation of emission reductions

>>

<u>Estimation of methane generation</u>

The MELF(Methane Emission from Landfill) was used to estimate the rate of methane generation from the site. MELF is based on First Order Decay Model Such as IPCC model, but did not use default value (L_0 and k). To estimate accurate parameter L_0 and k, we estimate the LFG generation and proportion of methane gas of it in the site with statistics and research reports.

Further details about MELF are described in ***annex 3***.

Determination of Adjustment Factor

It is required to calculate AF in order to estimate amount of methane gas treated by regulation or contract (MD_{reg}). However in Korea there exists no specific law regulating amount of methane gas treated in LFG site, and Sudokwon LFG site has concluded no contract on methane treatment. Therefore AF is calculated based on methane gas statistics in existing power station facility.(6.5MW, 3.38MW) and central incinerator before expansion of capture facility.
Amount of methane gas captured before capture facility was expanded is as following:

Year	1st site LFG captured	2nd site LFG captured	1st site CH_4 composition	2nd site CH_4 composition	total CH_4 captured
	LFG N ㎥/ yr	LFG N ㎥/yr	%	%	CH_4 N ㎥/ yr
1998	146,371,170		57.8%		**84,602,536**
1999	163,579,698		57.4%		**93,894,747**
2000	213,506,030		45.4%		**96,931,738**
2001	159,156,509		43.0%		**68,437,299**
2002	106,962,004	33,276,650	45.7%	44.0%	**63,523,362**
2003	30,812,718	57,407,183	51.2%	46.5%	**42,470,452**

This statistics was compared to 3 models(IPCC, Scholl Canyon, MELF) estimating methane gas, and the highest collection value of 42.80% in 1998. 42.80% was regarded as **'actual methane collection rate'.**

Year	IPCC	Scholl Canyon	MELF
1998	36.20%	26.66%	**42.80%**
1999	37.40%	29.01%	42.57%
2000	37.05%	30.07%	40.68%
2001	25.30%	21.25%	27.21%
2002	22.84%	19.74%	23.94%
2003	14.89%	13.09%	15.50%

In General Plan for Resoursification of LFG at Sudokwon Landfill Site (2000, June), estimated LFG collection rate was determined at 75%, in this plan '**estimated collection rate in the project'** was assumed to be 70.00% for conservative reasons.
The Adjustment Factor (AF) value used for this project is **61.15%** and is calculated as follows,

AF = Actual maximum LFG Collection rate / Estimated maximum LFG Collection rate (42.80% / 70.00%)

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Determination of Emission Factor (EF) of Electric Power Grid

The CO_2 emissions intensity of the electricity displaced (EF) is calculated as a combine margin, consisting of the combination of operating margin (OM) and build margin (BM) factors according to the three steps where described in section B6.1. as per approved methodology ACM0002

Simple OM method is used, because low-cost/must run resources in KEPCO grid system constitute less than 50% in 5 most recent years. BM sample group consists of the 20% of the most recent plants as result of comparison annual generation with 5 plants sample group.

	2001	2002	2003	2004	2005
Total generation (MWh)	272,243,517	292,746,000	308,225,887	326,879,672	348,187,780
must run/low cost generation	117,023,859	124,379,580	136,622,857	135,253,646	149,934,596
portion of MR/LC	42.98%	42.49%	44.33%	41.38%	43.06%

The Grid EF is calculated ex-ante based on the 3-year vintage data of 2003-05 and the same value shall be used through out the crediting period.
Data and calculation process is described as table in ***annex 3***

Operating Margin	2003 Sub total	0.7857
	2004 Sub total	0.7541
	2005 Sub total	0.7559
	2003-2005 Average	**0.7652**
Build Margin	2005	0.3679
Combined Margin		**0.5666**

Estimation of total emission reductions

The ex-ante estimation of emission reduction of the proposed project is calculated according to the formulas in section B.6.1:

$$ER_y = (MD_{project} - MD_{reg,y}) \times GWP_{CH4} + EL_y \times CEF_{electricity} + ET_y \times CEF_{thermal,y}$$

Total emission reductions can be calculated as following equation considering that no leakage effects need to be accounted as per ACM0001 ver. 04;

$$ER_{total} = BE_{methane\_avoidance} + BE_{electricity\_generation} - BE_{9.88MW} - PE_{fossilfuel}$$

Total baseline emissions	Baseline emissions from methane avoidance($BE_{methane\_avoidance}$)
	Baseline emissions from electricity generation($BE_{electricity\_generation}$)
	Baseline emissions from 9.88MW power plant($BE_{9.88MW}$)
Total project emissions	Project emissions from fossil fuel (LPG) usage($PE_{fossilfuel}$)

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Baseline emissions from methane avoidance($BE_{methane\_avoidance}$)

$$BE_{methane\_avoidance} = (MD_{project,y} - MD_{reg,y}) \times GWP_{CH4}$$

MD_{reg} is calculated by AF(Adjustment factor) and baseline emissions from methane avoidance.

$$MD_{reg} = MD_{project} \times AF$$

Accordingly, emission reductions from methane avoidance is

$$BE_{methane\_avoidance} = (MD_{project} \times (1 - AF)) \times GWP_{CH4}$$

$MD_{project,\ y}$, the amount of methane that would have been destroyed in year y, is calculated as follows; the weighted average of methane fraction from 1st, 2nd landfill and 50MW power plant multiplied in order to calculate methane content and global warming potential.

$$MD_{project,y} = (LFG_{electricity,y} \times W_{CH4} \times D_{CH4}) + (LFG_{flare,y} \times W_{CH4} \times D_{CH4} \times FE)$$

Thus,

$$BE_{methane\_avoidance} = \{(LFG_{electricity,y} \times W_{CH4} \times D_{CH4}) + (LFG_{flare,y} \times W_{CH4} \times D_{CH4} \times FE)\} \times (1 - AF)) \times GWP_{CH4}$$

Baseline emissions from electricity generation($BE_{electricity\_generation}$)

$$BE_{electricity\_generation} = EL \times CEF_{electricity}$$

In accordance with methodology, the amount of net generation and CO_2 emission factor of grid (EF) shall be used to calculate baseline emissions.

$$BE_{electricity\_generation} = (EL_{\exp} - EL_{imp}) \times EF$$

Baseline emissions from 9.88MW power plant($BE_{9.88MW}$)

The 9.88MW power plants had not been operated since 03/2007 due to the technical problem. Therefore, the rest of LFG which is not treated in 50MW power plants was destroyed by central flaring facility only.
Regarding the stoppage of 9.88MW power plants, request for review was made by CDM Executive Board during 1st request for issuance. In accordance with the request for review of CDM Executive Board, emissions from the electricity generated by the existing 9.88MW power plants are regarded as baseline emissions and should be deducted from calculated baseline emissions. It is calculated as follows;

$$BE_{9.88MW} = Maximum\ theoretical\ output\ of\ 9.88MW\ power\ plants \times monitoring\ period \times EF$$

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Project emissions from fossil fuel usage($PE_{fossilfuel}$)

Possible CO_2 emissions resulting from combustion of other fuels than the methane recovered should be accounted as project emissions as per ACM0001 ver.04. Thus, fossil fuel(LPG) usage for start-up(ignition) of power plant or flaring stacks are considered as project emissions.

$$PE_{fossilfuel} = ET_y \times CEF_{thermal,y}$$

ET_y is incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y. In the case of the proposed project, the whole fossil fuel used during project is considered as project emissions in a conservative manner. Thus, project emissions are calculated as follows;

$$PE_{LPG} = Usage(Kg) \times 0.509 Nm^3 / Kg \times 57.8 MJ / Nm^3 \times 20.2 CKg / GJ \times 10^{-6} \times \frac{44}{12} CO_2 / C$$

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2007	1,855,223	842,763	0	1,012,459
2008	2,446,133	1,111,193	0	1,334,940
2009	2,417,444	1,098,161	0	1,319,283
2010	2,388,017	1,084,793	0	1,303,224
2011	2,358,232	1,071,263	0	1,286,969
2012	2,328,401	1,057,712	0	1,270,689
2013	2,298,783	1,044,258	0	1,254,526
2014	2,102,163	954,940	0	1,147,223
2015	1,893,204	860,017	0	1,033,187
2016	1,706,034	774,992	0	931,042
2017	384,574	174,698	0	209,875
Total	**22,178,207**	**10,074,791**	**0**	**12,103,416**
Total number of crediting years	10			
Annual average over the crediting period	2,217,821	1,007,479	0	1,210,342

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	**$LFG_{total,y}$**
Unit	Nm^3
Description	Total amount of landfill gas captured in year y

Source of data	Measured by a flow meter
Value(s) applied	
Measurement methods and procedures	Measured by a flow meter continuously. Data to be aggregated monthly and yearly.
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	Data with low level of uncertainty. Flow meter should be subject to a regular maintenance and testing regime to ensure accuracy
Purpose of data	Calculation of baseline emissions
Additional comment	During the crediting period and two years after

Data / Parameter	$LFG_{electricity,y}$
Unit	Nm^3
Description	Amount of landfill gas combusted in power plant
Source of data	Measured by a flow meter
Value(s) applied	
Measurement methods and procedures	Measured by a flow meter continuously. Data to be aggregated monthly and yearly.
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	Data with low level of uncertainty. Flow meter should be subject to a regular maintenance and testing regime to ensure accuracy
Purpose of data	Calculation of baseline emissions
Additional comment	During the crediting period and two years after

Data / Parameter	$LFG_{flare,y}$
Unit	Nm^3
Description	Amount of landfill gas flared
Source of data	Measured by a flow meter
Value(s) applied	
Measurement methods and procedures	Measured by a flow meter continuously. Data to be aggregated monthly and yearly.
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	Data with low level of uncertainty. Flow meter should be subject to a regular maintenance and testing regime to ensure accuracy
Purpose of data	Calculation of baseline emissions
Additional comment	- This parameter will be monitored when central flaring facility operate in case of emergency or maintenance of 50MW power plant - During the crediting period and two years after

Data / Parameter	**FE**
Unit	%
Description	Flare/combustion efficiency, determined by the operation hours and the methane content in the exhaust gas

Source of data	measured and calculated
Value(s) applied	
Measurement methods and procedures	Continuous measurement of operation time of flare (with cylinder temperature) Periodic measurement of methane content of flare exhaust
Monitoring frequency	Periodic analysis was made for flare exhaust gas Continuous measuring & reading, hourly recording for TC-01 to TC-06
QA/QC procedures	Data with low level of uncertainty. Temperature, operation hour meter should to a regular maintenance and testing regime to ensure accuracy
Purpose of data	Calculation of baseline emissions
Additional comment	- This parameter will be monitored when central flaring facility operate in case of emergency or maintenance of 50MW power plant - During the crediting period and two years after

