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 3*
Report ID	
Date of Issue	*07-03-2021*
Project ID	*1146*
Monitoring Period	*01-06-2013 to 30-06-2017*
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CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The Hyundai Steel 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 1st monitoring period is from June 1st, 2013 to June 30th, 2017, Time-line of the project implementation status is described below:

Activity	Date
#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

During the 1stmonitoring period, 9,596,668 MWh electricity was exported to grid, and 6,008,438tCO2e 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)

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 1st monitoring period is from June, 1, 2013 to June, 30, 2017（The owner renounced the Emission Reduction from May 17, 2013 to May, 31, 2013 for no data available）

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.

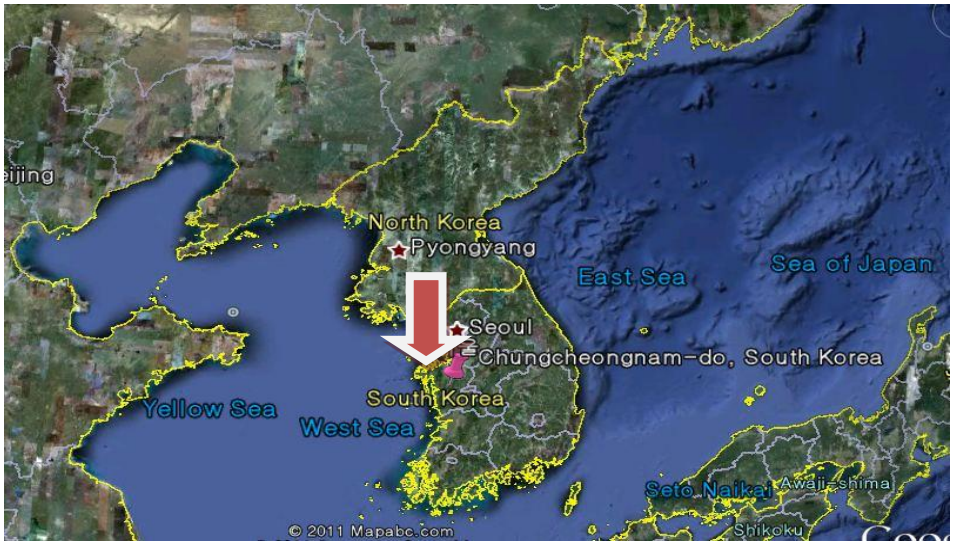


Figure 1. The location of the Chungchongnam province in Republic of Korea

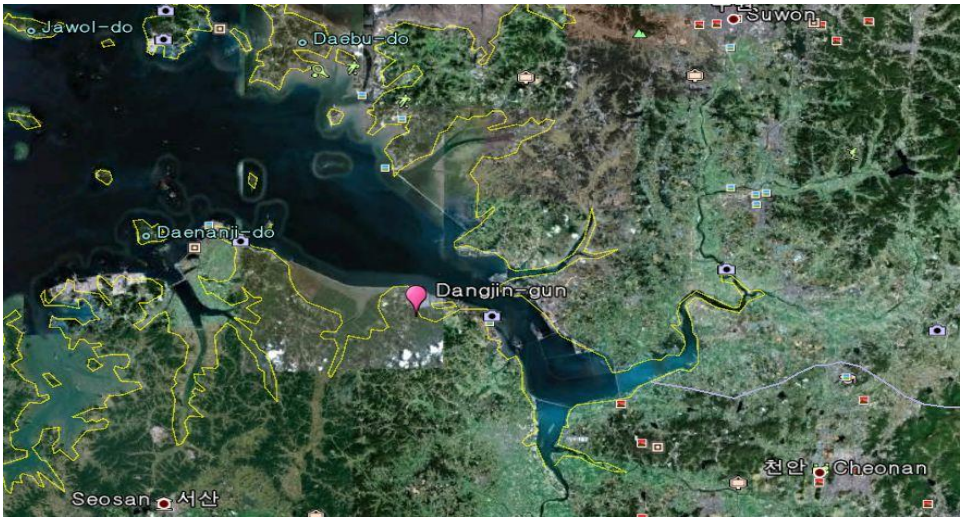


Figure 2. The location of Dangjin county in Chungchongnam Do

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 the waste gas. So the project proponent 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.

