THE 2ND MONITOING REPORT OF

THE HYUNDAI STEEL WASTE ENERGY RECOVERY CO-GENERATION PROJECT PHASE II

Document Prepared by CERPD Inc.

Project Title	*THE HYUNDAI STEEL WASTE ENERGY RECOVERY CO-GENERATION PROJECT PHASE II*
Version	*Version 02*
Report ID	
Date of Issue	*05-08-2022*
Project ID	*1146*
Monitoring Period	*01-07-2017 to 31-12-2019*
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CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The Hyundai Waste Energy Recovery Co-generation Project Phase II (hereafter referred in this document as the 'proposed project') is a 400MW cogeneration plant at Dangjin Hyundai Steel Mill, which is developed by Hyundai Green power CO., Ltd(hereafter referred in this document as the 'project owner').

The project utilizes surplus waste gases including BFG(Blast Furnace Gas), COG(Coke Oven Gas) and LDG(Converter Gas) produced by Dangjin Hyundai Steel Mill, to generate electricity. The waste gases created by Dangjin Hyundai Steel Mill are reused by the steel mill and the rest are consumed by the proposed project. Without the proposed project the rest of waste gases are emitted to atmosphere after incineration. And the electricity generated by the project is supplied to the grid.

The project activity started on 17 May, 2013, the 2nd monitoring period is from July 1st, 2017 to December 31th, 2019, Time-line of the project implementation status is described below:

Activity	Date
Date of construction	September 5, 2011
#5 turbine Commercial operation	May 17, 2013
#6 turbine Commercial operation	June 29, 2013
#7 turbine Commercial operation	September 12, 2013
#8 turbine Commercial operation	November 25, 2013
1st monitoring period operation	June 1, 2013 ~ June 30, 2017
2nd monitoring period operation	July 1, 2017 ~ December 31, 2019

During the 2nd monitoring period, 6,168,791.59 MWh electricity was exported to grid, and 3,892,640tCO2e GHG emission reductions were generated during the monitoring period.

1.2 Sectoral Scope and Project Type

The project activity pertains to scope 1 (Energy industries (renewable / non-renewable) & 4 (Manufacturing industries)

The project is not a grouped project.

1.3 Project Proponent

Organization name	**Hyundai Green power CO., Ltd**
Contact person	Donggug Kim
Title	energy management team
Address	North road 1480# Song amepChunchongnamdo Korea
Telephone	82-41-680-6143
Email	zugglae@hotmail.com

Organization name	**Hyundai Steel Mill CO., Ltd**
Contact person	Donggug Kim
Title	energy management team
Address	North road 1480# Song amepChunchongnamdo Korea
Telephone	82-41-680-6143
Email	zugglae@hotmail.com

1.4 Other Entities Involved in the Project

Organization name	**CERPD Inc.**
Role in the Project	Project developer
Contact person	Jongbum Kim
Title	CEO
Address	1420 156th AVE NE Ste H, Bellevue, WA, USA 98007
Telephone	82-10-6455-7855
Email	jbk@cerpd.com

1.5 Project Start Date

Project start date : May 17, 2013

1.6 Project Crediting Period

Project crediting period: 10 years (May 17, 2013 ~ May 16, 2023),

The 2nd monitoring period is from July, 1, 2017 to December, 31, 2019

1.7 Project Location

The project is located in Donggok-ri Songsan-myeon Dangjin-gun Chungchongnam-do, Republic of Korea. The geographical coordinates are126°42'11.60" E, 36°58'58.27" N. The maps show below the location of the project activity.

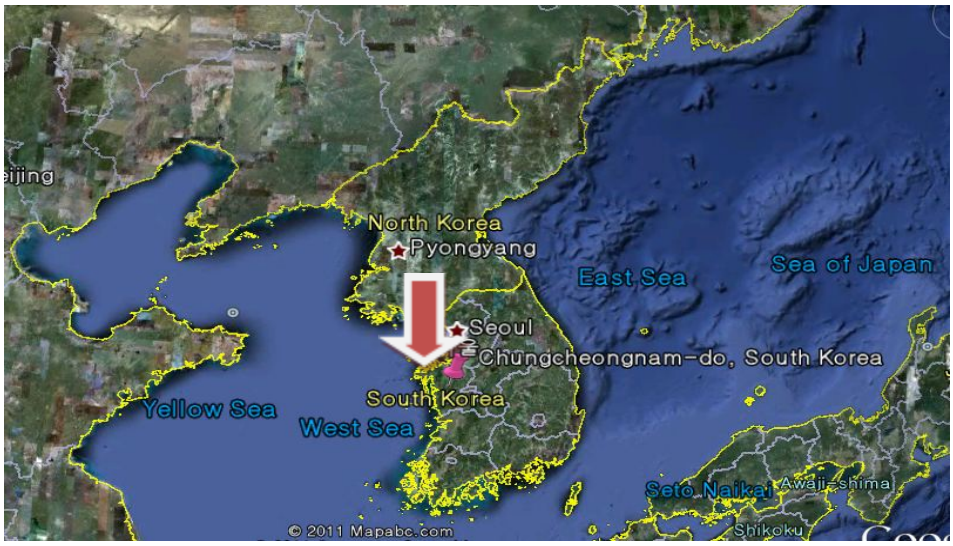


Figure 1. The location of the Chungchongnam province in Republic of Korea

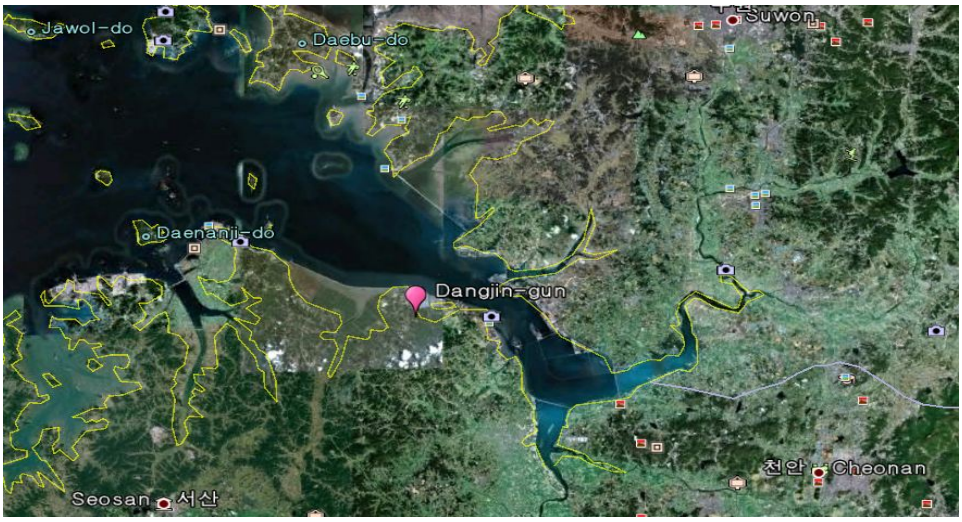


Figure 2. The location of Dangjin county in Chungchongnam Do

Figure 3. The proposed Project in Dangjin county

1.8 Title and Reference of Methodology

(a) The proposed project applies the following approved methodology for PD preparation:

Version 4.0.0 of ACM 0012: "Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects" which was approved on the EB's 60th meeting and detailed information refers to http://cdm.unfccc.int/methodologies/DB/L731WMCXLT0WE6ALG5AYAGLTJP7KW7

(b) The tools drawn upon from Version 4.0.0 of ACM0012 are:

Version 02.2.1 of the tool to calculate the emission factor for an electricity system; detailed information refers to: http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.1.pdf

Version 5.2 of the tool for the demonstration and assessment of additionality; detailed information refers to: http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.1.pdf

Version 01 of “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” detailed information refers to:

http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf

Version 02 of “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”, detailed information refers to:

http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf

1.9 Participation under other GHG Programs

The proposed project is not included in any emissions trading programs or any other mechanisms. The net GHG emission reductions generated by the Project during this monitoring period have not been used for compliance under any emission trading programs or mechanisms.

1.10 Other Forms of Credit

According to Korean Emission Trading Scheme(KETS), all power companies should be involved in KETS as compliance company even the fuel consumed is waste gas. So the project proposer:Hyundai greenpower is also a compliance company in KETS. But according to the allowance allocating regulation of KETS, the implementation of proposed project will neither cause any change of allowance allocation nor cause any GHG reduction double-counted.

Also the project has not sought or received any other form of GHG-related environmental credit including renewable energy certificates during this monitoring period.

List of all and any other programs under which the project is eligible to create another form of GHG-related environment credit: CDM, GS VER.

The project has been only registered under the VCS Program, and it has not been registered under any other approved or not approved GHG programs. A letter of assurance has been provided to DOE to confirm that the proposed project is not register with another GHG program other than VCS, which was issued by project owner during the time of request for register.

1.11 Sustainable Development

The proposed project is an energy saving project by using waste energy.

– Supplied 6,168,791.59 MWh electricity to local residents by applying clean technology that recovering waste gases from steel mill for power generation. Thus the project achieved SDG 7.1[1],

– Creating 136 Job opportunities during the project operation and construction, providing local residents with full and productive employment and decent work, provide high level salary and variety of employee benefits, such as insurance premiums, transportation, tuition fees and child support fees. Thus, the project achieved SDG 8.5[2]

– Achieve 3,892,640 tCO_2e emission reduction during this monitoring period. Thus the project achieved SDG 13.0[3],

[1] https://sdgs.un.org/goals/goal7

[2] https://sdgs.un.org/goals/goal8

[3] https://sdgs.un.org/goals/goal13

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	7.1	Providing electricity to local residents by applying clean technology	Implemented activities to increase	The project supplies 6,168,791.59 MWh electricity to local residents by applying clean technology that recovering waste gases from steel mill for power generation	Provided accumulated 15,765,459 MWh of electricity from clean technology by end of the reporting period.
2)	8.5	Number of decent job opportunities provided	Implemented activities to increase	During the project period, there are 136 stable job opportunities to local people with insurance premiums, transportation, tuition fees and child support fees. And the lowest average annual income was 50% higher than minimum wage in Korea.	from the operation start date of the project to the end of this monitoring period, 136 stable job opportunities provided to local people. The income of all the jobs are higher than minimum wage in Korea.
3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	By using the waste energy, the project has prevented the release of 3,892,640 tonnes of carbon dioxide into the atmosphere during the monitoring period	Prevented the release of 9,901,078 tonnes of carbon dioxide into the atmosphere from the operation start date of the project to the end of this monitoring period,

2 SAFEGUARDS

2.1 No Net Harm

According to the EIA (Environmental Impact Assessment) conducted by a third party, the environmental impact of the proposed project was reduced to the minimum level. Thus, there are no negative environmental and/or socio-economic impacts due to the project. In fact, the project as a waste energy recovering project which can reduce greenhouse gas emissions and the environmental pollution caused by fossil fuels consumption. Meanwhile, the implementation of the project improves local socio-economic development through creating career opportunities and paying taxes.

2.2 Local Stakeholder Consultation

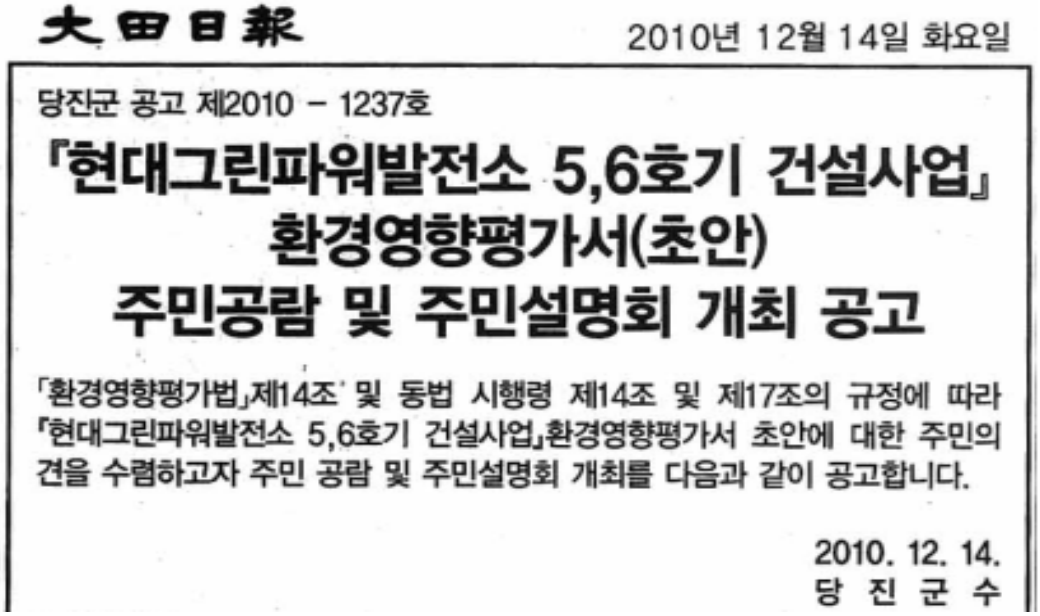
The owner of the Project held a series of meetings with local residents for the purpose of informing the local residents about the environmental effects and the development plans including environment division and local governments, and also received feedbacks from them. The residents expressed their concerns about the noise, pollution, and spreading of thermal effluent which have been taken into consideration. A series of solutions to minimize such civil complaints have been made and implemented.

< Presentation location, date and time>

Location: Dangjin-goon Songsan-myun & hwaseong city, ujeong-ep

Date and Time : 2010/12/21 & 2010/12/22

Audience: residents, organizations and entities that have their addresses in the region which would environmentally be affected by the implementation of the project.