Data / Parameter	$w_{CH4,y}$
Unit	Nm^3CH_4/Nm^3LFG
Description	Methane fraction in landfill gas
Source of data	Measured by gas analyser
Value(s) applied	0.430 ~ 0.578 for calculating AF (see in section B.6.3.)
Measurement methods and procedures	Preferably measured by continuous gas quality analyser. Methane fraction of the landfill gas to be measured on wet basis.
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	The gas analyser should be subject to a regular maintenance and testing regime to ensure accuracy
Purpose of data	Calculation of baseline emissions
Additional comment	During the crediting period and two years after

Data / Parameter	**T**
Unit	℃
Description	Temperature of the landfill gas
Source of data	Measured by thermometer
Value(s) applied	
Measurement methods and procedures	No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	During the crediting period and two years after

Data / Parameter	**P**
Unit	Pa
Description	Pressure of the landfill gas
Source of data	Measured by manometer

Value(s) applied	
Measurement methods and procedures	No separate monitoring of temperature is necessary when using flow meters that automatically measure pressure
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	During the crediting period and two years after

Data / Parameter	**$EL_{EX,LPG}$**
Unit	MWh
Description	Total amount of electricity exported out of the project boundary
Source of data	Electricity meter
Value(s) applied	
Measurement methods and procedures	According to the requirements of grid company (KEPCO), electricity meter is installed to monitor the actual electricity transmitted to the grid.
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	During the crediting period and two years after

Data / Parameter	**EL_{IMP}**
Unit	MWh
Description	Total amount of electricity imported to meet project requirement
Source of data	Electricity meter
Value(s) applied	
Measurement methods and procedures	According to the requirements of grid company (KEPCO), electricity meter is installed to monitor the actual electricity transmitted to the grid.
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	During the crediting period and two years after

Data / Parameter	**EF**
Unit	tCO_2/MWh
Description	CO2 emission intensity of the electricity
Source of data	Calculated
Value(s) applied	0.5666tCO2/MWh
Measurement methods and procedures	The Grid EF is calculated ex-ante and the same value be used through out the Crediting period
Monitoring frequency	
QA/QC procedures	

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Purpose of data	Calculation of baseline emissions
Additional comment	More details described in annex 4

Data / Parameter	**Regulatory requirements relating to landfill gas project**
Unit	Not applicable
Description	Regulatory requirements relating to landfill gas project
Source of data	Official announcement
Value(s) applied	
Measurement methods and procedures	The information will be recorded annually.
Monitoring frequency	Annually recorded
QA/QC procedures	Not applicable
Purpose of data	Not applicable
Additional comment	

Data / Parameter	**Hours**
Unit	hours
Description	Operation of the energy plant
Source of data	On-site measurement
Value(s) applied	
Measurement methods and procedures	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational
Monitoring frequency	Continuous measuring & reading, hourly recording
QA/QC procedures	
Purpose of data	
Additional comment	Data will be annually recorded and archived electronically during the crediting period and two years after

Data / Parameter	**LPG**
Unit	Kg
Description	The amount of LPG used for start-up (ignition) of 50MW power plant and each flares.
Source of data	Log data
Value(s) applied	
Measurement methods and procedures	The LPG consumption is checked with purchase record of SLC and bills issued by LPG seller. And, all purchased LPG vessels for the last 3 years are regarded as used LPG.
Monitoring frequency	Monthly recorded
QA/QC procedures	
Purpose of data	Calculation of project emissions
Additional comment	

B.7.2. Sampling plan

>> Not applicable

B.7.3. Other elements of monitoring plan

>>

All continuously measured parameters (LFG flow, CH_4 concentration, flare temperature, flare operating hours, engine operating hours, engine electrical output), will be recorded electronically via a data logger, which will have the capacity to aggregate and print the collected data at the frequencies as specified above.

Data monitoring

The data will be measured/collected at each control system of the project (50MW S/T), flaring system and existing power plant (9.88 MW G/T). This data will be reported and archived in every month. The data of flow, temperature, pressure of capturing facility will be measured in every two weeks by using portable meter. To inspect the state of capturing facility, composition, flow, pressure and temperature of each capturing facility will be estimated every week. And also flow and oxygen volume of landfill gas transfer will be estimated every two weeks.

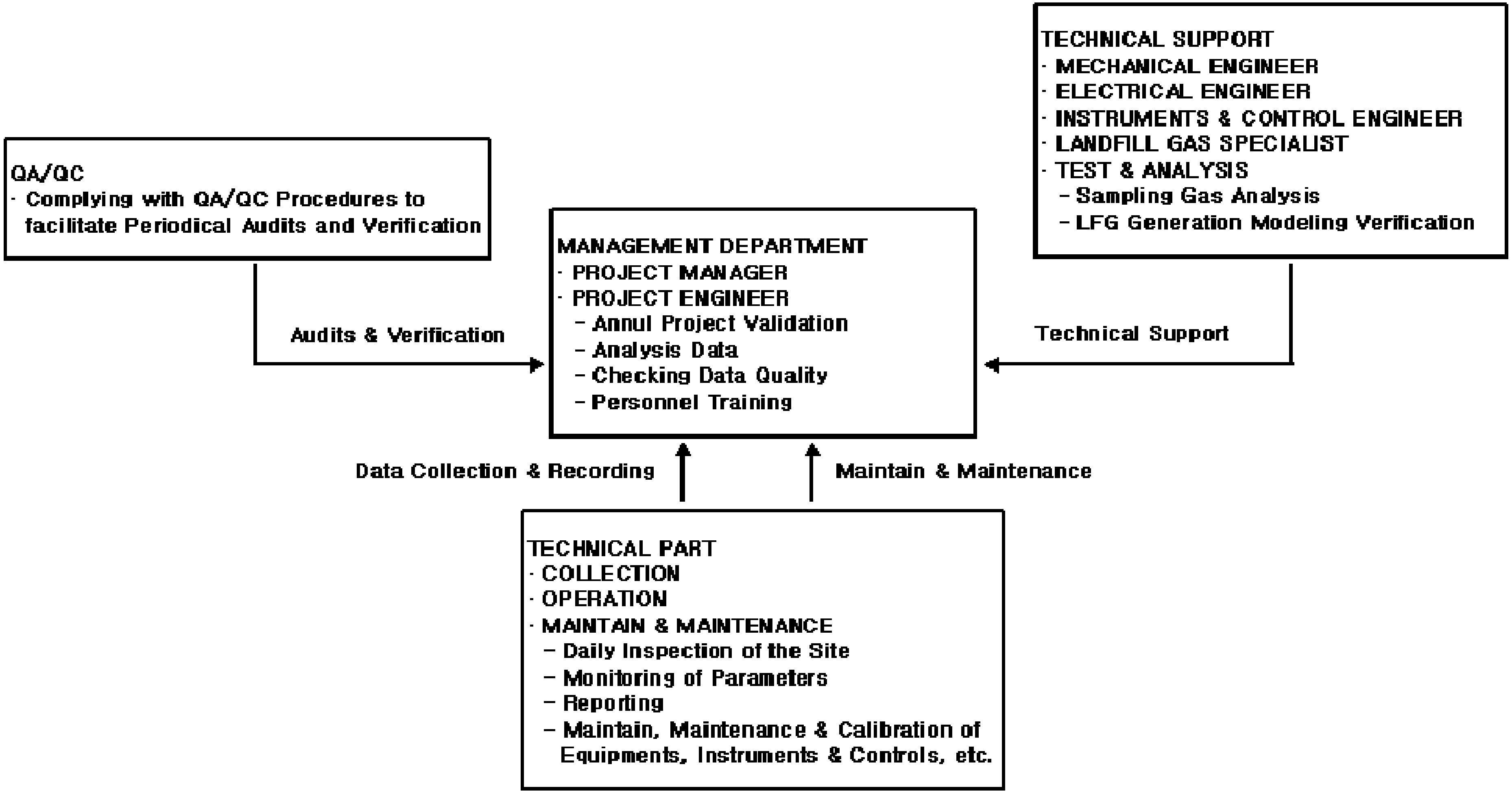
Data management

The data from control station will be analyzed and estimated for the verification of this project. Technical support will be required if necessary. We will analyze a sample gas to measure an accurate composition of landfill gas and this result will be included in operational guide. The operational guide should include monitoring procedure, operation, maintain and maintenance, problem solving procedure, monitoring system.

Instrument Calibration and maintenance

The manager always will check the data to optimize the condition of facility for collecting accurate data. If unusual data is detected, a field study will be conducted by engineer. The control of meter should be achieved by following document for meter control procedure. The portable meter will be adjusted before measure. Every half year, this portable meter will be adjusted by manufacturer and repaired in case of a problem.

The monitoring structure and management department are as follows.


TECHNICAL SUPPORT
· MECHANICAL ENGINEER
· ELECTRICAL ENGINEER
· INSTRUMENTS & CONTROL ENGINEER
· LANDFILL GAS SPECIALIST
· TEST & ANALYSIS
– Sampling Gas Analysis
– LFG Generation Modeling Verification
QA/QC
· Complying with QA/QC Procedures to facilitate Periodical Audits and Verification
MANAGEMENT DEPARTMENT
· PROJECT MANAGER
· PROJECT ENGINEER
– Annul Project Validation
– Analysis Data
– Checking Data Quality
– Personnel Training
Audits & Verification
Technical Support
Data Collection & Recording
Maintain & Maintenance
TECHNICAL PART
· COLLECTION
· OPERATION
· MAINTAIN & MAINTENANCE
– Daily Inspection of the Site
– Monitoring of Parameters
– Reporting
– Maintain, Maintenance & Calibration of Equipments, Instruments & Controls, etc.

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>
Date of Baseline completion **:** 20/01/2007

Person/entity determining the Baseline methodology

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Date of Monitoring completion (DD/MM/YYYY)**:** 19/11/2006

Person/entity determining the monitoring methodology

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These person/entities are not a project participant.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>> The project is expected to start electricity generation with LFG on 15 December, 2006.

C.1.2. Expected operational lifetime of project activity

>> The operational lifetime of this project is estimated as 30 year.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>> The project activity use a fixed crediting period

C.2.2. Start date of crediting period

>> 30/04/2007(Registration date)

C.2.3. Length of crediting period

10 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

According to the provisions of Enforcement Degree of the Act on Assessment of Impacts of Works on Environment, Traffic, Disasters, etc. (2005. 05. 31, partially revised) Article 4, Clause 1, Landfill gas to energy project, EIA shall be carried out.