- Energy saving (recycling) by using waste energy,

- Using local energy as opposed to importing energy from foreign countries,

- Reducing environmental pollution, and meeting the current environmental policies of South Korea.

Additionally, the project is innovative in that it differs from the traditional thermal electricity generation process, as it uses a high efficiency compound generation system decreasing the amount of imported fuel and reducing emissions by approximately 1,441,680 tCO2e/year.

2 SAFEGUARDS

2.1 No Net Harm

N/A

2.2 Local Stakeholder Consultation

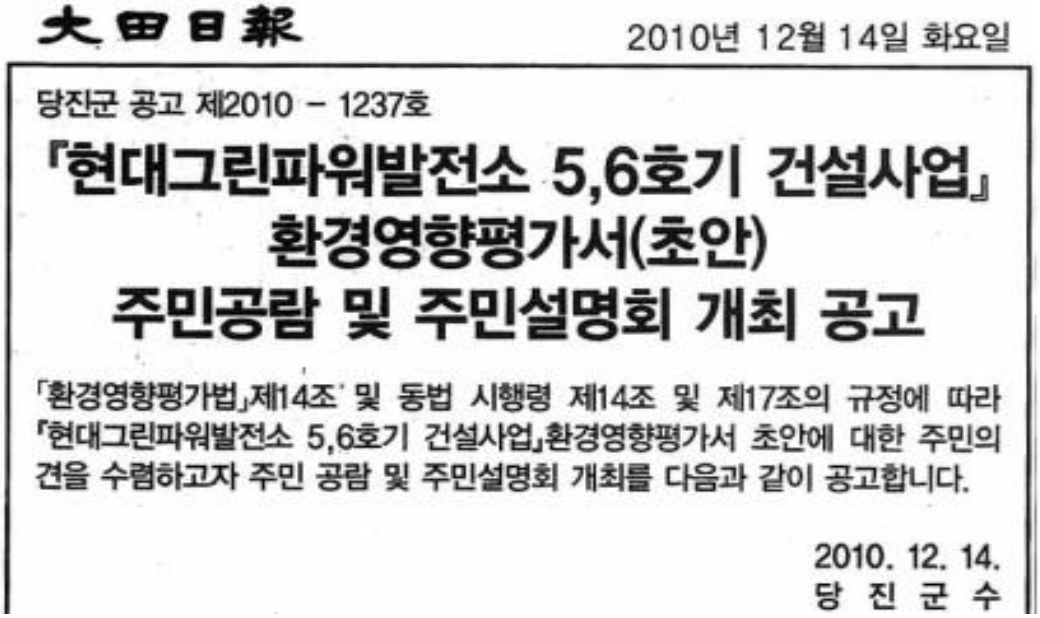
The owner of the Project held a series of meetings with local residents for the purpose of informing the local residents about the environmental effects and the development plans including environment division and local governments, and also received feedbacks from them. The residents expressed their 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 6. Stakeholders' comments public notice

Figure 7. 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 city focused onenvironment resources and the impact of marine products	All of the comments have been accepted and the project owner is working on the corrective actions to address these comments.
pyeontak city	No comments	
local residents	No comments	

During constructing and operating period, the project owner has took many actions to address the stake holders' comments. The main actions are as follows:

1. Air pollution:
To predict the impact on Air pollution, CALPUFF simulation model was used. When Hyundai Green power CO analysed the risk analysis, Hyundai Green power CO followed the Korea Department of Environment guideline to predict the average daily impact. Hyundai Green power CO has installed the Dust Collector and Scrubber to meet the Air pollution limit. Hyundai Green power CO has measured Ammonia, hydrogen cyanide, cadmium, hexavalent chromium, nickel. All of those chemicals have been predicted under the regulated level.