大田日報 2010년 12월 14일 화요일

당진군 공고 제2010 - 1237호

『현대그린파워발전소 5,6호기 건설사업』
환경영향평가서(초안)
주민공람 및 주민설명회 개최 공고

「환경영향평가법」제14조 및 동법 시행령 제14조 및 제17조의 규정에 따라 『현대그린파워발전소 5,6호기 건설사업』환경영향평가서 초안에 대한 주민의견을 수렴하고자 주민 공람 및 주민설명회 개최를 다음과 같이 공고합니다.

2010. 12. 14.
당 진 군 수

Figure 4. Stakeholders' comments public notice

Figure 5. Stakeholders' meeting

Main comment by stakeholders and the reply from Hyundai green power are as follows:

stakeholders	Comment(draft)	Reply from Hyundai
Ministry of the Environment	Many comments were suggested which included air pollution, marine ecological environment, soil environment, the public health care, and landscape	All of the comments have been accepted and the project owner is working on the corrective actions to address these comments.
Chungchongnam -do	The local government of Chungchongnam-do's comments are mainly focused on public health care and landscape	All of the comments have been accepted and the project owner is working on the corrective actions to address these comments.
Dangjin-goon	The local government of Dangjin-goon focused on public health, local economy, and input-output water management	All of the comments have been accepted and the project owner is working on the corrective actions to address these comments.
hwaseong city	The local government of hwaseong	All of the comments have

	city focused onenvironment resources and the impact of marine products	been accepted and the project owner is working on the corrective actions to address these comments.
pyeontak city	No comments	
local residents	No comments	

A series of actions have been implemented to respond for the stakeholders' comments. The detail actions are as follow:

1. Management to control noise during construction

Noise level has been checked periodically and a noise reducing percussive–rotary drilling (PRD) has been applied during the construction.

2. Plan for minimizing pollutants

Stricter standards than the legal standards for pollutants emission were applied

List		Legal standard	Internal standard
Air	NOx(PPm)	<50	<20
Waste water	pH	5.8~8.6	6.0~8.0
	BOD(mg/L)	<80	<20
	COD(mg/L)	<90	<20
	SS(mg/L)	<80	<20
	T-N(mg/L)	<60	<60
	T-P(mg/L)	<8	<8
	N-H Extracts(mg/L)	<5	<0.5
	Temp. (℃)	<40	<40
Black water	BOD(mg/L)	<20	<20

	SS(mg/L)	<20	<20

3. Noise control and risk management due to trucking

– Applied lots of washing facilities for trucks to reduce the dust

– Added covers for trucks in order to prevent things dropped from trucks to reduce the danger.

– Added lots of speed limit signs to control the speed of trucks.

4. Warm water discharging method analysis

During the construction of Hyundai Green–Power plant No.1–4, Hyundai Green power CO. collected extensive opinions from stakeholders and administrative agencies, and selected a submerged cooling water intake/discharge method that reduced the distance and the diffusion area of mixing the surface layer and the bottom layer. In order to decrease the temperature of heated effluent, the length of drainpipe was extended to 1,570m (existing 600m).

5. Recycling methods of waste energy resource

The researches to recycle the waste energy and improve the efficiency of power generation have been underway. We will try to recycle the waste energy if we find some technology that is adaptable to us.

Local Stakeholder Consultation during the project implementation stage:

Communications with local stakeholders are being carried out at periodic intervals. In this monitoring period, the project owner carried out questionnaire surveys for the local stakeholder to collect the relevant comments and suggestions in May 11th 2017,

September 5th 2017, December 14th 2018 and November 4th 2019. And there are no negative comments received for the project. In line with VCS requirements all the processes have been implemented to receive comments from local stakeholders as well as communicate with them at periodic intervals. Besides, In order to improve the living quality of local residents, the project owner invest funds every year to improve the local living conditions, such as roads improving, school repairing, scholarship providing, etc. The acts of improving local conditions and benefits during the project period are as follows:

Type	Number of projects	Cost (1000KRW)	Benefits
Improve income of local residence	1	24,570	Increase the working efficiency of farming through providing new cranes
Improve local environment	41	982,000	Increase the quality of living environment through rural road drainage channel repairing and Public community construction
Support Education	8	420,000	Increase the quality of education through school repairing and providing scholarship

2.3 AFOLU-Specific Safeguards

N/A

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

During this monitoring period, the project was operated normally, generators shut down 98 times by inspection or other normal reasons, all the shut down times and the reasons have been recorded when shut down happened. During the shutdown time, no emission reductions were generated and recorded. The information of shut down has been provided to DOE. Key technical specifications of main equipments are as follows:

Equipment	Number	Specification	Value
Generator	4	Model	SGEN6-100A-2P
		Quantity	1
		Rated Power	116.54MW
		Rated Voltage	13.8kV
		Rated Current	5736A
		Rated Speed	3600rpm
Turbine	4	Model(HP/IP)	SST-700/SST-900
		Quantity	1/1
		Rated Power(MW)	100(26.7%/73.3%)
		Rated Water Head(㎏/㎠)	127/33
		Rated Flux(ton/h)	287
		Rated Speed(RPM)	7116/3600
Boiler	4	Model	N/A
		BMCR	340ton/h
		Main steam temperature,℃	541
		Combustion mode	Front Firing
		Main steam pressure,kg/cm2	131
LDG booster fan	1	Volume flow	19.3 m^3/s
		Fan rotational speed	1190 rpm
		Total pressure rise	8698 Pa
		Motor Manufacture	Hyosung Corp

		Motor type	HSEP
		Motor power	240kw
		voltage	6600V
COG booster fan	2	Volume flow	16.6 m^3/s
		Fan rotational speed	1,790 rpm
		Total pressure rise	12018 Pa
		Motor Manufacture	Hyosung Corp
		Motor type	HSEP
		Motor power	450kw
		voltage	6600V

3.2 Deviations

3.2.1 Methodology Deviations

There is no deviation about methodology.

3.2.2 Project Description Deviations

According to the monitoring plan in the VCS PD, the quantity of electricity consumed by the project electricity consumption ($EC_{PJ,y}$),would be measured by standard meter continually. However, there is no standard meter for measuring electricity consumed in actual operation.

In this monitoring report, the amount of electricity consumption of booster fan was calculated with the default value of manufacture's specification. (For conservative approach, it was calculated with the assumption of full operation for the whole year)

<Calculation for the electricity consumption of booster fans>

FAN for COG

450kW X2 sets X 24hr X 365 days = 7,884,000 kWh/yr

Fan for LDG

240kW X 1 set X 24hrs X 365days = 2,102,400 kWh/yr

The amount of electricity consumption of booster fan is 9,986,400 kWh for a year (27.36MW per day). The monitoring period covers 914days. Therefore, total amount of the electricity consumption of booster fan is 25,007.04 MWh for the second monitoring period. Detail calculation can refer to 4.2 Data and Parameters Monitored.