Sudokwon Landfill Site Management Corporation was established in Oct. 2003, approved by Korean Government on Dec. 2003.

The following aspects of the Landfill gas to energy project were addressed in EIA.

Air – On construction, Variation of air quality caused by construction machinery and vehicle's driving is estimated. But, the result of prior review modeling predicted that environmental criteria of one hour and air pollutant emitted by operating landfill gas power plant is in compliance

Water - Sewage from construction labors and office workers is produced on construction and from plant workers and visitors on operation. Chemical wastewater and oily wastewater from boiler, cooling tower drain, demi-water treatment system is discharged during normal operation periods.

In addition, some wastewater is produced during normal and abnormal maintenance periods.

Noise & Vibration – limitation of life-noise is satisfied during construction of landfill gas power plant, but estimated not to be met during construction of foundation work for power transmission tower.

Limitation of life-vibration caused by operation of construction machinery is also satisfied under limitation during construction of landfill gas power plant as a result of prior estimation.

There will be some increase in noise from the equipment at work, but there are no effects.

Waste – During construction, construction waste due to power plant construction and wood waste due to construction of power transmission railroad line is produced.

During operation, Industrial waste and designated waste are also produced.

Scenery - Viewing facility around main residence area is only 65m height stack, landfill gas power plant does not provide visual heterogeneity.

Soil - Transformation of the soil structure, nature of the soil, depth of the soil is expected due to excavation and raising of the ground level.

Electric Wave – radio reception interference can be occurred within 30m from the power transmission railroad line, but there is no possibility of TV reception interference.

D.2. Environmental impact assessment

>>
The completed EIA had covered above environmental assessment items as followsing,

Air – low NOx burner and flue gas recirculation system is installed to minimize the air pollutant, especially nitrogen oxide, during power plant operation period. In other to reduce scattering dust and noise/vibration during construction, the 1.8m height or more dustproof wall, periodic water sprinkling, car washing equipment are installed and low speed driving of vehicles and weekly construction are carried out.

Water – Proper capacity septic tank is installed for temporary construction office, sewage treatment system is installed during operation period to treat sewage from power plant workers and visitors.
Wastewater produced from power plant during operation period is collected and treated at the integrated wastewater treatment facilities. Reused wastewater system is installed and managed.

Noise & Vibration – Height 2~3m, Length 30m movable soundproof panel is installed around town boundary due to impacts during construction of foundation work for power transmission tower.
Silencer, damping for each equipment is installed to keep up the noise under the design value.
Indoor equipment is treated with sound- absorption.

Waste - Separate waste collection made as principle, reusable waste is disposed. Construction waste also is reused according to recycle guide.

Soil - Although transformation of the soil structure, nature of the soil, depth of the soil is expected due to excavation and raising of the ground level, sandy soil raises the ground in landfill area and hardenes during the excavation time. The settling reservoir and temporary drainage ditch are installed.
Repairs and oil replacement of construction equipment is carried out at a fixed place, water oil is stored at the temporary area and then treated by delegated hazardous waste disposal business or renewable facility.

Electric Wave – If radio and TV reception interference occurs due to project enforcement, Sudokwon landfill site management corporation would have lengthy discussion with local residents and will install an a public antenna and an amplifier.

Therefore, there are no significant environmental impacts resulting from the project activity.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>
When EIA is performed, comments by local stakeholders are required as a matter of duty.
Draft EIA for Sudokwon landfill gas to energy project is reported.
Then, according to the provisions of Enforcement Degree of the Act on Assessment of Impacts of Works on Environment, Traffic, Disasters, etc. Article 6(Collection opinion), local stakeholders opinion collection is requested to Incheon city - west ward header which had jurisdiction over the place of project.
Gyryang-gu, Incheon-city, Ministry of Environment, Kyungin Environmental Management Office reviewed draft EIA and submitted their opinions.

According to the provisions of Enforcement Degree of the Act on Assessment of Impacts of Works on Environment, Traffic, Disasters, etc. an Enforcement Ordinance, Article 6, 7, 8 and 9, draft EIA is submitted to public inspection, presentation for resident and public hearing is held.

- Public inspection of Draft EIA : 2003.6.10 ~ 7.12 (for 33 days)
- The day fixed for a presentation: 2003. 06. 18, 14:00 ~
- The day fixed for public hearing: 2003. 9. 2, 14:00 ~

E.2. Summary of comments received

>>

Local stakeholder's opinions gathered through EIA public inspection, presentation, public hearing is summarized as follows.

- Optimum location selection for power transmission railroad line and prediction of the environmental impacts due to installation of power plant
- Minimize discharge pollutants and make maximum efforts to preserve the natural environment
- Problem of alternative fuel usage according to reduction of landfill gas generation rate in the future

In the EIA stage, consideration of specific countermeasure for the environmental impacts of this project, necessity and feasibility for this project are all agreed and there are no significant impacts resulting from the project activity

E.3. Report on consideration of comments received

>>

All comments received by now were solved through approval process of EIA, and positive countermeasure such as post environmental impact assessment is published to confirm performance of reduction method for environment.

Through presentation for local stakeholder and public hearing including numerous specialists, this project is fully introduced and **there is no significant impacts resulting from the project activity.**

SECTION F. Approval and authorization

>> The DNA Approval for the project activity has been received on 21 November, 2006.

Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☐ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Sudokwon Landfill Site Management Corp (SLC)
Street/P.O. Box	58
Building	SLC main building
City	Incheon
State/Region	Baekseok-dong, Seo-gu
Postcode	404-706
Country	Republic of Korea
Telephone	+82-31-5609-607
Fax	+82-31-5609-609
E-mail	
Website	www.slc.or.kr
Contact person	
Title	CEO
Salutation	Mr
Last name	Jang
Middle name	
First name	Joon-Young
Department	
Mobile	
Direct fax	+82-31-5609-609
Direct tel.	+82-31-5609-607
Personal e-mail	hlb2305@slc.or.kr , jssong@ecofrontier.co.kr

Appendix 2. Affirmation regarding public funding

This project will not receive any public funding.

Appendix 3. Applicability of methodology and standardized baseline

The applicability of methodologies has been detailed in section B.1 and B.2.

Appendix 4. Further background information on ex ante calculation of emission reductions

BASELINE INFORMATION

I. Methane Emission from Landfill (MELF)

Model Description

The CH_4 gas would be generated at the expense of biological degradation of organic wastes in a landfill. A number of researches have tried to correlate the decomposition reaction of organic wastes in a landfill with the generation rate of CH_4. The CH_4 generation models were implemented from specific assumptions on the degradation pattern of organic wastes in a landfill. Most models assumed that the decomposition reaction of organic wastes in a landfill would be accounted for by the first-order reaction.

The MELF was also developed on the basis of the assumption of the first-order reaction of degradable wastes in a landfill. Thus, the kinetic equation for degradation of organic wastes in a landfill can be mathematically denoted by:

$$\frac{dM_w}{dt} = -kM_w \qquad (1)$$

where M_w stands for the remaining mass (ton) of biologically degradable wastes in a landfill in a year *t* apart from a landfilled year (*t=0*). In accordance with the degradation kinetics of organic wastes, the CH_4 generation kinetics can be expressed by:

$$\frac{dM_{CH_4}}{dt} = -L_0 \frac{dM_w}{dt} = kL_0 M_w \qquad (2)$$

where M_{CH_4} represents the accumulated generation amount of CH_4 (ton) at a year *t*, L_0 is the methane generation potential (ton/ton) of organic wastes, and k is the decomposition reaction constant of landfilled wastes or the generation reaction constant of methane (yr^{-1}).

Thus, the remaining quantity of waste in a landfill at a year *t* is described to be:

$$M_w = M_{w0} e^{-kt} \qquad (3)$$

where M_{w0} stands for the landfilled quantity of waste at a year (*t=0*). Substituting eq. (3) into eq. (2) yields:

$$\frac{dM_{CH_4}}{dt} = -L_0 \frac{dM_w}{dt} = kL_0 M_{w,0} e^{-kt} \qquad (4)$$

Integrating eq. (4) allows:

$$M_{CH_4}(t) = M_{w,0} L_0 (1 - e^{-kt}) \qquad (5)$$

At a year *t*, the generation rate of CH_4 from a waste at a landfill year *i* can be shown as:

$$Q_{i,CH_4}(t) = M_{w0,i} L_0 \{e^{-k(t-1)} - e^{-kt}\} \quad (6)$$

where Q_{i,CH_4} is the generation rate of CH_4 at a year *t* from organic wastes at a landfill year *i* and $M_{w0,i}$ is the landfilled quantity at a landfill year *i*.

Therefore, the total generation rate of CH_4 at a time *t* from all landfilled organic wastes can be expressed by:

$$Q_{CH_4}(t) = \sum_{i=1}^{N} M_w(i) L_0(i) \left[e^{-k(t-i)} - e^{-k(t-i+1)}\right] \quad (6)$$

where Q_{CH_4} stands for the total generation rate of CH_4 at a time *t* from all landfilled solid wastes and N is the last year for landfill.

The MELF can estimate the *k* value from the best fit to the measured generation rate of CH_4 at a time *t*. The goodness of fit to calculated Q_{CH_4} to the measured Q_{CH_4} can be judged by the square of difference between the calculated Q_{CH_4} and the measured Q_{CH_4}:

$$S^2 = (Q_{CH_4,mea} - Q_{CH_4,cal})^2 \quad (7)$$

where $Q_{CH_4,mea}$ and $Q_{CH_4,cal}$, respectively, are the measured and calculated generation rate of CH_4 at a time *t*. The calculation algorithm for $Q_{CH_4,cal}$ is displayed in Fig. 1. A FORTRAN code was developed to implement the MELF calculation algorithm.