2. Marine ecological environment
According to Environmental Impact analysis, Hyundai Greenpower has selected the multiple points within 15km from the plant to analyse the impact on the Marine ecological environment in every quarterly. Those analysis includes the Temperature, pH, Salinity, DO, COD, SS, TN, TP, PCB, Cr, Cd, Zn, Cu, Pb, As, Hg, CN. Zooplankton, plant plankton, fishery, The analysis has been followed under Marine Pollution Standard Analysis, 2002

3. Public health care
Hyundai Green power CO has predicted two criteria: Cancer Risk and Non-Cancer related Risk (hazard quotient). The health impact index includes Ammonia (non- Carcinogenesis), hydrogen cyanide (non- Carcinogenesis), cadmium (Carcinogenesis), hexavalent chromium(Carcinogenesis), nickel (Carcinogenesis). The model CALPUF shows that the detect levels are less than the limits guided in Environmental Health Regulation, Appendix 1.

4. Input-Output water management
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).

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 281 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. According to the record, except August 2016,the generator shut down several time every month during the monitoring period, the detail information of shut down has been provided to DOE.

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 X2set X 24hr X 365 days = 7,884,000 kWh/yr

Fan for LDG

240kW 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. Therefore, total amount of the electricity consumption of booster fan is 40,778 MWh for the 1st monitoring period. Detail calculation can refer to 4.2 Data and Parameters Monitored.

The project was implemented according to the registered monitoring plan and applied methodology. Only minor changes in the monitoring and measurement section from registered PD. As a result, the deviation of proposed project will not impact the applicability of the methodology, additionality, or the appropriateness of the baseline scenario. The GHG emission has been calculated by conservative approach.

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	calculated
Value applied	0.7177
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	$EF_{grid,BM,y}$
Data unit	tCO_2/MWh
Description	Build Margin emission factor
Source of data	calculated
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	calculated
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	$TDL_{j,y}$
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	See attachment EF_{grid} calculation
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	**$EFCO2,i,y$**
Data unit	tCO2/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	See attachment EF_{grid} calculation
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 fcap 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 record every day.
Value monitored	9,596,668
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 Type : Actaris Accuracy class : 0.5s Serial number : 62014885 Backup meter M6 Type : Actaris Accuracy class : 0.5s Serial number : 62014886

<table>
<tr><td></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>28-04-2012</td><td>28-10-2016</td><td rowspan="16">Korea Testing Certification(KTC)</td></tr>
<tr><td>28-10-2016</td><td>28-04-2019</td></tr>
<tr><td rowspan="2">M2</td><td>28-04-2012</td><td>28-10-2016</td></tr>
<tr><td>28-10-2016</td><td>28-04-2019</td></tr>
<tr><td rowspan="2">M3</td><td>28-04-2012</td><td>28-10-2016</td></tr>
<tr><td>28-10-2016</td><td>28-04-2019</td></tr>
<tr><td rowspan="2">M4</td><td>28-04-2012</td><td>28-10-2016</td></tr>
<tr><td>28-10-2016</td><td>28-04-2019</td></tr>
<tr><td rowspan="2">M5</td><td>28-04-2012</td><td>28-10-2016</td></tr>
<tr><td>28-10-2016</td><td>28-04-2019</td></tr>
<tr><td rowspan="2">M6</td><td>28-04-2012</td><td>28-10-2016</td></tr>
<tr><td>28-10-2016</td><td>28-04-2019</td></tr>
<tr><td rowspan="2">M7</td><td>28-04-2012</td><td>28-10-2016</td></tr>
<tr><td>28-10-2016</td><td>28-04-2019</td></tr>
<tr><td rowspan="2">M8</td><td>28-04-2012</td><td>28-10-2016</td></tr>
<tr><td>28-10-2016</td><td>28-04-2019</td></tr>
</table>
Backup meter M7
Type : Actaris
Accuracy class : 0.5s
Serial number : 62014887

Backup meter M8
Type : Actaris
Accuracy class : 0.5s
Serial number : 62014889
</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>The amount of power generation is crosschecked with the receipt.
The meters are calibrated every3.5years(with error testing at the 4th 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>
</table>

Comments	-

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	40,778
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)/12X49/1000=40,778MWh
Comments	-

Data / Parameter	AFi,j,y
Data unit	Nm^3
Description	LNG consumed on-site for power generation.