As a result, the deviation of proposed project will not impacts the applicability of the methodology, additionality, or the appropriateness of the baseline scenario. The GHG emission has been calculated by conservative approach. The deviation approach was also applied for the previous monitoring period and accepted by Verra.

3.3 Grouped Projects

This is not a grouped project activity.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	$EF_{grid,OM,y}$
Data unit	tCO_2/MWh
Description	Operating Margin emission factor
Source of data	Refer to the registered PD
Value applied	0.7177
Justification of choice of data or	The data calculation was done according to "Tool to calculate the emission factor for an

description of measurement methods and procedures applied	electricity system".
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	The value numbers were calculated around the time of the submission of the PD and would not change during the accreditation period.

Data / Parameter	$EF_{grid,BM,y}$
Data unit	tCO_2/MWh
Description	Build Margin emission factor
Source of data	Refer to the registered PD
Value applied	0.5514
Justification of choice of data or description of measurement methods and procedures applied	The data calculation was done according to "Tool to calculate the emission factor for an electricity system".
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	The value numbers were calculated around the time of the submission of the PD and would not change during the accreditation period.

Data / Parameter	EF_y
Data unit	tCO_2/MWh
Description	Carbon emission factor of Korea National power grid

Source of data	"Refer to the registered PD"
Value applied	0.6345
Justification of choice of data or description of measurement methods and procedures applied	The data calculation was done according to "Tool to calculate the emission factor for an electricity system".
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	The value numbers were calculated around the time of the submission of the PD and would not change during the accreditation period.

Data / Parameter	$COEF_{j,y}$
Data unit	$kgCO_2/TJ$
Description	Weighted average CO2 emission factor of fuel type i in year y
Source of data	IPCC2006
Value applied	54,300
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	-
Comments	-

Data / Parameter	$TDL_{j,y}$
Data unit	-

Description	Average technical transmission and distribution losses for providing electricity to source j in year y.
Source of data	Tool to calculate baseline, project and/or leakage emissions from electricity consumption.
Value applied	20%
Justification of choice of data or description of measurement methods and procedures applied	Use as default values of 20% for project or leakage electricity consumption sources according to “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	NCV_i
Data unit	kcal/l, kcal/kg
Description	Net calorific value for fuel consumed in OM power plants.
Source of data	STATISTICS OF ELECTRIC POWER IN KOREA(2009,2010,2011)
Value applied	Refer to the registered PD
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$EF_{CO2,i,y}$
Data unit	tCO_2/TJ
Description	CO2 emission factor of fossil fuel type i consumed by OM power plants in the year y.
Source of data	IPCC 2006
Value applied	Refer to the registered PD
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	f_{cap}
Data unit	-
Description	Factor that determines the energy that would have been produced in project year y using waste energy generated at a historical level, expressed as a fraction of the total energy produced using waste source in year y.
Source of data	ACM0012 ver. 4.0.0
Value applied	1
Justification of choice of data or description of measurement methods and procedures applied	According to ACM0012 ver. 4.0.0, the value of f_{cap} is 1 for Greenfield facilities.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	F_{wcm}
Data unit	-
Description	Fraction of total electricity generated by the project activity using waste energy.
Source of data	ACM0012 ver. 4.0.0
Value applied	1
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	f_{wcm} is assumed as 1 because the f_{wcm} is not available due to technical constraints; the emissions due to auxiliary fossil fuel combusted will be calculated in project emission.

4.2 Data and Parameters Monitored

Data / Parameter	$EG_{j,y}$
Data unit	MWh
Description	Quantity of electricity supplied to the grid by the project activity during the year *y*.
Source of data	Measurement records
Description of measurement methods and procedures to be applied	Direct measurement by project participants through standard meter continually. And the data can be monitored by the system of EMS-IRTV.
Frequency of monitoring/recording	The electricity generation amount is monitored continuously and recorded every day and aggregated monthly

Value monitored	6,168,791.59
Monitoring equipment	Main meter M1 Type : ION Accuracy class : 0.2s Serial number : PT1203A32301 Main meter M2 Type : ION Accuracy class : 0.2s Serial number : PT1203A32401 Main meter M3 Type : ION Accuracy class : 0.2s Serial number : PT1203A32501 Main meter M4 Type : ION Accuracy class : 0.2s Serial number : PT1203A32601 Backup meter M5 for M1 Type : Actaris Accuracy class : 0.5s Serial number : 62014885 Backup meter M6 for M2 Type : Actaris Accuracy class : 0.5s Serial number : 62014886 Backup meter M7 for M3 Type : Actaris Accuracy class : 0.5s Serial number : 62014887 Backup meter M8 for M4 Type : Actaris Accuracy class : 0.5s Serial number : 62014889

<table>
<tr><td></td><td></td></tr>
<tr><td>QA/QC procedures to be applied</td><td>
<table>
<tr><th rowspan="2">Meter</th><th colspan="2">Calibration</th><th rowspan="2">Calibration Entity</th></tr>
<tr><th>Date of calibration</th><th>Valid until</th></tr>
<tr><td rowspan="2">M1</td><td>28/10/2016</td><td>28/04/2019</td><td rowspan="16">Korea Testing Certification(KTC)</td></tr>
<tr><td>29/01/2019</td><td>29/01/2023</td></tr>
<tr><td rowspan="2">M2</td><td>28/10/2016</td><td>28/04/2019</td></tr>
<tr><td>25/04/2019</td><td>25/04/2023</td></tr>
<tr><td rowspan="2">M3</td><td>28/10/2016</td><td>28/04/2019</td></tr>
<tr><td>25/04/2019</td><td>25/04/2023</td></tr>
<tr><td rowspan="2">M4</td><td>28/10/2016</td><td>28/04/2019</td></tr>
<tr><td>29/01/2019</td><td>29/01/2023</td></tr>
<tr><td rowspan="2">M5</td><td>28/10/2016</td><td>28/04/2019</td></tr>
<tr><td>29/01/2019</td><td>29/01/2023</td></tr>
<tr><td rowspan="2">M6</td><td>28/10/2016</td><td>28/04/2019</td></tr>
<tr><td>25/04/2019</td><td>25/04/2023</td></tr>
<tr><td rowspan="2">M7</td><td>28/10/2016</td><td>28/04/2019</td></tr>
<tr><td>25/04/2019</td><td>25/04/2023</td></tr>
<tr><td rowspan="2">M8</td><td>28/10/2016</td><td>28/04/2019</td></tr>
<tr><td>03/01/2019</td><td>03/01/2023</td></tr>
</table>
The amount of power generation is crosschecked with the Electricity Transation Notes (ETNs).
The meters are calibrated at average of every 3.5 years(with error testing at the second year and calibrating at the 7th year).

