



**Verified Carbon
Standard**

VERIFICATION REPORT FOR HYUNDAI WASTE ENERGY RECOVERY CO- GENERATION PROJECT PHASE II



Document Prepared By China Classification Society Certification
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Project Title	<i>The Hyundai Steel Waste Energy Recovery Co-generation Project Phase II</i>
Version	<i>Version 2</i>
Report ID	EC10(B)2017002

Report Title	<i>VCS Verification Report for The Hyundai Steel Waste Energy Recovery Co-generation Project Phase II</i>
Client	<i>CERPD, Inc.</i>
Pages	<i>35</i>
Date of Issue	<i>11-03-2021</i>
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Summary:

China Classification Society Certification Company(CCSC), commissioned by CERPD, Inc., has performed the 1st periodic Verification of the The Hyundai Steel Waste Energy Recovery Co-generation Project Phase II in Dangjin-gun Chungchongnam-do, Republic of Korea (hereafter referred to as “the project”), on the basis of requirements of VCS Standard (Version 4.0) /18/.

The Project has been validated by First Environment, Inc. (Validation report /15/ issued on 17/12/2014) based on the VCS PD /16/, dated on 26/11/2014. The Project was registered as a VCS project activity on 19/12/2014 under approved CDM ACM0012 (Version 4.0.0) /17/ “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”.

A desk review of documents and an on-site visit have been conducted to verify the data submitted in the monitoring report. CCSC verified the asserted emission reductions against the approved consolidated baseline methodology ACM0012 (Version 4.0.0) “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”, on the basis of the VCS Validation and Verification Manual (Version 3.2), as well as criteria given to provide for consistent project operations, monitoring and reporting.

CCSC appointed a qualified verification team in accordance with internal procedures to perform the verification.

In the course of the verification, 2 Corrective Action Requests (CARs) were raised and successfully closed.

As a result of this verification, the verification team confirms that:

- All operations of the project are implemented and installed as planned and described in the validated VCS PD;

- The monitoring plan is in compliance with the applied methodology ACM0012 version 4.0.0 “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects” and the actual monitoring has been carried out in accordance with the monitoring plan in the validated VCS PD.

- The monitoring system is in place and functional;

- The installed equipment for measuring parameters required for calculating emission reductions are calibrated appropriately.

Based on the information observed and evaluated, the verification team confirms that the emission reductions are correctly calculated in the MR /1/ (Version 03 dated 07/03/2021).

The 10-year crediting period of the project is from 17/05/2013 to 16/05/2023. This is the first monitoring period covering from 01/06/2013 to 30/06/2017 . Due to the unavailability of early data, the Project Owner voluntarily abandon the emission reductions from 17/05/2013 to 31/05/2013.

Therefore CCSC certifies 9,596,668 MWh electricity was exported to grid and the emission reductions amounting to 6,008,438 tCO₂e covering the monitoring period from 01/06/2013 to 30/06/2017 (1490 days included) and requests issuance of the equivalent VCUs.

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1 INTRODUCTION

1.1 Objective

CERPD, Inc. has commissioned CCSC to perform the 1st VCS verification of greenhouse gas (GHG) emission reductions of the project activity “The Hyundai Steel Waste Energy Recovery Co-generation Project Phase II” (hereafter referred to as “the Project”) for the period from 01/06/2013 to 30/06/2017, on the basis of requirement of VCS Standard (Version 4.0) and the approved methodology ACM0012 (Version 4.0.0) .

CCSC as the validation/verification body (VVB) of the project has been accredited as a DOE by UNFCCC and also meets the competence requirements as set out in ISO 14065:2007.

The objectives of verification are to:

- Ensure that the project activity has been implemented and operated as per the VCS project description (VCS-PD) and that all physical features (technology, project equipment, and monitoring and metering equipment) of the project are in place;
- Ensure that the monitoring report and other supporting documents provided are complete in accordance with the latest applicable version of Registration and Issuance Process and in accordance with the additional requirements stated by the VCS Association (VCSA);
- Ensure that actual monitoring systems and procedures comply with the monitoring systems and procedures described in the monitoring plan and the approved methodology;
- Evaluate the data recorded and stored as per the monitoring methodology.