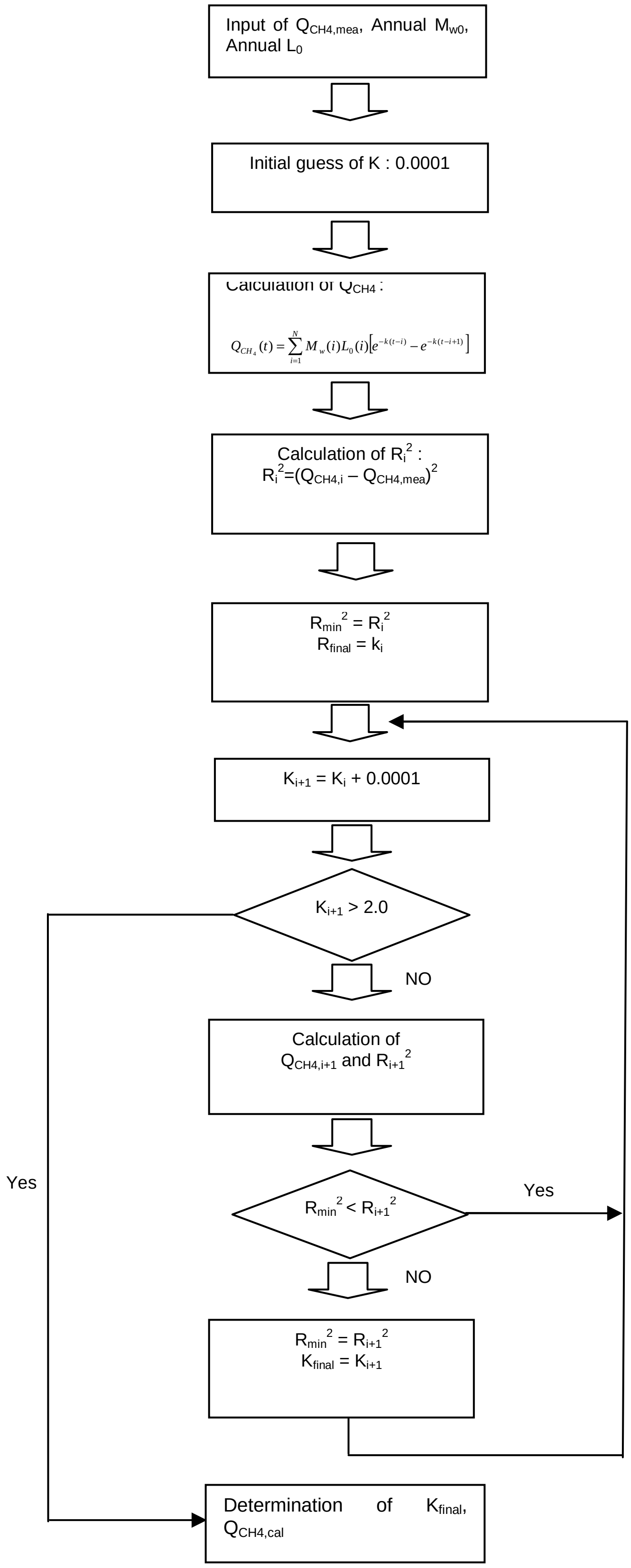


Fig. 1. MELF calculation algorithm for estimating *k* value

Model Parameters

For the MELF, it is prerequisite to obtain three parameter values: (1) annual L_0 values and (2) annual landfilled amount, $M_w(i)$, and (3) measured generation rate of CH_4 at a time *t*, $Q_{CH_4,mea}$.

1) Estimation of annual L_0 value

The L_0 value for a specific year can be described by:

$$L_0(i) = \sum_{k=1}^{n} f_k \times L_k \qquad (8)$$

where $L_0(i)$ is methane generation potential in a landfill year *i*, f_k is the weight fraction of waste *k* landfilled in a landfill year *i*, and L_k is the methane generation potential of waste *k*.

According to eq. 8, we need estimate L_0 value for each organic waste (L_k) landfilled in a landfill year *i* and the weight fraction of certain solid waste. Table 1 displays the L_0 value for each organic waste and Table 2 does the weight fraction of each solid waste landfilled during the landfill period.

Table 1. Methane generation potential (L_0) value for each organic waste

L_0	Foods	Papers	Woods	Rubbers	Plastics	Sludge	Other combustible
m^3 CH_4/ton wet waste	117.1	239.2	116.0	79.9	66.6	19.1	109.3

* Reference: SLC 2004, Study Report (Issue No. 2004-11-019-01)

Table 2. Annual compositional data of solid wastes landfilled in the Sudokwon Landfill Sites

Site	Year	Waste composition ratio(%, wet weight base)							
		Foods	Papers	Woods	Rubbers	Plastics	Sludge	Textile	Others
1st landfill site	1992	23.84	21.33	1.19	2.67	12.26	8.83	3.64	2.70
	1993	25.74	23.22	2.02	2.89	13.57	2.94	4.01	2.89
	1994	18.45	17.66	5.08	2.07	11.40	1.63	3.25	2.10
	1995	19.69	18.51	4.28	2.22	11.96	1.28	3.35	2.31
	1996	20.54	19.10	3.72	2.31	12.21	1.03	3.42	2.30
	1997	20.41	19.00	3.75	2.29	12.16	0.24	3.40	2.11
	1998	20.98	19.40	3.38	2.35	12.38	0.10	3.45	2.10
	1999	19.76	18.54	4.16	2.22	12.18	0.18	3.35	2.00
	2000	20.11	15.30	5.04	1.89	14.34	0.17	2.91	0.51
2nd landfill site	2000	20.11	15.30	5.04	1.89	14.34	0.17	2.91	0.51
	2001	19.79	13.47	6.18	1.25	12.63	0.03	3.39	0.55
	2002	14.02	15.43	7.07	0.13	14.51	0.04	2.04	-
	2003	10.10	15.57	8.38	-	20.67	0.04	2.67	0.17
	2004	5.74	19.73	13.09	-	22.81	0.01	2.85	-
	2005	4.58	15.61	16.02	-	22.82	0.01	2.66	-
	2006	3.93	13.61	16.92	-	21.43	0.01	2.42	-
	2007	3.69	12.89	17.24	-	20.94	0.01	2.33	-
	2008	3.55	12.46	17.43	-	20.64	0.01	2.28	-

	2009	3.55	12.46	17.43	-	20.64	0.01	2.28	-
	2010	3.55	12.46	17.43	-	20.64	0.01	2.28	-
	2011	3.55	12.46	17.43	-	20.64	0.01	2.28	-
	2012	3.55	12.46	17.43	-	20.64	0.01	2.28	-
	2013	3.55	12.46	17.43	-	20.64	0.01	2.28	-

* References: SLC 2006, study report (issue No. 2005-03-033-01)

2) Annual landfilled amount, $M_w(i)$

The Sudokwon Landfill Sites (SLS) are composed of two sites. The first site was closed in year 2000. Yearly landfilled quantities for the first site are available from the national report published by the Sudokwon Landfill Sites Management Corporation (SLM)(Table 3). The second site is active landfill that is expected to be closed in year 2011. The landfilled amount data are available until year 2005 and the yearly landfilled amount from 2006 to 2011 should be predicted from the population resided within the coverage of SLSMC and per capita generation rate of solid wastes (Table 3).

Table 3. Yearly amount of solid waste landfilled in the Sudokwon Landfill Sites

Site	Year	Amount of solid waste landfilled(ton)
1st landfill site	1992	1,462,254
	1993	8,088,911
	1994	11,664,891
	1995	9,177,982
	1996	8,613,533
	1997	7,702,975
	1998	6,603,425
	1999	6,027,635
	2000	5,430,742
2nd landfill site	2000	775,858
	2001	6,339,140
	2002	7,342,719
	2003	6,989,013
	2004	6,010,159
	2005	4,844,488
	2006	4,844,488
	2007	4,844,488
	2008	4,844,488
	2009	4,844,488
	2010	4,844,488
	2011	4,844,488
	2012	4,844,488
	2013	787,207

* Reference : SLC 2006, Sudokwon Landfill Statistics Yearbook

3) Measured generation rate of CH_4 at a time *t*, $Q_{CH_4,mea}$

There are three types of CH_4 from the SLS: 1) CH_4 introduced to a central incinerator, 2) CH_4 burnt by small incinerators, and 3) surface diffused CH_4. To estimate the generation rate of CH_4 from the SLS, it is necessary to estimate those of CH_4 from three sources. Only monthly quantities of CH_4 introduced to a central incinerator are available. The CH_4 generation rates from small incinerators were measured once (March 2006). The surface diffused quantity of CH_4 during 4 seasons of year 2005 was measured and calculated. As already noted, there is little information on the CH_4 quantity burnt by small incinerators and the surface diffused CH_4. Thus, it is essential to calculate the contribution extents of CH_4 by the small incinerators and surface diffusion in its total generation rate. To this end, we adopted the result of the previous study (Table 4).

Table 4. Contribution extent of CH_4 by central incineration station, small incinerators, and surface diffusion process in total generation rate

emission source	Contribution extent of CH_4 emission by classified source of emission(%)							
	1st landfill site				2nd landfill site			
	1st sampling (winter)	2nd sampling (spring)	3th sampling (summer)	4rd sampling (fall)	1st sampling (winter)	2nd sampling (spring)	3th sampling (summer)	4rd sampling (fall)
surface diffusion	0.1	0.1	0.2	0.1	7.2	60.6	45.5	45.5
Small incineration station	5.9	7.1	8.6	4.8	49.0	20.8	30.7	21.8
Central incineration station (amount of LFG captured)	94.0	92.8	91.2	95.1	43.8	18.6	23.8	32.7
Total	100	100	100	100	100	100	100	100

* References: SLC 2005, study report (issue No. 2005-03-033-01)

Model Result

Table 5. Determination of K value by MELF

Year	K value in 1st landfill site(yr^{-1})	K value in 2nd landfill site(yr^{-1})
1997	0.02907*	-
1998	0.08694	-
1999	0.09123	-
2000	0.09221	-
2001	0.06095	-
2002	0.04002	0.08178*
2003	0.00485*	0.10986
2004	0.02484*	0.13750
2005	0.01982*	0.12526
average	0.07427	0.12420