The latest dates of calibration for the meters are as follows:</td></tr>
<tr><td>Purpose of the data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Calculation method</td><td>-</td></tr>
<tr><td>Comments</td><td>-</td></tr>
</table>

Data / Parameter	$EC_{PJ,y}$

Data unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source j in year y.
Source of data	Designed value
Description of measurement methods and procedures to be applied	Calculation with the designed data
Frequency of monitoring/recording	-
Value monitored	25,007.04
Monitoring equipment	Due to the absence of electricity meters of facilities that consumed electricity for the project activity, designed value was applied for calculating the amount of electricity consumption.(with the assumption of full operation for the year.(24hrs a day, 365days a year))
QA/QC procedures to be applied	-
Purpose of the data	Calculation of project emissions
Calculation method	FAN for COG 450kW X2set X 24hr X 365 days = 7,884,000 kWh/yr Fan for LDG 240kW X 24hrs X 365days = 2,102,400 kWh/yr Total $EC_{PJ,y}$=(7,884,000+2,102,400)/365X(184+365+365)/1000 =25,007.04MWh
Comments	-

Data / Parameter	$AF_{i,j,y}$
Data unit	Nm^3
Description	LNG consumed on-site for power generation.
Source of data	Measurement records.
Description of measurement methods and procedures to be applied	Direct measurement by project participants through standard flow meter continually.
Frequency of monitoring/recording	Direct measurement by project participants through standard meter continually. The data is displayed by DCS with accumulated flow; the amount of LNG consumption is reported every month
Value monitored	1,151,978
Monitoring equipment	Tag No. | Model | Uncertainty | Remark 10513238 (old) | G4000 | ± 0.62% | Has been replaced by new meters listed below in 2017.11 10528940 | SM-RI-X | ±0.5% | New installed in 2017.11
QA/QC procedures to be applied	The meters would be calibrated by LNG supplier when the meter is at abnormal condition. Consumption recordings crosschecked with invoices.
Purpose of the data	Calculation of project emissions
Calculation method	–
Comments	–

Data / Parameter	*NCV_i (for $AF_{i,j,y}$ calculation)*

Data unit	TJ/Gg
Description	Net calorific value for fuel LNG
Source of data	IPCC 2006[4]
Description of measurement methods and procedures to be applied	IPCC default values at the upper limit of the uncertainty at a 95% according to "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
Frequency of monitoring/recording	-
Value monitored	50.4
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of the data	Calculation of project emissions
Calculation method	-
Comments	In project PDD, the source of NCV_i was KOREA GAS CORPORATION, but the project owner did not record the value of NCV_i during the monitoring period, so for conservative approach, according to "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"IPCC default values at the upper limit of the uncertainty at a 95% was considered.

Data / Parameter	$EF_{CO2,i,y}$
Data unit	kgCO2/TJ
Description	CO2 emissions factor for LNG.

[4] The NCV_i is used only in calculating project emission caused by LNG consumption. And in the calculation for EF_{OM} and EF_{BM}, the specific NCV of LNG for each power plant was adopted.

Source of data	*IPCC 2006*
Description of measurement methods and procedures to be applied	IPCC default values at the upper limit of the uncertainty at a 95% according to "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
Frequency of monitoring/recording	-
Value monitored	58,300
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of the data	Calculation of project emissions
Calculation method	-
Comments	The value will be upgraded when the value in IPCC changed.

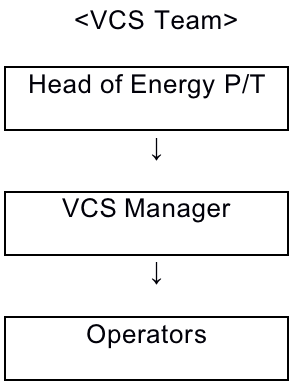
Data / Parameter	Abnormal operation of the project facility including emergencies and shut down
Data unit	Hours
Description	The hours of abnormal operation of parts of project facility that can have an impact on waste energy generation and recovery
Source of data	Measurement records
Description of measurement methods and procedures to be applied	Direct measurement by project participants through EMS–IRTV system
Frequency of monitoring/recording	Daily, aggregated annually

Value monitored	183.5
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of the data	To demonstrate that no emission reduction is claimed for the hours during the abnormal operation of the part of project facility which have impact on waste energy generation and recovery
Calculation method	-
Comments	During abnormal operation, the generators were shut down, which no power was generated. So Abnormal operation has no impact on Emission Reduction calculating.

4.3 Monitoring Plan

1. Allocation of project management

The Engineering Team at Hyundai Green Power plant is responsible for the monitoring plan of the proposed project. The team manages the measurement and record of all data and the maintenance of equipment associated with the project. Operators under the Engineering Team are composed to implement the accurate monitoring, and are assigned to the task of monitoring as follows;



	Tasks
Head of Energy P/T	-Cross-check and management of monthly an annual data related to ER calculation. - Check the annual emission reduction and approve the monitoring report.
VCS Manager	- Check and verification of monthly and annual data related to ER calculation. - Calculation of annual GHG emissions reduction and documentation of monitoring report, and report to Head of Energy P/T.
Operator	Operation of facilities and logging. - Logging and record of daily data related to ER calculation. - Maintenance and management of meters. - report to VCS manager every month about the monitored data.

All of the team members are from Hyundai Green Power and Hyundai Steel Mill. A head of Energy P/T and the VCS Manager who are from Hyundai Green Power are mainly in charge of the monitoring for the proposed project. Some of the operators are from Hyundai Steel mill who are in charge of providing the data of electricity consumed in the proposed project.

All monitored data is kept during the crediting period and 2 years after the end of

crediting period.

2. Management and operational system

2.1 Data collection and storage

For power generation, the data is monitored and collected by EMS-IRTV system. Also, the data collected by EMS-IRTV is sent to Korea Power exchange for the purchase of electricity and will be stored for 3 years after the end of the project crediting period..

For LNG consumption, the data is displayed by DCS with accumulated flow; the amount of LNG consumption is reported every month and will be stored for 3 years after the end of the project crediting period.

The location of monitoring equipment and monitoring points are as flows:

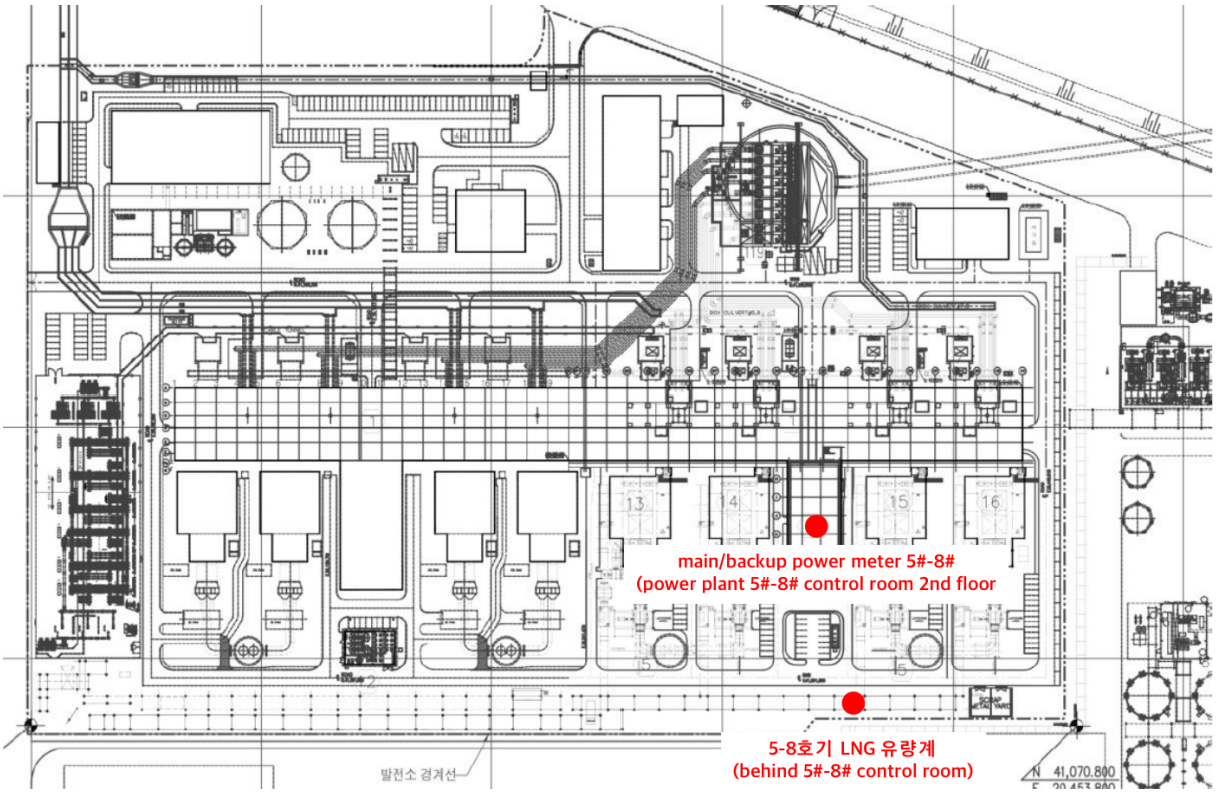


Figure 6. Location of monitoring equipments

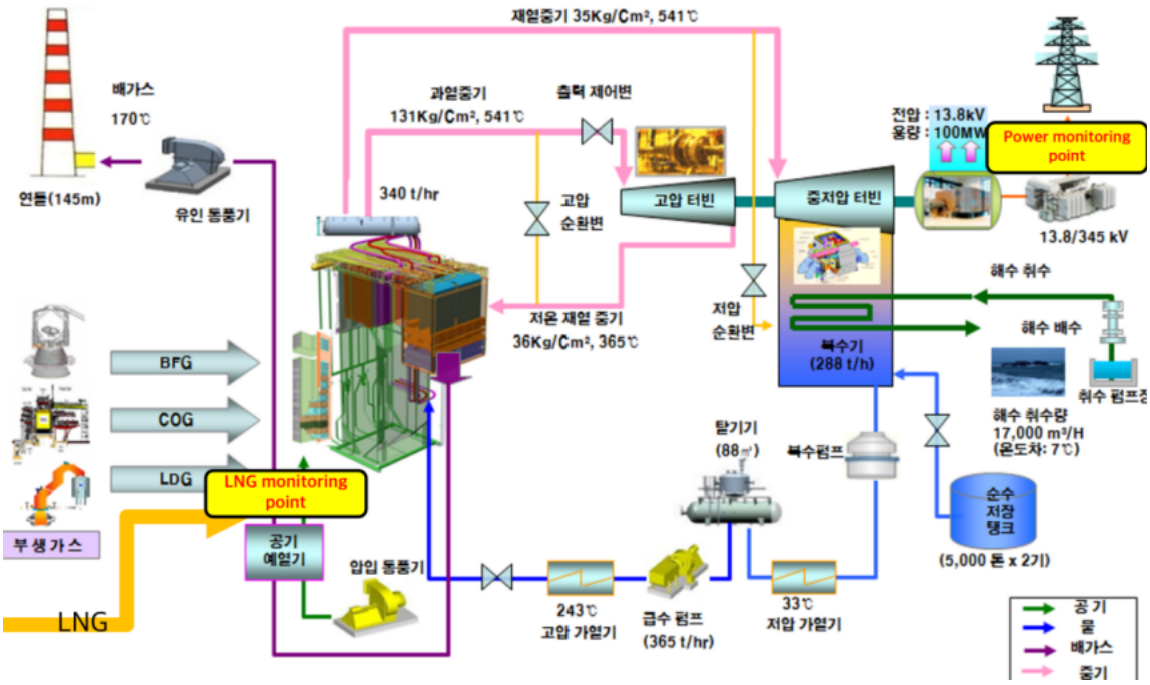


Figure 7. monitoring points

1.2 Cross checking

The amount of power generation and LNG consumption is crosschecked with the receipt, if there is any deference between monitored data and receipt, the reason of the deference must be found out. If it cannot be found out, for conservative consideration, the data leading to lower Emission Reductions will be used for calculation.

2.3 Training

Internal training is provided to operational staff to enable them to undertake the tasks required by the monitoring plan and to share the latest information on relevant laws and regulations.

3. Procedures for handling internal auditing and non-conformities

Internal auditing procedures are followed after the data were collected and the emission reduction was calculated. The procedures of internal auditing are as follows:

(a) Set up an internal audit team, the team members are mainly consisted by the VCS team

(b) Set up an internal auditing plan, the main process of the internal auditing is to check the accuracy of the calculation and data collection. Members should not audit the parts which they are in charge of.

(c) If some non-conformities are found, the one who in charge of should be informed and be ordered to correct

(d) The Emission Reduction calculation and monitoring report should be revised according to the result of the internal auditing.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

According to methodology ACM0012 ver.4.0.0, the baseline emission calculation shall be determined as follows:

$$BE_y = BE_{En,y} + BE_{flst,y} \quad (1)$$

Where:

BE_y	The total baseline emissions during the year *y* in tCO_2.
$BE_{En,y}$	The baseline emissions from energy generated by the project activity during the year *y* in tCO_2.
$BE_{flst,y}$	Baseline emissions from fossil fuel combustion, if any, either directly for

flaring of waste gas or for steam generation that would have been used for flaring the waste gas in the absence of the project activity (tCO_2).

As for the proposed project, there is no fossil fuel combusted for flaring the waste gas in the absence of the proposed project. So $BE_{flst,y}=0$.

1. Baseline emissions from energy generated by the project activity ($BE_{En,y}$).

According to the methodology BE_y of The proposed project should be calculated as follows

$$BE_{En,y} = BE_{Elec,y} + BE_{Ther,y} \quad \textbf{(2)}$$

Where:

$BE_{Elec,y}$	Baseline emissions from electricity during the year y in tCO_2.
$BE_{Ther,y}$	Baseline emissions from thermal energy (due to heat generation by elemental processes) during the year y (tCO_2).