<table>
<tr><td>Source of data</td><td>Measurement records.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>Direct measurement by project participants through standard flow meter continually.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>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</td></tr>
<tr><td>Value monitored</td><td>23,635,064</td></tr>
<tr><td>Monitoring equipment</td><td><table>
<tr><td>Tag No.</td><td>Model</td><td>Uncertainty</td><td>remark</td></tr>
<tr><td>FQIT-02 (previous)</td><td>SM-RI-X</td><td>±1%</td><td>Has been replaced by new meters listed below in 2014.09.03</td></tr>
<tr><td>10513238 (new)</td><td>G4000</td><td>± 0.62%</td><td>New installed in 2014.09.03</td></tr>
</table></td></tr>
<tr><td>QA/QC procedures to be applied</td><td>The meters would be calibrated by LNG supplier when the meter is at abnormal condition.</td></tr>
<tr><td>Purpose of the data</td><td>Calculation of project emissions</td></tr>
<tr><td>Calculation method</td><td>-</td></tr>
<tr><td>Comments</td><td>-</td></tr>
</table>

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[1]
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 CO2 emissions from fossil fuel combustion".

[1] The NCV_i is used only in calculating project emission caused by LNG consumption. And in the calculation for EFOM and EFBM, the specific NCV of LNG for each power plant was adopted.

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 CO2 emissions from fossil fuel combustion"IPCC default values at the upper limit of the uncertainty at a 95% was considered.

Data / Parameter	$EF_{AF,i,}$
Data unit	kgCO2/TJ
Description	CO2 emissions factor for LNG.
Source of data	Measurement records.
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 CO2 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.

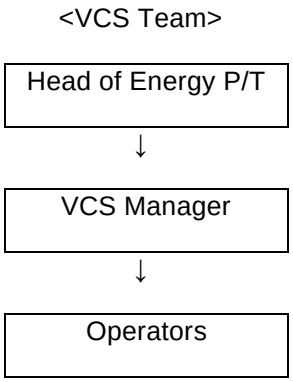
Data / Parameter	Abnormal operation of the project facility including emergencies and shut down
Data unit	Hours
Description	The hours of abnormal operation of parts of project facility that can have an impact on waste energy generation and recovery
Source of data	Operation and production records
Description of measurement methods and procedures to be applied	The starting time and ending time of abnormal operation will be recorded by DCS when abnormal operation happened.
Frequency of monitoring/recording	Daily, aggregated annually
Value monitored	0
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of the data	This parameter is 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	When the abnormal conditions happened, the time of abnormal conditions will be record and the electricity generated during abnormal conditions will be deducted during the calculation of Emission Reduction
Comments	There is no abnormal operation that can have an impact on waste energy generation and recovery during monitoring period， For regular shut down, there is no power generated, so no Emission Reduction needs to be deducted.

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.

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.

Since the proposed project is a single location project, the implementation of sampling approaches is not applicable.

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 (tCO2).

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

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

Where:

$BE_{Elec,y}$	Baseline emissions from electricity during the year y in tCO2.
$BE_{Ther,y}$	Baseline emissions from thermal energy (due to heat generation by elemental processes) during the year y (tCO2).

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

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

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 $EF_{elec,i,j,y}$= $EF_{elec,gr,j,y,}$. The CO_2 emission factor of the electricity $EF_{elec,gr,j,y}$ was calculated following the guidance provided in the “Tool to calculate the emission factor for an electricity system”.