* Outlier

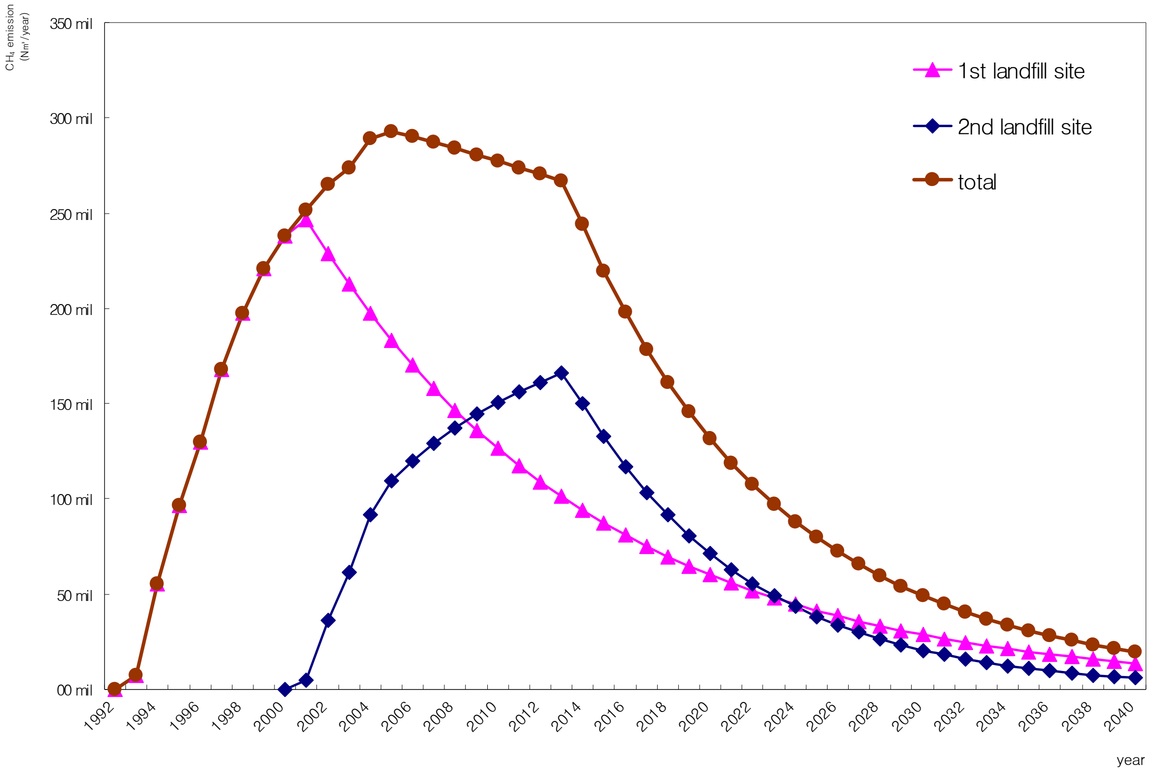


Fig 2. Annual CH_4 emission in the Sudokwon Landfill Sites by MELF

II. Operating Margin, Build Margin and Combined Margin

Operating Margin(OM) and Build Margin(BM) are calculated according to CDM methodology ACM0002. The used data are from "Statistics of Electric Power 2004-6(KEPCO)". Detail information about OM, BM is submitted to DOE.

- Result of Combined Margin –

Operating Margin	2003 Sub total	0.7857
	2004 Sub total	0.7541
	2005 Sub total	0.7559
	2003-2005 Average	**0.7652**
Build Margin	2005	0.3679
Combined Margin		**0.5666**

2003 Operational Margin

No	Type	Plants	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil Consumption	L.N.G Consumption	Coal Caloric value	Heavy oil Caloric value	Diesel oil Caloric value	L.N.G. Caloric value	F×COEF	CEF
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO2	tCO2/MWh
1	coal	Honam #1	1,372,873	633,609	3,528	409	0	5,693	9,859	8,844	0	1,411,935	1.0285
2	coal	Honam #2	1,784,483	832,014	641	366	0	5,655	9,901	8,847	0	1,828,722	1.0248
3	coal	Samchonpo #1	3,745,916	1,535,849	0	1,144	0	5,846	0	9,009	0	3,487,113	0.9309
4	coal	Samchonpo #2	4,110,134	1,680,305	0	657	0	5,844	0	9,011	0	3,812,150	0.9275
5	coal	Samchonpo #3	4,051,427	1,634,224	0	838	0	5,862	0	8,948	0	3,719,553	0.9181
6	coal	Samchonpo #4	4,250,404	1,710,195	0	299	0	5,855	0	8,992	0	3,886,237	0.9143
7	coal	Samchonpo #5	3,606,167	1,430,182	0	2,118	0	5,766	0	9,000	0	3,205,707	0.8890
8	coal	Samchonpo #6	3,609,696	1,436,503	0	1,570	0	5,765	0	9,000	0	3,217,778	0.8914
9	coal	Boryeong #1	3,237,526	1,263,072	0	968	0	6,066	0	8,942	0	2,975,658	0.9191
10	coal	Boryeong #2	3,380,013	1,311,401	0	934	0	6,075	0	8,944	0	3,093,901	0.9154
11	coal	Boryeong #3	4,090,927	1,478,200	0	59	0	6,254	0	8,749	0	3,587,359	0.8769
12	coal	Boryeong #4	3,754,883	1,355,767	0	307	0	6,254	0	8,777	0	3,290,915	0.8764
13	coal	Boryeong #5	4,063,865	1,468,153	0	152	0	6,254	0	8,749	0	3,563,227	0.8768
14	coal	Boryeong #6	3,709,092	1,343,310	0	356	0	6,239	0	8,749	0	3,252,995	0.8770
15	coal	Taean #1	3,995,111	1,466,761	0	319	0	6,181	0	9,013	0	3,518,776	0.8808
16	coal	Taean #2	3,651,716	1,333,563	0	730	0	6,192	0	9,013	0	3,206,141	0.8780
17	coal	Taean #3	3,994,351	1,459,118	0	193	0	6,188	0	9,013	0	3,504,059	0.8773
18	coal	Taean #4	3,708,360	1,358,587	0	628	0	6,198	0	9,013	0	3,269,147	0.8816
19	coal	Taean #5	3,370,362	1,243,228	0	994	0	6,155	0	9,013	0	2,971,977	0.8818
20	coal	Taean #6	3,637,652	1,335,853	0	1,011	0	6,167	0	9,013	0	3,199,462	0.8795
21	coal	Hadong #1	3,995,331	1,476,164	0	390	0	6,149	0	8,941	0	3,523,186	0.8818
22	coal	Hadong #2	3,739,800	1,377,617	0	445	0	6,144	0	8,984	0	3,285,538	0.8785
23	coal	Hadong #3	3,694,945	1,362,366	0	613	0	6,146	0	8,912	0	3,250,686	0.8798
24	coal	Hadong #4	4,029,035	1,483,166	0	302	0	6,145	0	8,957	0	3,537,351	0.8780
25	coal	Hadong #5	3,733,243	1,375,276	0	435	0	6,148	0	8,871	0	3,282,049	0.8791
26	coal	Hadong #6	4,013,010	1,473,500	0	223	0	6,142	0	8,839	0	3,512,362	0.8752
27	coal	Dangjin #1	3,677,169	1,369,223	0	926	0	6,102	0	8,892	0	3,244,512	0.8823
28	coal	Dangjin #2	3,685,913	1,360,761	0	787	0	6,121	0	8,904	0	3,234,132	0.8774
29	coal	Dangjin #3	4,034,969	1,488,422	0	510	0	6,129	0	8,889	0	3,541,204	0.8776
30	coal	Dangjin #4	4,096,642	1,501,207	0	746	0	6,118	0	8,893	0	3,565,847	0.8704
31	oil	Ulsan #1	430,067	0	113,103	484	0	0	9,861	9,018	0	358,885	0.8345
32	oil	Ulsan #2	404,834	0	104,734	1,061	0	0	9,856	9,047	0	333,867	0.8247

No	Type	Plants	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil Consumption	L.N.G Consumption	Coal Caloric value	Heavy oil Caloric value	Diesel oil Caloric value	L.N.G. Caloric value	F×COEF	CEF
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO2	tCO2/MWh
33	oil	Ulsan #3	414,630	0	109,039	500	0	0	9,862	9,035	0	346,120	0.8348
34	oil	Ulsan #4	1,507,363	0	361,447	1,450	0	0	9,921	9,120	0	1,153,631	0.7653
35	oil	Ulsan #5	2,025,171	0	484,842	1,740	0	0	9,912	9,120	0	1,545,499	0.7631
36	oil	Ulsan #6	1,363,879	0	327,005	1,525	0	0	9,921	9,120	0	1,044,299	0.7657
37	oil	Youngnam #1	890,011	0	250,280	1,024	0	0	9,196	8,997	0	740,666	0.8322
38	oil	Youngnam #2	753,536	0	223,269	270	0	0	9,043	8,993	0	648,003	0.8599
39	oil	Yosu #1	703,557	0	173,830	370	0	0	9,979	8,975	0	557,113	0.7919
40	oil	Yosu #2	328,981	0	85,905	86	0	0	9,983	8,970	0	275,163	0.8364
41	oil	Pyongtaek #1	1,465,460	0	343,765	167	2,727	0	9,838	8,974	0	1,084,649	0.7401
42	oil	Pyongtaek #2	1,393,188	0	325,723	195	2,402	0	9,844	8,972	12,955	1,035,720	0.7434
43	oil	Pyongtaek #3	1,400,056	0	329,779	111	2,238	0	9,845	8,977	12,929	1,047,885	0.7485
44	oil	Pyongtaek #4	1,539,552	0	361,331	123	2,370	0	9,842	8,976	12,950	1,147,562	0.7454
45	oil	Namjeju #1	38,080	0	12,520	20	0	0	9,852	8,900	0	39,597	1.0398
46	oil	Namjeju #2	36,860.0	0	12,216	24	0	0	9,853	8,958	0	38,652	1.0486
47	oil	Jeju #1	30,288	0	10,363	23	0	0	10,009	9,238	0	33,317	1.1000
48	oil	Jeju #2	439,474	0	107,856	65	0	0	9,945	8,928	0	344,041	0.7828
49	oil	Jeju #3	513,880	0	124,954	0	0	0	9,943	8,928	0	398,294	0.7751
50	gas	Seoul #4	132,599	0	0	0	32,670	0	0	9,070	13,013	99,325	0.7491
51	gas	Seoul #5	503,381	0	0	4	126,211	0	0	7,515	13,003	383,429	0.7617
52	gas	Incheon #1	225,023	0	22,390	6	25,930	0	9,828	7,526	13,018	149,421	0.6640
53	gas	Incheon #2	242,806	0	22,656	6	28,612	0	9,833	8,986	13,018	158,456	0.6526
54	gas	Incheon #3	267,999	0	24,998	247	34,035	0	9,822	8,993	13,017	182,901	0.6825
55	gas	Incheon #4	214,153	0	23,774	170	24,093	0	9,830	8,988	13,015	148,648	0.6941
56	gas	Pyongtaek C/C	863,292	0	0	96,032	76,012	0	0	8,926	13,026	494,401	0.5727
57	gas	Ilsan C/C	3,097,425			40,006	530,874			8,966	13,021	1,725,072	0.5569
58	gas	Bundang C/C	3,344,852	0	0	0	598,396	0	0	0	13,030	1,821,656	0.5446
59	gas	Ulsan C/C	1,557,954	0	0	63,295	189,997	0	0	9,053	13,007	753,234	0.4835
60	gas	Seoincheon C/C	7,012,289	0	0	44,792	1,012,670	0	0	9,151	12,999	3,201,266	0.4565
61	gas	Shinincheon C/C	10,459,986	0	0	47,393	1,405,724	0	0	9,150	13,005	4,404,228	0.4211
62	gas	Boryeong C/C	4,436,234	0	0	97,106	571,742	0	0	9,131	13,016	2,010,771	0.4533
63	gas	Busan C/C	1,574,883	0	0	1,213	234,533	0	0	9,242	12,997	715,605	0.4544
64	gas	Hallim C/C	55,044	0	0	16,286	0	0	0	8,964	0	44,804	0.8140
65	gas	Anyang C/C	1,793,725	0	0	0	325,207	0	0	0	13,033	990,233	0.5521