1.2 Scope and Criteria

The verification scope encompasses an independent and objective review and ex-post determination of the monitored reductions in GHG emissions by the CCSC. The verification scope covers the relevant documents (e.g. the VCS-PD, the monitoring plan, the VCS monitoring report (VCS-MR), the emission reduction calculation spreadsheet, supporting documents available to the verifier and information collected through performing interviews and during the on-site assessment, VCSA's requirements publicly available, relevant rules, including the host country legislation, etc.) to be independently reviewed, the project geographical locations to be visited on-site, the related project local stakeholders to be interviewed with, and processes that are necessary to acquire objective evidence for the evaluation of the project compliance to the VCS requirements, CDM approved methodology ACM0012 (Version 4.0.0) and associated interpretations.

The above verification activities are conducted according to the VCSA requirements. In doing so, the principles of accuracy and completeness, relevance, reliability and credibility were followed.

The verification is not meant to provide any consulting service towards the PPs. However, stated requests for clarifications and/or corrective actions may provide input for improvement of the project.

1.3 Level of Assurance

CCSC has carried out the verification work to a reasonable level of assurance as per the requirement of the VCS Standard, v4.0 and ISO 14064-3:2019. It requires a reasonable level of assurance in verification that GHG assertions are free of material errors, omissions and misrepresentations. The verification conclusion is based on the VCS-PD, VCS-MR, supporting evidences made available to the verifier and information collected through performing interviews and during the on-site inspection.

1.4 Summary Description of the Project

The Hyundai Steel Waste Energy Recovery Co-generation Project is a 400MW cogeneration plant at Dangjin Hyundai Steel Mill, which is developed by Hyundai Green power Co., Ltd. The project utilizes surplus waste gases including BFG (Blast Furnace Gas), COG (Coke Oven Gas) and LDG (Linz Donawitz Gas/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.

Without the proposed project, the rest of waste gases are emitted to atmosphere after incineration, the electricity generated by the proposed project will be supplied by grid.

The Project is owned by Hyundai Green power CO., Ltd (hereafter referred to as “the PP”), and is located in Donggok-ri Songsan-myeon Dangjin-gun Chungchongnam-do, Republic of Korea. The geodetic coordinates are 126° 42'11.60" E, 36°58'58.27" N.

The Project has been validated by First Environment, Inc.(Validation report issued on 17/12/2014) based on the VCS PD, dated on 26/11/2014. The Project was registered as a VCS project activity on 19/12/2014 under approved CDM ACM0012 (Version 4.0.0) “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”.

After verification, CCSC confirms that the total emission reductions during this VCS monitoring period covers from 01/06/2013 to 30/06/2017 inclusive were 6,008,438 tCO₂e.

2 VERIFICATION PROCESS

2.1 Method and Criteria

The overall verification, from Contract Review to Verification Report & Opinion, was conducted using CCSC internal procedures.

CCSC verified the project against the requirements set in VCS Standard (Version 4.0) and other relevant VCS requirements.

2.2 Document Review

A desk review of the VCS-PD,/16/ the validation report, the applied monitoring methodology, VCS monitoring report (VCS-MR) /1/ and supporting documents was conducted by the verification team. The aim of the desk review of the documentation was to verify the completeness of the data and the information presented, to carry out the compliance check of the VCS-MR with respect to the monitoring plan and the applied methodology. Particular attention was given to the frequency of measurements, the quality of the metering equipment including calibration requirements, and the quality assurance and quality control procedures. The evaluation of data management and the quality assurance and quality control system in the context of their influence on the generation and reporting of emission reductions was also conducted.

To address the CCSC's corrective action and clarification requests, the VCS-MR /1/ was revised and resubmitted by PP. The final verification conclusion presented in this report is based on the revised VCS-MR /1/ (version03, dated on 07/03/2021).

Section 6 of this report contains a complete list of all documents and proofs reviewed by the verification team.

2.3 Interviews

From 26/10/2017, CCSC performed an on-site assessment at the physical site of the project located in Donggok-ri Songsan-myeon Dangjin-gun Chungchongnam-do, Republic of Korea.

The verification team verified that the actual implementation of the project was as described in the VCS-PD /16/ and VCS-MR /1/. This included the review of the project operation based on the evidence of on-site observation and presented documents.

During the on-site assessment, the verification team has interviewed with key personnel from the project owner (the project participant) and the consultancy.

The assessment content and topics/the persons interviewed at the on-site assessment were provided in the below table.