(a) Baseline emissions from electricity ($BE_{Elec,y}$) generation.

$$BE_{Elec,y} = f_{cap} * f_{wcm} * \sum_j \sum_i (EG_{i,j,y} * EF_{Elec,i,j,y}) \quad \textbf{(3)}$$

Where:

$BE_{elec,y}$	Baseline emissions due to displacement of electricity during the year *y* (tCO_2)
$EG_{i,j,y}$	The quantity of electricity supplied to the recipient *j* by generator, which in the absence of the project activity would have been sourced from source *i* (the grid) during the year *y* in MWh.
$EF_{elec,i,j,y}$	The CO_2 emission factor for the electricity source *i* (gr for the grid), displaced due to the project activity, during the year *y* (tCO_2/MWh).
f_{wcm}	Fraction of total electricity generated by the project activity using waste energy. This fraction is 1 if the electricity generation is purely from use of waste energy.
f_{cap}	Factor that determines the energy that would have been produced in project year *y* using waste energy generated at a historical level, expressed as a fraction of the total energy produced using waste source in year *y*. The ratio is 1 if the waste energy generated in

project year *y* is the same or less than that generated at a historical level.

For f_{wcm} *calculation of* the project, calculating f_{wcm} is not available due to technical constraints; the emissions due to auxiliary fossil fuel combusted will be calculated in project emission according to ACM0012 ver04 equation 41.

As the project is a Greenfield power plant, f_{cap} of this project is 1.

For this project, the power is exported to the grid, so $EF_{elec,i,j,y} = EF_{y,}$. The CO_2 emission factor of the electricity EF_y was calculated following the guidance provided in the "Tool to calculate the emission factor for an electricity system".

The result of EF_y *is 0.6345*(tCO_2/MWh).

(b) Baseline emissions for generation of thermal energy ($BE_{ther,y}$) and steam-generated mechanical energy

This project doesn't claim GHG emission reductions from thermal energy for conservative, so this step is skipped.

Calculation of Baseline emission reductions:

$$BE_y = BE_{En,y} + BE_{flst,y}$$

$$= BE_{Elec,y} + BE_{Ther,y} + BE_{flst,y}$$

$$= f_{cap} * f_{wcm} * \sum_j \sum_i (EG_{i,j,y} * EF_{Elec,i,j,y}) + BE_{Ther,y} + BE_{flst,y}$$

= 1×1×6168791.59MWh×0.6345 tCO_{2e}/MWh+0+0

= 3,914,098 (tCO2e)

Calculation of Baseline emission reductions by years:

year	f_{cap}	f_{wcm}	$EG_{j,y}$ (MWh)	EF_y (tCO_{2e}/MWh)	$BE_{Elec,y}$ (tCO_{2e})	$BE_{Ther,y}$ (tCO_{2e})	$BE_{flst,y}$ (tCO_{2e})	BE_y (tCO_{2e})
2017.7.1-2017.12.31	1	1	1,166,684.21	0.6345	740,261	0	0	740,261

2018	1	1	2,596,035.65	0.6345	1,647,185	0	0	1,647,185
2019	1	1	2,406,071.74	0.6345	1,526,653	0	0	1,526,653
Total	/	/	6,168,791.59	/	3,914,098	/	/	3,914,098

Detail information for calculation of Baseline Emission calculation can be found in the excel file attachment of "2nd_ER calculation sheet for Hyundai phase II monitoring".

5.2 Project Emissions

Project Emissions include emissions due to (1) combustion of auxiliary fuel to supplement waste gas/heat, and (2) electricity emissions due to consumption of electricity for cleaning of gas before being used for generation of energy or other supplementary electricity consumption.

$$PE_y = PE_{AF,y} + PE_{EL,y} \quad (4)$$

Where:

PE_y The total project emissions during the year y

$PE_{AF,y}$ Project activity emissions from on–site consumption of fossil fuels by the unit process(es) and/or co–generation plant(s) if they are used as supplementary fuels

$PE_{EL,y}$ Project activity emissions from on–site consumption of electricity for gas cleaning equipment or other supplementary electricity consumption (tCO2) (as per Table 1: Summary of gases and sources included in the project boundary)

In this project, although LNG is not used for the purpose of generation, LNG is used for sparking when starting up and in case the NCV of waste gas is too low to burn.

The emission due to consumption of LNG was calculated according to latest approved tool "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion".

According to the tool CO2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO2 emission coefficient of those fuels, as follows:

$$PE_{AF,j,y} = \sum_i AF_{i,j,y} \times NCV_{i,y} \times EF_{CO2,i,y} \quad \textbf{(5)}$$

= 1,151,978Nm^3 X 1000 / 22.4L/mol X 16g/mol / 10^9 X 50.4 TJ/Gg X 58,300kgCO_2/TJ /1000

= 0.8228 Gg X 50.4 TJ/Gg X 58,300kgCO_2/TJ /1000

= 2418 tCO_2e

Where:

$AF_{i,j,y}$	LNG consumed on-site for power generation
NCV_i	Net calorific value for fuel LNG
$EF_{CO2,i,y}$	Carbon dioxide emissions factor for LNG
$PE_{AF,y}$	Project activity emissions from on-site consumption of fossil fuels by the unit process(es) and/or co-generation plant(s) if they are used as supplementary fuels

Calculation of $PE_{AF,y}$ by years

Year	$AF_{i,j,y}$ (Nm^3)	$AF_{i,j,y}$ (Gg)	NCV_i (TJ/Gg)	$EF_{CO2,i,y}$ (kgCO2/TJ)	$PE_{AF,y}$ (tCO_{2e})
2017.7.1-2017.12.31	91026	0.0650	50.4	58,300	191
2018	495037	0.3536	50.4	58,300	1,039

2019	565915	0.4042	50.4	58,300	1,188
Total	1,151,978	0.8228	/	/	2,418

As for $PE_{EL,y}$, according to Methodology ACM0012, project emissions due to electricity consumption of gas cleaning equipment or other supplementary electricity consumption are calculated by using latest approved tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

According to the Tool, baseline methodology procedure should be followed: first a generic approach to calculate emissions from consumption of electricity is introduced. Then guidance on the determination of the emission factor for electricity generation is provided. Finally, simplified alternative approaches to the generic approach are introduced. These simplified alternative approaches are only applicable to scenario B and to project and leakage emissions.