No	Type	Plants	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil Consumption	L.N.G Consumption	Coal Caloric value	Heavy oil Caloric value	Diesel oil Caloric value	L.N.G. Caloric value	F×COEF	CEF
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO2	tCO2/MWh
66	gas	Bucheon C/C	1,454,854	0	0	0	266,577	0	0	0	13,022	811,024	0.5575
67	gas	KIE Co.	2,683,591	0	0	103,057	381,684	0	0	9,092	13,014	1,448,077	0.5396
68	gas	LG Bugog	1,221,992	0	0	67,273	121,037	0	0	9,033	13,018	554,625	0.4539
69	oil	namjeju (D/P)	265,063	0	56401	84	0	0	9852	8,881	0	178,363	0.6729
		2003 Sub total	**166,911,027**									**130,428,181**	**0.7814**

(Source: KEPCO 2004)

2004 Operational Margin

No	Type	Plants	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil Consumption	L.N.G Consumption	Coal Caloric value	Heavy oil Caloric value	Diesel oil Caloric value	L.N.G. Caloric value	F×COEF	CEF
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO2	tCO2/MWh
1	coal	Honam #1	1,855,554	885,758	606	300	0	5,493	9,814	8,848	0	1,890,666	1.0189
2	coal	Honam #2	1,625,399	783,300	1,714	335	0	5,430	9,817	8,850	0	1,656,717	1.0193
3	coal	Samchonpo #1	3,974,202	1,624,500	0	1,674	0	5,527	0	9,012	0	3,488,595	0.8778
4	coal	Samchonpo #2	3,839,080	1,564,986	0	744	0	6,275	0	9,010	0	3,812,617	0.9931
5	coal	Samchonpo #3	3,652,769	1,467,177	0	814	0	6,530	0	9,006	0	3,719,829	1.0184
6	coal	Samchonpo #4	3,811,371	1,538,768	0	785	0	6,507	0	9,004	0	3,887,415	1.0200
7	coal	Samchonpo #5	4,147,957	1,707,777	0	230	0	4,829	0	9,000	0	3,200,657	0.7716
8	coal	Samchonpo #6	4,185,213	1,734,977	0	652	0	4,773	0	9,000	0	3,215,089	0.7682
9	coal	youngheung #1	2,986,382	1,114,254	0	27,916	0	5,892	0	8,927	0	2,623,967	0.8786
10	coal	youngheung #2	1,172,450	459,217	0	18,314	0	5,852	0	8,720	0	1,091,778	0.9312
11	coal	Boryeong #1	4,014,109	1,599,557	0	311	0	5,924	0	8,770	0	3,677,716	0.9162
12	coal	Boryeong #2	3,915,285	1,555,055	0	616	0	5,922	0	8,910	0	3,575,060	0.9131
13	coal	Boryeong #3	3,746,265	1,427,263	0	574	0	5,943	0	8,749	0	3,292,893	0.8790
14	coal	Boryeong #4	4,097,489	1,560,014	0	179	0	5,945	0	8,749	0	3,599,175	0.8784
15	coal	Boryeong #5	3,660,240	1,397,343	0	422	0	5,931	0	8,749	0	3,216,981	0.8789
16	coal	Boryeong #6	4,093,207	1,559,785	0	350	0	5,937	0	8,749	0	3,594,264	0.8781
17	coal	Taean #1	3,780,097	1,438,094	0	999	0	5,980	0	8,765	0	3,339,663	0.8835
18	coal	Taean #2	3,975,123	1,509,379	0	310	0	5,977	0	8,699	0	3,501,457	0.8808
19	coal	Taean #3	3,732,363	1,415,585	0	390	0	5,975	0	9,004	0	3,283,077	0.8796
20	coal	Taean #4	4,048,258	1,539,502	0	254	0	5,967	0	8,721	0	3,565,198	0.8807
21	coal	Taean #5	4,091,406	1,547,217	0	329	0	5,996	0	8,912	0	3,600,692	0.8801
22	coal	Taean #6	4,056,835	1,531,751	0	230	0	5,996	0	8,804	0	3,564,430	0.8786
23	coal	Hadong #1	3,688,313	1,389,739	0	533	0	6,032	0	9,002	0	3,254,286	0.8823
24	coal	Hadong #2	4,028,529	1,515,681	0	145	0	6,025	0	8,975	0	3,543,875	0.8797
25	coal	Hadong #3	3,997,064	1,501,027	0	670	0	6,046	0	8,983	0	3,523,295	0.8815
26	coal	Hadong #4	3,724,757	1,397,482	0	737	0	6,097	0	8,993	0	3,308,218	0.8882
27	coal	Hadong #5	4,013,845	1,501,672	0	318	0	5,982	0	8,983	0	3,486,545	0.8686
28	coal	Hadong #6	3,685,698	1,379,396	0	689	0	5,935	0	8,983	0	3,178,585	0.8624
29	coal	Dangjin #1	3,986,406	1,502,885	0	294	0	6,011	0	8,880	0	3,506,197	0.8795
30	coal	Dangjin #2	4,038,457	1,523,605	0	211	0	6,000	0	8,889	0	3,547,796	0.8785
31	coal	Dangjin #3	3,711,787	1,404,465	0	605	0	5,976	0	8,897	0	3,258,414	0.8779
32	coal	Dangjin #4	3,801,495	1,434,844	0	528	0	5,966	0	8,898	0	3,323,081	0.8742
33	oil	Ulsan #1	271,544	0	73,408	114	0	0	9,893	9,010	0	233,129	0.8585
34	oil	Ulsan #2	244,246	0	65,316	82	0	0	9,901	9,010	0	207,544	0.8497

No	Type	Plants	Net generation MWh	Coal Consumption ton	Heavy oil Consumption kilo liter	Diesel oil Consumption kilo liter	L.N.G Consumption ton	Coal Caloric value Kcal/kg	Heavy oil Caloric value kcal/l	Diesel oil Caloric value Kcal/l	L.N.G. Caloric value kcal/kg	F×COEF tCO2	CEF tCO2/MWh
35	oil	Ulsan #3	268,231	0	71,305	554	0	0	9,896	9,010	0	227,744	0.8491
36	oil	Ulsan #4	1,759,376	0	420,739	1,238	0	0	9,972	9,120	0	1,348,494	0.7665
37	oil	Ulsan #5	2,141,162	0	513,497	931	0	0	9,963	9,120	0	1,642,684	0.7672
38	oil	Ulsan #6	2,196,344	0	527,083	1,603	0	0	9,959	9,120	0	1,687,282	0.7682
39	oil	Youngnam #1	973,872	0	347,107	837	0	0	7,432	8,865	0	829,277	0.8515
40	oil	Youngnam #2	665,973	0	248,049	274	0	0	7,679	8,876	0	611,377	0.9180
41	oil	Yosu #1	723,968	0	181,712	571	0	0	10,011	8,924	0	584,737	0.8077
42	oil	Yosu #2	1,304,109	0	316,523	436	0	0	10,009	8,956	0	1,016,821	0.7797
43	oil	Pyongtaek #1	850,533	0	204,664	247	2,095	0	9,877	8,917	12,920	655,041	0.7702
44	oil	Pyongtaek #2	880,646	0	209,664	232	2,515	0	9,879	8,941	12,907	672,229	0.7633
45	oil	Pyongtaek #3	751,633	0	179,921	240	3,791	0	9,902	8,907	12,910	583,229	0.7759
46	oil	Pyongtaek #4	800,854	0	192,294	225	3,217	0	9,903	8,915	12,956	620,830	0.7752
47	oil	Namjeju #1	50,294	0	16,510	6	0	0	9,900	9,333	0	52,416	1.0422
48	oil	Namjeju #2	48,714	0	16,040	13	0	0	9,901	8,846	0	50,947	1.0458
49	oil	Jeju #1	44,659	0	15,306	7	0	0	9,897	8,961	0	48,582	1.0878
50	oil	Jeju #2	486,401	0	118,473	73	0	0	9,912	8,936	0	376,659	0.7744
51	oil	Jeju #3	509,330	0	124,160	41	0	0	9,919	8,928	0	394,920	0.7754
52	gas	Seoul #4	90,322	0	0	1	22,409	0	0	9,070	13,011	68,121	0.7542
53	gas	Seoul #5	480,919	0	0	3	117,908	0	0	9,070	13,014	358,507	0.7455
54	gas	Incheon #1	47,491	0	0	0	10,523	0	0		13,038	32,054	0.6750
55	gas	Incheon #2	49,144	0	0	0	11,094	0	0		13,039	33,796	0.6877
56	gas	Incheon #3	19,018	0	0	149	4,235	0	0	8,951	13,038	13,310	0.6998
57	gas	Pyongtaek C/C	596,001	0	0	21	98,846	0	0	8,758	13,033	301,036	0.5051
58	gas	Ilsan C/C	3,281,407	0	0	0	593,548	0	0	0	13,017	1,805,095	0.5501
59	gas	Bundang C/C	3,650,122	0	0	0	653,880	0	0	0	13,026	1,989,951	0.5452
60	gas	Ulsan C/C	2,329,524	0	0	0	347,076	0	0	0	12,920	1,047,660	0.4497
61	gas	Seoincheon C/C	8,353,619	0	0	88	1,209,806	0	0	9,211	13,010	3,677,526	0.4402
62	gas	Shinincheon C/C	11,596,955	0	0	0	1,587,638	0	0	0	13,017	4,828,316	0.4163
63	gas	Boryeong C/C	6,979,928	0	0	0	988,548	0	0	0	13,025	3,008,214	0.4310
64	gas	Busan C/C	9,884,075	0	0	2,687	1,298,418	0	0		13,004	3,944,798	0.3991
65	gas	Hallim C/C	96,435	0	0	28,796	0	0	0	8,972	0	79,292	0.8222
66	gas	Anyang C/C	1,506,070	0	0	0	270,559	0	0	0	13,025	823,328	0.5467
67	gas	Bucheon C/C	1,425,073	0	0	0	258,596	0	0	0	13,013	786,199	0.5517
68	gas	KIE Co.	2,809,983	0	0	0	467,583	0	0	0	13,023	1,422,666	0.5063
69	gas	LG Bugog	1,894,996	0	0	0	260,653	0	0	0	13,028	793,366	0.4187