Date:26/10/2017	
Interview topics	Interviewed Organizations and persons
–The status of VCS project implementation. – Any changes of the VCS project. – The project on-site inspection—The evidences of construction, status and operation of key equipment, parameters monitoring and data processing activities, monitor equipment and calibration. – Monitoring data. – Quality Management; organizational structure, responsibilities and competencies. Internal QA/QC Management procedures and document control (QA/QC).	Hyundai Green power CO., Ltd. (the project owner): Woosuk Sung (Team Manager) Junsuk Ahn (Assistant Manager) Kyung soo Jung (Assistant Manager) Hyundai Steel Mill CO., Ltd. Dong-Kuk Kim (Manager)
– Preparation of Monitoring Report. – Compliance of the monitoring plan with the monitoring methodology – Compliance of monitoring with the monitoring plan – Assessment of data and calculation of GHG emission reductions	CERPD Inc. : (the Consultant): 1. Jongbum Kim 2. Wang Jun

2.4 Site Inspections

The on-site assessment involved following activities,

- 1) An assessment of the implementation and operation of the project activity as per the VCS-PD;
- 2) A review of information flows for generating, aggregating and reporting the monitoring parameters;

- 3) Interviews with relevant personnel to confirm that the operational and data collection procedures are implemented in accordance with the approved monitoring plan;
- 4) A cross-check between information provided in the monitoring report and data from other sources such as operational records or similar data sources;
- 5) A check of the monitoring equipment including calibration performance and observations of monitoring practices against the requirements of the VCS-PD and the selected methodology;
- 6) A review of calculations and assumptions made in determining the GHG data and emission reductions;

An identification of quality control and quality assurance procedures in place to prevent or identify and correct any errors or omissions in the reported monitoring parameters.

2.5 Resolution of Findings

During the verification of a project activity, to identify issues that need to be further elaborated upon, researched or added to in order to confirm that the project activity meets the VCSA requirements and can achieve credible emission reductions, the verification team will issue a Corrective Action Request (CAR), a Clarification Request (CL) or a Forward Action Request (FAR) depending on different situations.

The objective of this phase of the verification is to resolve issues related to the monitoring, implementation and operations of the registered project activity that could impair the capacity of the registered project activity to achieve emission reductions or influence the monitoring and reporting of emission reductions prior to CCSC's positive conclusion on the GHG emission reduction calculation.

Findings established during the verification can either be seen as a non-fulfilment of criteria ensuring the proper implementation of a project or where a risk to deliver high quality emission reductions is identified.

A Corrective Action Request (CAR) will be raised if one of the following occurs:

- (a) Non-compliance with the monitoring plan or methodology are found in monitoring and reporting and has not been sufficiently documented by the project participants, or if the evidence provided to prove conformity is insufficient;
- (b) Modifications to the implementation, operation and monitoring of the registered project activity has not been sufficiently documented by the project participants;
- (c) Mistakes have been made in applying assumptions, data or calculations of emission reductions that will impact the quantity of emission reductions;

(d) Issues identified in a FAR during validation to be verified during verification or previous verification(s) have not been resolved by the project participants.

A Clarification Request (CL) will be raised if information is insufficient or not clear enough to determine whether the applicable VCS requirements have been met.

A Forward Action Request (FAR) will be raised, for actions if the monitoring and reporting require attention and/or adjustment for the next verification period.

To guarantee the transparency of the verification process, the concerns raised are documented in more detail in Appendix B.

2.5.1 Forward Action Requests

There was no FAR to be addressed during the verification.

2.6 Eligibility for Validation Activities

The VVB of “China Classification Society Certification Company” (CCSC) commissioned by the project participant is one of eligible VVBs listed on the VCS website (<http://www.v-c-s.org/china-classification-society-certification-company>), and it holds the accreditation for validation/verification for the relevant sectoral scope. Therefore, CCSC is eligible for the validation/verification of the project activity.

3 VALIDATION FINDINGS

3.1 Participation under Other GHG Programs

The verification team has checked the official website of other GHG Programs like CDM, GS VER, and is able to confirm that the project is not included in any GHG programs or any other mechanisms that include GHG allowance trading. 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. The Project have not sought or received any other form of GHG-related environmental credit during this monitoring period.

The Project has been registered as a VCS project (Registration No.1146, and it did not apply for any other approved or not approved GHG programs.

In conclusion, CCSC can confirm that the project is eligible to participate under the VCS Program.

3.2 Methodology Deviations

No deviation from the methodology is needed to be submitted.