The result of $EF_{elec,i,j,y}$ *is 0.6345*(tCO2/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:

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

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

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

= 1×1×9,596,668MWh×0.6345 tCO_{2e}/MWh+0+0

= 6,089,086 (tCO2e)

Calculation of Baseline emission reductions by years:

year	f_{cap}	f_{wcm}	$EG_{i,j,y}$ (MWh)	$EF_{Elec,i,j,y}$ (tCO_{2e}/MWh)	$BE_{Ther,y}$	$BE_{flst,y}$	BE_y (tCO_{2e})
2013.6.1-2013.12.31	1	1	699,445	0.6345	0	0	443,798
2014	1	1	2,434,415	0.6345	0	0	1,544,636
2015	1	1	2,593,225	0.6345	0	0	1,645,402
2016	1	1	2,606,210	0.6345	0	0	1,653,641
2017.1.1-2017.6.30	1	1	1,263,372	0.6345	0	0	801,610
Total	/	/	9,596,668	/	/	/	6,089,086

Detail information for calculation of Baseline Emission calculation can be found in the excel file attachment of "1st_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 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

$PE_{AF,y}$ 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)

$PE_{EL,y}$ The total project emissions during the year y

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:

$$\mathrm{PE}_{\mathrm{AF,y}} = \sum_{i} AF_{project,i,y} * NCV_{i} * EF_{AF,i} \quad \textbf{(5)}$$

= 23,632,293Nm^3 X 1000 / 22.4L/mol X 16g/mol / 10^9 X 50.4 TJ/Gg X 58,300kgCO2/TJ

= 16.88 Gg X 50.4 TJ/Gg X 58,300kgCO2/TJ

= 49,599 tCO2e

Where:

$AF_{product\ plant,l,j}$	LNG consumed on-site for power generation
NCV_i	Net calorific value for fuel LNG
$EF_{AF,i}$	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	$AF_{product\ plant,l,j}$ (Nm^3)	NCV_i (TJ/Gg)	$EF_{AF,i}$ (kgCO2/TJ)	$PE_{AF,y}$ (tCO_{2e})
2013.6.1-2013.12.31	8,366,014	50.4	58,300	17,559
2014	9,451,207	50.4	58,300	1,986
2015	2,598,372	50.4	58,300	5,453
2016	2,992,053	50.4	58,300	6,280

2017.1.1-2017.6.30	224,647	50.4	58,300	471
Total	23,632,293	/	/	49,599

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

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

= 40,778 MWh X 0.6345 tCO2/MWh X(1+0.2)

= 31,048tCO2e

Where:

$PE_{EL,y}$	Project emissions from electricity consumption in year y (tCO2/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 (tCO2/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})
2013.6.1-2013.12.31	5,825	0.6345	0.2	4,435

2014	9,986	0.6345	0.2	7,604
2015	9,986	0.6345	0.2	7,604
2016	9,986	0.6345	0.2	7,604
2017.1.1-2017.6.30	4,993	0.6345	0.2	3,802
Total	40,778	/	/	31,048

Calculation of Project emission reductions:

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

$$PE_y = PE_{AF,y} + PE_{EL,y}$$

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

= 49,599 +31,048

= 80,648 (tCO_2e)

Calculation of Project emission reduction by years

Year	$PE_{AF,y}$ (tCO_2e)	$PE_{EL,y}$ (tCO_2e)	PE_y (tCO_2e)
2013.6.1-2013.12.31	17,559	4,435	21,994
2014	1,986	7,604	27,440
2015	5,453	7,604	13,057
2016	6,280	7,604	13,883
2017.1.1-2017.6.30	471	3,802	4,273
Total	49,599	31,048	80,648

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:

$$ER_y = BE_y - PE_y - LE_y \quad (7)$$

= 6,089,086 – 80,648 – 0

= 6,008,438 tCO_2e/yr

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

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)
2013.6.1-2013.12.31	443,798	21,994	0	421,804
2014	1,544,636	27,440	0	1,517,196
2015	1,645,402	13,057	0	1,632,344
2016	1,653,641	13,883	0	1,639,757
2017.1.1-2017.6.30	801,610	4,273	0	797,336
Total	6,089,086	80,648	-	6,008,438

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 2013>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage
COG	314,433	29.60%	747,922	70.40%	1,062,355	100%
BFG	1,300,654	77.54%	376,818	22.46%	1,677,472	100%
LDG	160,385	80.53%	38,770	19.47%	199,155	100%
Total	1775472	60.41%	1,163,510	39.59%	2,938,982	100%