No	Type	Plants	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil Consumption	L.N.G Consumption	Coal Caloric value	Heavy oil Caloric value	Diesel oil Caloric value	L.N.G. Caloric value	F×COEF	CEF
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO2	tCO2/MWh
70	gas	Yulchon	36,366	0	0	596	7,388	0	0	11,731	13,014	24,609	0.6767
71	oil	Namjeju (D/P)	274,089	0	57808	80	0	0	9901	8,867	0	183,704	0.6702
		2004 Sub total	**187,510,831**									**141,393,715**	**0.7541**

(Source: KEPCO 2005)

2005 Operational Margin

No	Type	Plants	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil Consumption	L.N.G Consumption	Coal Caloric value	Heavy oil Caloric value	Diesel oil Caloric value	L.N.G. Caloric value	F×COEF	CEF
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO2	tCO2/MWh
1	coal	Honam #1	1,787,715	870,214	961	278	0	5,392	9,835	8,809	0	1,824,362	1.0205
2	coal	Honam #2	1,875,790	912,497	338	185	0	5,376	9,854	8,804	0	1,905,142	1.0156
3	coal	Samchonpo #1	3,810,079	1,534,223	0	1,220	0	5,913	0	8,841	0	3,523,582	0.9248
4	coal	Samchonpo #2	4,323,618	1,731,265	0	626	0	5,924	0	8,883	0	3,981,410	0.9209
5	coal	Samchonpo #3	4,343,666	1,723,152	0	377	0	5,897	0	9,000	0	3,943,881	0.9080
6	coal	Samchonpo #4	4,112,297	1,632,334	0	1,029	0	5,898	0	8,943	0	3,738,557	0.9091
7	coal	Samchonpo #5	3,542,728	1,516,654	0	1,415	0	5,347	0	8,614	0	3,150,192	0.8892
8	coal	Samchonpo #6	3,643,969	1,546,663	0	1,001	0	5,376	0	9,000	0	3,229,168	0.8862
9	coal	youngheung #1	5,623,299	2,081,972	0	4,541	0	6,131	0	8,935	0	4,965,349	0.8830
10	coal	youngheung #2	4,658,862	1,761,395	0	2,903	0	6,053	0	8,947	0	4,145,062	0.8897
11	coal	Boryeong #1	3,547,140	1,440,343	0	761	0	5,830	0	8,943	0	3,260,449	0.9192
12	coal	Boryeong #2	3,433,608	1,388,532	0	551	0	5,816	0	8,943	0	3,135,122	0.9131
13	coal	Boryeong #3	4,124,745	1,589,150	0	90	0	5,882	0	8,740	0	3,627,299	0.8794
14	coal	Boryeong #4	3,698,705	1,421,343	0	603	0	5,890	0	8,748	0	3,250,088	0.8787
15	coal	Boryeong #5	4,121,314	1,587,999	0	156	0	5,882	0	8,749	0	3,624,850	0.8795
16	coal	Boryeong #6	3,283,477	1,260,305	0	627	0	5,901	0	8,749	0	2,887,481	0.8794
17	coal	Taean #1	3,992,112	1,508,570	0	621	0	6,000	0	8,692	0	3,513,654	0.8801
18	coal	Taean #2	3,484,251	1,323,078	0	395	0	6,009	0	8,684	0	3,085,999	0.8857
19	coal	Taean #3	3,957,054	1,494,175	0	650	0	6,007	0	8,676	0	3,484,586	0.8806
20	coal	Taean #4	3,653,534	1,383,297	0	365	0	5,999	0	8,705	0	3,221,048	0.8816
21	coal	Taean #5	3,744,413	1,411,398	0	742	0	6,032	0	8,676	0	3,305,427	0.8828
22	coal	Taean #6	3,999,847	1,504,962	0	417	0	6,017	0	8,691	0	3,515,006	0.8788
23	coal	Hadong #1	3,997,914	1,513,930	0	284	0	6,003	0	8,940	0	3,527,334	0.8823
24	coal	Hadong #2	3,732,583	1,410,099	0	792	0	5,997	0	8,928	0	3,283,441	0.8797
25	coal	Hadong #3	3,769,077	1,422,196	0	472	0	5,998	0	8,982	0	3,311,211	0.8785
26	coal	Hadong #4	3,989,315	1,511,054	0	567	0	5,999	0	8,938	0	3,518,903	0.8821
27	coal	Hadong #5	3,553,901	1,345,648	0	614	0	5,995	0	8,975	0	3,132,031	0.8813
28	coal	Hadong #6	4,037,763	1,520,774	0	331	0	5,995	0	8,928	0	3,538,494	0.8763
29	coal	Dangjin #1	3,797,307	1,438,702	0	637	0	5,962	0	8,834	0	3,329,950	0.8769
30	coal	Dangjin #2	3,798,078	1,437,473	0	632	0	5,962	0	8,915	0	3,327,360	0.8761
31	coal	Dangjin #3	4,081,017	1,549,041	0	141	0	5,935	0	8,844	0	3,567,763	0.8742
32	coal	Dangjin #4	4,079,557	1,544,010	0	134	0	5,941	0	8,828	0	3,559,859	0.8726
33	coal	Dangjin #5	1,318,670	499,714	0	5,701		6,115	0	8,904	0	1,201,287	0.9110
34	coal	Dangjin #6	96,365	38,671	0	1,779	0	6,221	0	11,095	0	99,403	1.0315

No	Type	Plants	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil Consumption	L.N.G Consumption	Coal Caloric value	Heavy oil Caloric value	Diesel oil Caloric value	L.N.G. Caloric value	F×COEF	CEF
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO2	tCO2/MWh
35	oil	Ulsan #1	262,393	0	70,183	750	0	0	9,900	9,116	0	224,831	0.8568
36	oil	Ulsan #2	255,812	0	67,296	585	0	0	9,903	9,113	0	215,276	0.8415
37	oil	Ulsan #3	200,518	0	53,085	662	0	0	9,908	9,119	0	170,474	0.8502
38	oil	Ulsan #4	1,549,091	0	375,417	1,971	0	0	10,001	9,122	0	1,209,093	0.7805
39	oil	Ulsan #5	1,500,935	0	363,992	1,676	0	0	9,993	9,122	0	1,170,805	0.7801
40	oil	Ulsan #6	1,454,644	0	352,776	1,708	0	0	9,979	9,118	0	1,133,366	0.7791
41	oil	Youngnam #1	1,022,470	0	359,910	844	0	0	7,482	8,942	0	865,627	0.8466
42	oil	Youngnam #2	531,006	0	190,085	584	0	0	7,729	8,943	0	472,574	0.8900
43	oil	Yosu #1	430,310	0	106,919	434	0	0	9,960	8,887	0	342,586	0.7961
44	oil	Yosu #2	904,597	0	218,356	346	0	0	9,944	8,886	0	697,043	0.7706
45	oil	Pyongtaek #1	1,258,662	0	293,214	118	3,553	0	9,903	8,943	12,898	941,865	0.7483
46	oil	Pyongtaek #2	1,376,342	0	321,188	140	2,641	0	9,905	8,961	12,872	1,028,180	0.7470
47	oil	Pyongtaek #3	1,321,167	0	308,042	132	1,784	0	9,907	8,949	12,942	984,133	0.7449
48	oil	Pyongtaek #4	1,338,204	0	311,245	138	2,047	0	9,909	8,949	12,893	995,246	0.7437
49	oil	Namjeju #1	44,602	0	14,628	15	0	0	9,878	9,318	0	46,367	1.0396
50	oil	Namjeju #2	44,654	0	15,031	12	0	0	9,879	9,307	0	47,639	1.0668
51	oil	Jeju #1	36,266	0	12,564	12	0	0	9,932	8,885	0	40,037	1.1040
52	oil	Jeju #2	532,700	0	129,516	0	0	0	9,929	0	0	412,254	0.7739
53	oil	Jeju #3	502,189	0	122,866	48	0	0	9,925	8,938	0	391,061	0.7787
54	gas	Seoul #4	207,498	0	0	0	49,143	0	0	0	13,002	149,281	0.7194
55	gas	Seoul #5	444,324	0	0	1	108,761	0	0	9,070	13,008	330,537	0.7439
56	gas	Incheon #1	16,450	0	0	0	4,365	0	0	0	13,032	13,290	0.8079
57	gas	Incheon #2	37,727	0	0	0	8,505	0	0	0	13,025	25,881	0.6860
58	gas	Incheon #4	29,202	0	0	400	6,620	0	0	8,954	13,026	21,246	0.7276
59	gas	Pyongtaek C/C	659,932	0	0	1	110,953	0	0	8,950	13,030	337,770	0.5118
60	gas	Ilsan C/C	2,873,958	0	0	0	533,188	0	0	0	13,011	1,620,821	0.5640
61	gas	Bundang C/C	3,742,073	0	0	0	671,944	0	0	0	13,025	2,044,787	0.5464
62	gas	Ulsan C/C	3,131,075	0	0	0	470,131	0	0	0	12,750	1,400,437	0.4473
63	gas	Seoincheon C/C	7,001,031	0	0	335	989,645	0	0	9,200	13,009	3,008,905	0.4298
64	gas	Shinincheon C/C	10,543,280	0	0	0	1,458,763	0	0	0	13,013	4,435,177	0.4207
65	gas	Boryeong C/C	8,221,926	0	0	0	1,161,510	0	0	0	13,030	3,535,905	0.4301
66	gas	Incheon	2,055,016	0	0	0	281,813	0	0	0	13,012	856,719	0.4169
67	gas	Busan C/C	9,076,327	0	0	0	1,211,144	0	0		13,000	3,678,431	0.4053
68	gas	Hallim C/C	100,346	0	0	29,686	0	0	0	8,973	0	81,748	0.8147
69	gas	Anyang C/C	1,433,978	0	0	0	261,202	0	0	0	13,025	794,861	0.5543