3.3 Project Description Deviations

Through on-site interviews and document review, the verification team confirm that the project was implemented according to the registered monitoring plan and applied methodology. Only minor changes in the monitoring and measurement section from registered VCS-PD (refer to in Section 4.1) . Thus, the deviation of proposed project will not impact the applicability of the methodology, additionality, or the appropriateness of the baseline scenario.

3.4 Grouped Project

Not Applicable since the project is a non-grouped project.

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

4.1.1 Project Implementation in accordance with the VCS PD

The verification team has performed an on-site visit to verify the real implementation of the project against the description in the VCS-PD /16/.

The project was verified to be a newly built waste energy recovery Co-generation power plant located in Donggok-ri Songsan-myeon Dangjin-gun Chungchongnam-do, Republic of Korea. Based on the site visit, the verification team confirms that all physical features of the Project presented in the registered VCS PD /16/ are in place and the PP has operated the Project as per the registered VCS PD /16/.

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. Figure 1 illustrates the project activity.

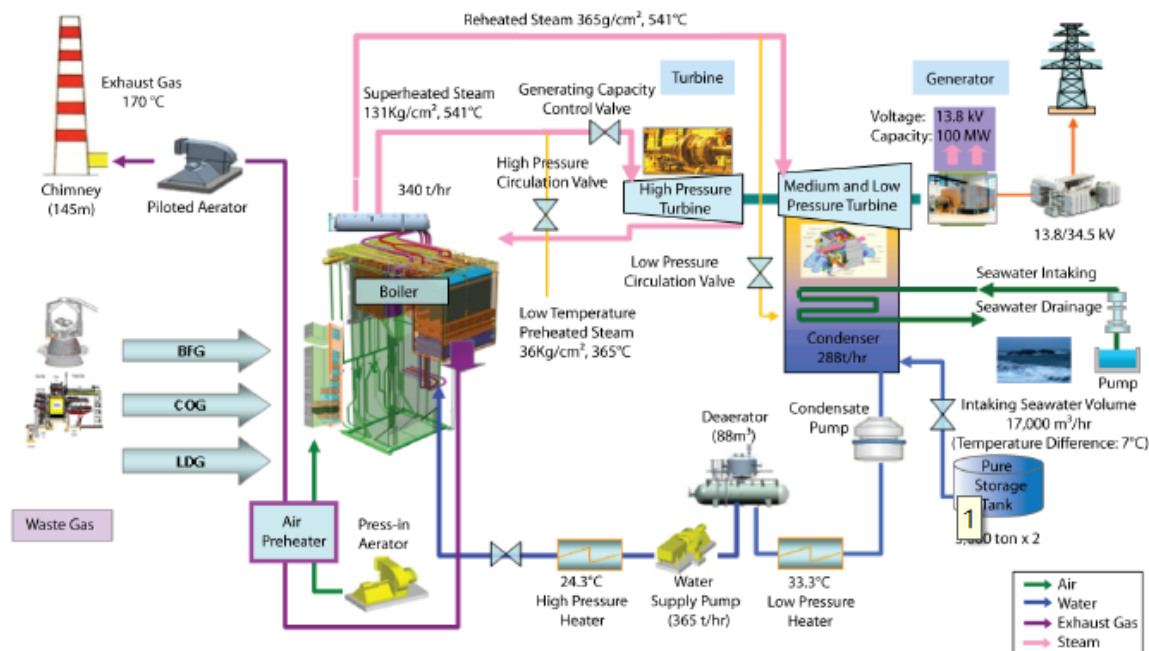


Figure 1. Project Activity Flow Chart

The Project was put into commercial operation on 17/05/2013, which was confirmed by previous validation. All the components of the project activity were in place and well operated, and no change to the project design was observed during the site visit. The operation and maintenance records for the power plant have been provided during site visit. No special event which would affect the monitoring of the project was observed during the given monitoring period.

There are no remaining issues from the previous validation. Further, the validation process for the Project did not identify any deviations from the ACM0012 methodology.

According to the information collected during on-site visit and the relevant evidence provided by project owner, CCSC can confirm that no project design change occurred during the monitoring period and the project was implemented in accordance with the registered VCS-PD /16/.

4.1.2 Compliance of monitoring with the monitoring plan

Through document review and on site visit, the verification team was able to confirm that the monitoring, including the actual monitoring system, data management has been carried out in accordance with the monitoring plan in the registered VCS-PD/16/ apart from the only minor changes shown below.