<The actual energy balance in 2014>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage
COG	1,018,116	29.02%	2,489,759	70.98%	3,507,875	100%
BFG	4,589,713	74.36%	1,582,906	25.64%	6,172,619	100%
LDG	867,890	77.98%	245,102	22.02%	1,112,992	100%
Total	6,475,719	60.00%	4,317,767	40.00%	10,793,486	100%

<The actual energy balance in 2015>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage

COG	1,084,436	30.63%	2,456,032	69.37%	3,540,469	100%
BFG	3,990,013	65.77%	2,076,987	34.23%	6,067,000	100%
LDG	1,013,886	94.91%	54,357	5.09%	1,068,243	100%
Total	6,088,335	57.03%	4,587,377	42.97%	10,675,712	100%

<The actual energy balance in 2016>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage
COG	1,086,687	31.52%	2,360,585	68.48%	3,447,272	100%
BFG	4,136,626	68.57%	1,896,164	31.43%	6,032,791	100%
LDG	959,366	95.62%	43,947	4.38%	1,003,313	100%
Total	6,182,680	58.98%	4,300,697	41.02%	10,483,376	100%

<The actual energy balance in 2017>

Waste Gas	For Hyundai Greenpower		For alternative uses (Hyundai Steel)		Total	
	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage	Amount (Gcal)	Percentage
COG	512,883	24.76%	1,558,380	75.24%	2,071,263	100%
BFG	2,481,907	70.90%	1,018,741	29.10%	3,500,648	100%
LDG	606,866	91.97%	52,973	8.03%	659,838	100%
Total	3,601,656	57.80%	2,630,093	42.20%	6,231,749	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 2013 to 2017 are 39.59%, 40.00%, 42.97%, 41.02%, 42.20%. 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)
2013-6	85,610	2,106,143	820.80
2013-7	80,951	1,251,815	848.16
2013-8	59,804	1,340,805	848.16
2013-9	127,319	2,197,372	820.80
2013-10	163,636	659,783	848.16
2013-11	174,906	810,096	820.80
2013-12	7,219	-	848.16
2014-1	176,195	1,237,680	848.16
2014-2	187,639	1,216,503	766.08
2014-3	193,875	1,322,169	848.16
2014-4	223,474	1,461,054	820.80
2014-5	220,047	1,472,502	848.16
2014-6	189,865	1,404,561	820.80
2014-7	238,008	366,352	848.16
2014-8	223,019	120,098	848.16
2014-9	210,916	91,483	820.80
2014-10	207,692	170,586	848.16
2014-11	176,015	148,115	820.80
2014-12	187,671	440,104	848.16
2015-1	232,929	462,441	848.16
2015-2	209,002	479,935	766.08
2015-3	234,481	561,112	848.16
2015-4	208,566	341,475	820.80
2015-5	196,057	185,610	848.16
2015-6	241,902	156,582	820.80
2015-7	221,483	127,021	848.16
2015-8	184,953	55,627	848.16
2015-9	209,176	8,976	820.80

2015-10	204,038	50,871	848.16
2015-11	222,746	50,869	820.80
2015-12	227,891	117,853	848.16
2016-1	235,292	698,487	848.16
2016-2	176,979	312,966	766.08
2016-3	232,187	384,268	848.16
2016-4	219,308	204,730	820.80
2016-5	226,288	488,085	848.16
2016-6	195,499	671,897	820.80
2016-7	218,104	9,092	848.16
2016-8	255,162	3,559	848.16
2016-9	222,047	320	820.80
2016-10	202,235	81,259	848.16
2016-11	223,707	22,483	820.80
2016-12	199,402	114,907	848.16
2017-1	212,275	45,660	848.16
2017-2	211,419	53,717	766.08
2017-3	198,662	11,089	848.16
2017-4	174,164	93,667	820.80
2017-5	228,124	18,615	848.16
2017-6	238,728	1,899	820.80
Total	9,596,668	23,632,293	40,778