No	Type	Plants	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil Consumption	L.N.G Consumption	Coal Caloric value	Heavy oil Caloric value	Diesel oil Caloric value	L.N.G. Caloric value	F×COEF	CEF
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO2	tCO2/MWh
70	gas	Bucheon C/C	1,404,160	0	0	0	261,705	0	0	0	13,003	795,019	0.5662
71	gas	POSCO Power	2,571,095	0	0	0	445,253	0	0	0	13,024	1,354,801	0.5269
72	gas	GS Bugog	2,189,808	0	0	0	297,976	0	0	0	13,756	957,662	0.4373
73	gas	Yulchon	1,300,627	0	0	159	194,534	0	0	10,930	13,023	592,413	0.4555
74	oil	Namjeju D/P	268,073	0	56,727	37	0	0	9,877	8,975	0	179,724	0.6704
		2004 Sub total	**194,888,238**									**147,318,622**	**0.7559**

(Source: KEPCO 2006)

Build Margin

No	Plants	technology	year	2005 Net Generation	F×COEF	CEF
				MWh	tCO2	tCO2/MWh
1	Suncheon	Solar power	2005. 12	215	-	0.0000
2	Samcheonpo	Solar power	2005. 12	37	-	0.0000
3	Dangjin #5	thermal	2005. 10	1,318,670	1,201,300	0.9110
4	YangYang	Small hydro power	2005. 10	2,141	-	0.0000
5	Taean	Solar power	2005. 10	43	-	0.0000
6	Uelchon #1 S/T	Combined cycle	2005. 7	3,744,413	3,305,484	0.8828
7	Incheon#1	Combined cycle	2005. 7	2,055,016	856,719	0.4169
8	Daegok	Small hydro	2005. 7	522	-	0.0000
9	Donhwa	Small hydro	2005. 7	2,399	-	0.0000
10	Euljin#6	nuclear	2005. 4	7,085,820	-	0.0000
11	Hanryeo	LFG	2005. 4	4,774	-	0.0000
12	Seoul Marine#1	Solar power	2005. 3	4,181	-	0.0000
13	Busan#1,2	biogas	2005. 3	120	-	0.0000
14	Yongdam	small hydro	2004. 12	21,649	-	0.0000
15	Maebongsan wind power	wind	2004. 12	5,543	-	0.0000
16	Daegwanryung wind power	wind	2004. 12	4,137	-	0.0000
17	youngheung #1	steam(bituminous)	2004. 11	4,658,862	4,145,033	0.8897
18	Gunsan wind power	wind	2004. 11	6,582	-	0.0000
19	New solar energy	solar power	2004. 11	209	-	0.0000
20	Ulchin #5	nuclear(uranium)	2004. 7	7,313,595	-	0.0000
21	youngheung #1	steam(bituminous)	2004. 7	5,623,299	4,965,480	0.8786
22	Yulchon	combined cycle(LNG)	2004. 7	1,300,627	592,422	0.6767
23	Duksong	small hydro	2004. 7	8,765	-	0.0000
24	Busan C/C	combined cycle(LNG)	2004. 3	9,076,327	3,678,514	0.3991

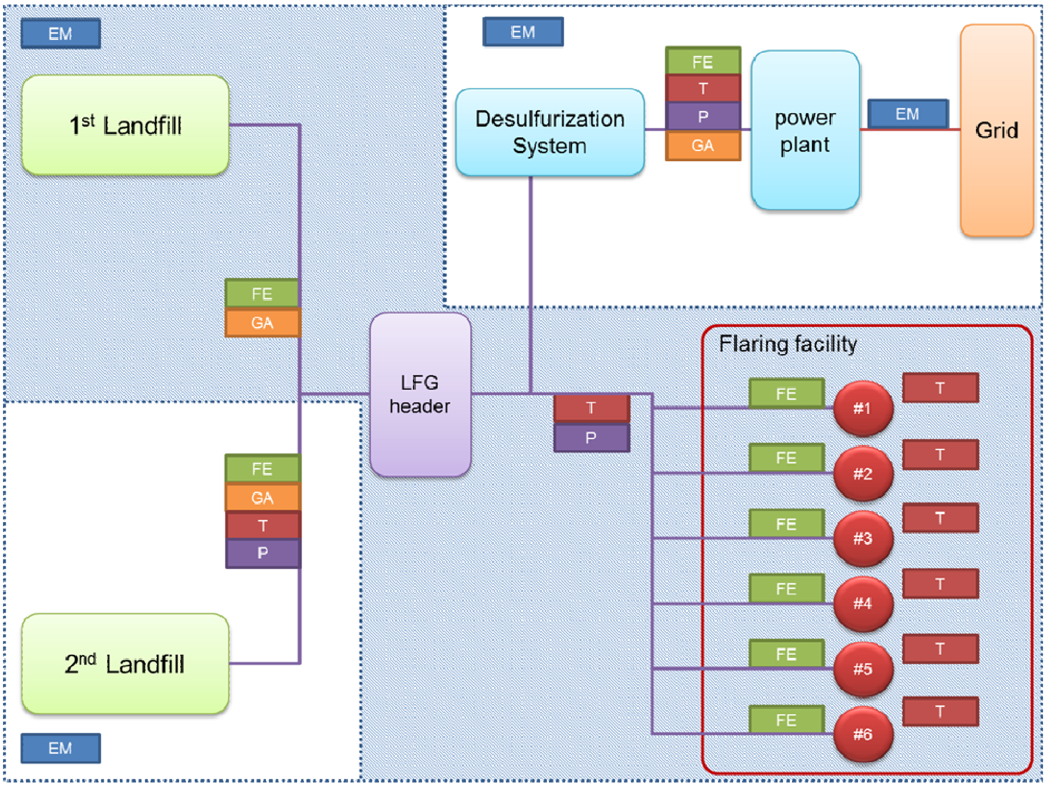
No	Plants	technology	year	2005 Net Generation	F×COEF	CEF
				MWh	tCO2	tCO2/MWh
25	Hankyung- wind power	wind	2004. 3	18,265	-	0.0000
26	Chunsang	small hydro	2004. 2	40	-	0.0000
27	Cheongju	steam by LPG(LFG)	2004. 2	6,168	-	0.0000
28	Wunjeong LFG	steam by LPG(LFG)	2003. 12	13,166	-	0.0000
29	Daejon Geumgodong	steam by LPG(LFG)	2003. 6	12,794	-	0.0000
30	Hoicheon ENC	steam by LPG(LFG)	2003.5	3,650	-	0.0000
31	Muju	small hydro	2003. 4	569	-	0.0000
32	Seohee-ENC	steam by LPG(LFG)	2003. 4	31,360	-	0.0000
33	Sangwon ENC	steam by LPG(LFG)	2003. 3	39,309	-	0.0000
34	Yonggwang #6	nuclear(uranium)	2002. 12	7,776,138	-	0.0000
35	Boryeong C/C	combined cycle(LNG)	2002. 7	8,221,926	3,535,906	0.4301
36	Taean #6	steam(bituminous)	2002. 5	3,999,847	3,514,856	0.8787
37	Yonggwang #5	nuclear(uranium)	2002. 5	7,748,431	-	0.0000
TOTAL				70,109,609	**25,795,714**	**0.3679**

- Estimation of Emission Reductions by CDM project -

Year	Estimation of baseline emission reductions (tonnes of CH_4)	Estimation of project activity emission reductions (tonnes of CH_4)	Net emission reductions (tonnes of CH_4)	Net emission reductions (tonnes of CO_2e)	Estimation of annual LFG electricity generation (MWh/yr)	Estimation of emission reduction for displacing grid electricity (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)	Estimation of emission reductions consider crediting start* (tonnes of CO_2e)
	MD_{reg}	MD_{pro}	MD_{pro}-MD_{reg}		EL_y	El_y*EF		
2007	88,152	144,161	56,009	1,176,182	306,678	173,764	1,349,946	**1,012,459**
2008	87,172	142,558	55,386	1,163,107	303,269	171,832	1,334,940	**1,334,940**
2009	86,150	140,886	54,736	1,149,466	299,712	169,817	1,319,283	**1,319,283**
2010	85,101	139,171	54,070	1,135,474	296,064	167,750	1,303,224	**1,303,224**
2011	84,040	137,436	53,396	1,121,311	292,371	165,657	1,286,969	**1,286,969**
2012	82,977	135,697	52,720	1,107,127	288,673	163,562	1,270,689	**1,270,689**
2013	81,921	133,971	52,050	1,093,044	285,001	161,481	1,254,526	**1,254,526**
2014	74,914	122,512	47,598	999,554	260,624	147,670	1,147,223	**1,147,223**
2015	67,468	110,334	42,866	900,196	234,717	132,991	1,033,187	**1,033,187**
2016	60,798	99,426	38,629	811,199	211,512	119,843	931,042	**931,042**
2017	54,820	89,650	34,831	731,441	190,716	108,060	839,501	**209,875**
Total estimated reductions in 10years								**12,103,416**
Annual average over the crediting period								**1,210,342**

* Crediting period is 10years from 01.Apr.2007 to 31.Mar.2017.

Appendix 5. Further background information on monitoring plan



FE : Flow Element
T : Temperature Element
P : Pressure Element
GA : Gas Analyzer
EM : Electric Meter

Appendix 6. Summary of post registration changes

A summary of the post registration change is presented below:

1) Change Annex1 project participants from Rhodia Energy GHG to DASCO Partners LLP and Ecoeye Co.,Ltd
2) Update of GWP_{CH4}(tCO_2e/tCH_4) to 25 for the 2nd commitment period according to COP/MOP decisions[15]
3) Change the desulfurization system installed capacity due to construction of the extended desulfurization.
4) Add the Desulfurization System flow chart
5) Change the table for major specification of Sudokwon LFG Collection system

Document information

Version	*Date*	*Description*
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revisions to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; Editorial improvement.

[15] IPCC Fourth Assessment Report : Climate Change 2007, item 2.10.2 : Direct Global Warming Potentials, Table 2.14, available at : http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html , accessed on 08/10/2014 and in accordance with EB69, Annex 3 and decision 4/CMP.7, available at : http://cdm.unfccc.int/Reference/Standards/meth/reg_stan02.pdf , accessed on 08/10/2014

Version	Date	Description
05.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from *F-CDM-PDD* to *CDM-PDD-FORM;* • Editorial improvement.
04.1	11 April 2012	• Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document