Parameter	Monitoring Requirement from VCS PD	Actual situation of the project implementation	Justification and Verification Conclusion
EG _{PJ,y}	Measurement records of electricity	Two electric fans for COG (Coke Oven Gas) and	Electricity consumption from these fans has been accounted for as project emissions.

	consumption by the Project recorded monthly.	one fan for LDG (Linz—Donawitz Process Gas) are used without metering. Electricity consumption by the Project is estimated based on electric ratings of those fans.	In this monitoring report, the amount of electricity consumption of booster fans (2 fans each with rated capacity of 450kW for COG; 1 fan with rated capacity of 240kW for LDG) was calculated with the default value of manufacture's specification with the assumption of full operation for the monitoring period. Using the fans rated power capacity and assumed round-clock operation will account maximum electricity consumption, then leading to more conservative value those results in the lower overall emission reductions of the project activity.
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4.1.3 Remaining Issues from Previous Validation or Verification

There are no remaining issues from the previous validation /15/. Further, deviations identified in the 1st verification process for the Project are minor and resolved in satisfactory way, in line with GHG principles and the ACM0012 methodology.

4.1.4 Participation under other GHG Programs

The 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.

4.1.5 Other Forms of Credit

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

By checking the letter of assurance provided by the project owner, CCSC confirm that the project is not register with another GHG program other than VCS.

4.2 Safeguards

4.2.1 No Net Harm

There are not any potential negative environmental and socio-economic impacts in this project.

4.2.2 Local Stakeholder Consultation

A stakeholder consultation meeting was held on December 21 and 22, 2010 in Dangjin. Several comments were received from local stakeholders; the VCS-MR provides additional detail on the

comments received and the actions taken in response.

4.3 AFOLU-Specific Safeguards

N/A.

4.4 Accuracy of GHG Emission Reduction and Removal Calculations

4.4.1 Parameters and information flow

The parameters required by the monitoring plan and the way CCSC has verified the information flow (from data generation, aggregation, to recording, calculation and reporting for these parameters including the values) in the monitoring reports are described below:

(1) Electricity exported

Data / Parameter	EG _{j,y}
Data unit	MWh
Description	Quantity of electricity supplied to the grid by the project activity during the year y.
Measured /Calculated /Default:	Measured
Value monitored	9,596,668
Measurement Frequency	Continuously measured and daily recorded
QA/QC Procedures Applied, including calibration	Cross check measurement results with KPX Electricity Transaction Notes (ETNs) which were aggregated monthly and annually. QA/QC procedures conducted on site was verified via review of following documents: Monthly aggregation record of the electricity supplied to the grid /3/ ETNs for the electricity delivered to the grid /8/ Calibration Records for the electricity meters /11/ VCS Monitoring Manual /10/ Training records /14/

Verification Observations/Assessment

The quantity of electricity generated by the Project and supplied to the grid is monitored continuously by 8 meters (4 Main meters, 4 back-up meters). Data recorded by the meters are aggregated monthly and reported to the grid operator, Korea Power Exchange (KPX). KPX Electricity Transaction Notes (ETNs) were used for the purposes of cross-check. The ETNs are commercial evidences for billing and it can provide the reliable basis for cross-checking the electricity delivered to grid. Moreover the ETNs provider is Korea Power Exchange (KPX), the grid operator, who is authority for this service.

The accuracy and calibration of the meters are shown as the following.

Main meter: M1		
Type	ION	
SN	PT1203A32301	
Accuracy	0.2s	
Calibration date	28/04/2012	28/10/2016
Validity	28/10/2016	04/2019
Calibrated by	Korea Testing Certification (KTC)	

Main meter: M2		
Type	ION	
SN	PT1203A32401	
Accuracy	0.2s	
Calibration date	28/04/2012	28/10/2016
Validity	28/10/2016	04/2019
Calibrated by	Korea Testing Certification(KTC)	

Main meter: M3		
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	Type		ION	
	SN		PT1203A32501	
	Accuracy		0.2s	
	Calibration date		28/04/2012	28/10/2016
	Validity		28/10/2016	04/2019
	Calibrated by		Korea Testing Certification(KTC)	
	Main meter: M4			
	Type		ION	
	SN		PT1203A32601	
	Accuracy		0.2s	
	Calibration date		28/04/2012	28/10/2016
	Validity		28/10/2016	04/2019
	Calibrated by		Korea Testing Certification(KTC)	
	Backup meter: M5			
	Type		Actaris	
	SN		62014885	
	Accuracy		0.5s	
	Calibration date		28/04/2012	28/10/2016
	Validity		28/10/2016	04/2019
	Calibrated by		Korea Testing Certification(KTC)	
Backup meter: M6				
Type		Actaris		
SN		62014886		