Generic approach

According to the tool, the project emissions from consumption of electricity are calculated based on the following formula

$$PE_{EL,y} = \sum_{j} EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \quad (6)$$

= 25,007.04 MWh X 0.6345 tCO_2/MWh X(1+0.2)

= 19,040 tCO2e

Where:

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

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

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

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

Calculation of $PE_{EL,y}$ by years

Year	$EC_{PJ,j,y}$ (MWh)	$EF_{EL,j,y}$ (tCO2/MWh)	$TDL_{j,y}$	$PE_{EL,y}$ (tCO_{2e})
2017.7.1-2017.12.31	5034.24	0.6345	20%	3,833
2018	9,986.40	0.6345	20%	7,604
2019	9,986.40	0.6345	20%	7,604
Total	25,007.04	0.6345	20%	19,040

Calculation of Project emission reductions:

As detail described above calculation of emission reductions are calculated as follows

$$PE_y = PE_{AF,y} + PE_{EL,y} \quad (7)$$

$$= \sum_i AF_{project,i,y} \times NCV_i \times EF_{CO2,i,y} + PE_{EL,y}$$

= 2,418 +19,040

= 21,458 (tCO_{2e})

Calculation of Project emission reduction by years

Year	$PE_{AF,y}$ (tCO_{2e})	$PE_{EL,y}$ (tCO_{2e})	PE_y (tCO_{2e})
2017.7.1-2017.12.31	191	3,833	4,024
2018	1,039	7,604	8,643
2019	1,188	7,604	8,792
Total	2418	19,040	21,458

Detail information for calculation of Project Emission calculation can be found in the excel file attachment of "ER calculation sheet".

5.3 Leakage

In accordance with ACM 0012, no leakage is considered.

5.4 Net GHG Emission Reductions and Removals

Emission Reduction of the proposed project can be determined as follows:

$$ER_y = BE_y - PE_y - LE_y \quad (8)$$

= 3,914,098 – 21,458 – 0

= 3,892,640 tCO_2e/yr

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
2017.7.1-2017.12.31	740,261	4,024	0	736,237
2018	1,647,185	8,643	0	1,638,542
2019	1,526,653	8,791	0	1,517,861
Total	3,914,098	21,458	0	3,892,640

APPENDIX 1: INFORMATION ABOUT PROJECT ENERGY BALANCE

According to the approved methodology ACM0012, if there is a decrease in the energy recovery of WECM(s) in the extended boundary excluding the project WECM, a technical justification along with energy balance should be demanded explaining why the reduction in recovery is not due to the CDM project.

In order to improve there is no decrease in the energy recovery of WECM(s) in the extended boundary excluding the project WECM(s), the comparison of energy balance is as follows;

<The designed energy balance in the VCS PD>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage
COG	542,221	23.20%	1,794,535	76.80%	2,336,756	100%
BFG	4,906,450	69.20%	2,182,446	30.80%	7,088,896	100%
LDG	997,200	80.60%	239,837	19.40%	1,237,037	100%
Total	6445871	60.50%	4,216,818	39.50%	10,662,689	100%

<The actual energy balance in 2017.7~2017.12>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage
COG	409,522	23.19%	1,356,286	76.81%	1,765,808	100%
BFG	1,920,657	79.19%	504,616	20.81%	2,425,273	100%
LDG	454,706	97.29%	12,669	2.71%	467,375	100%
Total	2,784,885	59.78%	1,873,571	40.22%	4,658,456	100%

<The actual energy balance in 2018>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage
COG	1,020,267	28.28%	2,587,021	71.72%	3,607,288	100%
BFG	4,090,827	72.21%	1,574,237	27.79%	5,665,064	100%
LDG	996,586	97.84%	22,013	2.16%	1,018,599	100%
Total	6,107,680	59.35%	4,183,271	40.65%	10,290,951	100%

<The actual energy balance in 2019>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage
COG	870,636	23.29%	2,866,810	76.71%	3,737,446	100%
BFG	3,726,050	80.16%	922,262	19.84%	4,648,312	100%
LDG	1,008,211	96.59%	35,622	3.41%	1,043,833	100%
Total	5,604,897	59.44%	3,824,694	40.56%	9,429,591	100%

As described above, the ratio of 'WECM stream for alternative uses' in designed energy balance is 39.5%, and the ratio in actual energy balances from 2017 to 2019 are 40.22%, 40.65%, 40.56%. Therefore, there is no decrease in the energy recovery of WECM(s) in the extended boundary excluding the project WECM.

APPENDIX 2: MONITORING DATAS FOR EMISSION REDUCTION CALCULATION

Date	Power generation (Mwh)	LNG consumption (Nm^3)	Electricity consumption (Mwh)
2017-7	222,960.13	2,771	848.16
2017-8	223,121.91	2,000	848.16
2017-9	186,872.56	2,000	820.80
2017-10	212,372.17	5,372	848.16
2017-11	154,440.66	47,692	820.80
2017-12	166,916.78	31,191	848.16
2018-1	192,948.34	162,180	848.16
2018-2	192,894.03	120,173	766.08
2018-3	224,816.05	142	848.16
2018-4	217,966.91	1,865	820.80
2018-5	242,895.63	12,639	848.16
2018-6	235,792.13	19,747	820.80
2018-7	209,486.04	-	848.16
2018-8	254,913.74	-	848.16
2018-9	197,430.16	-	820.80
2018-10	209,815.86	5,453	848.16
2018-11	206,384.57	162,466	820.80
2018-12	210,692.22	10,372	848.16
2019-1	198,394.67	77,800	848.16
2019-2	151,211.81	89,801	766.08
2019-3	182,357.91	22,377	848.16
2019-4	195,400.36	6,266	820.80
2019-5	248,144.91	44,449	848.16
2019-6	210,803.92	27,311	820.80
2019-7	235,381.18	5,176	848.16

2019-8	236,388.05	11,921	848.16
2019-9	185,050.84	3,875	820.80
2019-10	199,455.83	3,900	848.16
2019-11	186,386.43	26,228	820.80
2019-12	177,095.82	246,811	848.16
Total	6,168,791.59	1,151,978	25,007

APPENDIX 3: EVIDENCES OF SUSTAINABLE DEVELOPMENT GOAL

Evidence for SDG 8:

Confirmation letter of hiring local residence for the project

At the very beginning of the project implementation in 2013, the project mainly employed the unemployed and/or under-poverty persons in the nearby villages, in order to relieve the unemployment issues. Up to now, there are 136 employees working for the project, including 4 female employees and 132, 11 of them were unemployed lived nearby the project area.

Hyundai Green power CO., Ltd

2022.8.24

Comparison of our salary level against the legal minimum wage

From 2017 to 2019, Our lowest-paid employee earned about fifty percent or more than compared with minimum wage in this country.

Please refer to the attracted file for information on the legal minimum wage for each year.

Hyundai Green power CO. Ltd

2022.8.24

Evidence for SDG 7 and SDG 13: From project operation date onwards, the electricity supplied to the grid and corresponding emission reductions in every VCS monitoring period have been listed in below table.

Period		Electricity	ER	Status	Program
From	To	MWh	tCO_2e		
June 1st, 2013	June 30th, 2017	9,596,668	6,008,438	Approved	VCS
July 1st, 2017	December 31th, 2019	6,168,791.59	3,892,640	Issuance request	VCS
Total		15,765,459.59	9,901,078.00	_	_

Please refer to section 4 and section 5 of this monitoring report for the evidence of the project's contribution during this monitoring period to SDG 7 and SDG 13.