	Accuracy	0.5s	
	Calibration date	28/04/2012	28/10/2016
	Validity	28/10/2016	04/2019
	Calibrated by	Korea Testing Certification(KTC)	
	Backup meter: M7		
	Type	Actaris	
	SN	62014887	
	Accuracy	0.5s	
	Calibration date	28/04/2012	28/10/2016
	Validity	28/10/2016	04/2019
	Calibrated by	Korea Testing Certification(KTC)	
	Backup meter: M8		
	Type	Actaris	
	SN	62014889	
	Accuracy	0.5s	
	Calibration date	28/04/2012	28/10/2016
	Validity	28/10/2016	04/2019
	Calibrated by	Korea Testing Certification (KTC)	
	The calibration date of electricity meter is not accurate to the exact date, moreover, the calibration date does not cover the entire monitoring period in the MR (Version01). Therefore, CAR1 was raised.		
	By checking the revised MR and the Calibration Records for the electricity meters /11/, CCSC can confirm that the meter information in the updated MR (Version 02) is consistent with		

	the calibration record and the real situation confirmed by the site visit. Hence, CAR1 was closed. CCSC reviewed records of the calibration events for the current monitoring period for all eight meters used to record electricity generation data. The records indicated that the meters were operating accurately.
Conclusions	The monitoring results have been recorded consistently as per the approved frequency in the registered VCS PD /16/.

(2) Electricity Consumed

Data / Parameter	$EC_{PJ,y}$
Data unit	MWh
Description	Quantity of electricity consumed by the project in year y.
Value monitored	40,778
Measured /Calculated /Default:	As noted in Section 4.1 (Deviation), the quantity of electricity consumed by the Project ($EC_{PJ,y}$) was calculated based on the equipment rating specified by the manufacturer, and the conservative assumption is that the equipment was in continuous operation during the entire verification period.
Measurement Frequency	/
QA/QC Procedures Applied, including calibration	As per the registered VCS PD Version 4, 2 dated 4 January 2012 /16/, this parameter was obtained from Measurement records of electricity consumption by the Project recorded monthly. While actually the conservative approach was sought, calculated based on the equipment rating specified by the manufacturer, and the conservative assumption that the equipment was in continuous operation during the entire verification period is deemed proper by verification team. QA/QC procedures conducted on site was verified via review of following documents: Specifications of rated power of LDG fans /6/ Specifications of rated power of COG fans /7/ VCS Monitoring Manual /10/

Verification Observations/Assessment	Electricity consumption by the Project is estimated based on electric ratings of Project equipment. The following is the rated capacity of the fans: No fan for BFG, as the BFG gas has pressure of 800-1000 mm Hg; 2 sets of fans (450 kW) in operation with one fan (450 kW) stand-by for COG gas, with gas pressure of 400-600 mm Hg; 1 set of fan (240 kW) in operation with one fan (240 kW) stand-by for LDG gas, with gas pressure of 400-600 mm Hg.
Conclusions	This option uses the maximum electricity consumption, which result in a less emission reductions accounting. Therefore, this is conservative.

(3) LNG consumed

Data / Parameter	$AF_{i,j,y}$
Data unit	Nm ³
Description	LNG consumed on-site for power generation.
Measured /Calculated /Default:	Measured
Value monitored	23,635,064
Measurement Frequency	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.
QA/QC Procedures Applied, including calibration	Invoice for buying the LNG was used for cross-checking total LNG consumed. QA/QC procedures conducted on site was verified via review of following documents: Monthly aggregation record of the LNG gas consumed /4/ ; Monthly invoice of LNG consumption /9/ VCS Monitoring Manual /10/ Training records /14/

Verification Observations/Assessment	Flow meters are used to record the LNG consumed. Data are recorded daily and monthly aggregated. The flow meters are calibrated upon abnormal operation by Korean Testing Certification (KTC). The relevant information of flow meters has been shown in the Table below: <table><tr><td>Tag No.</td><td>Model</td><td>Accuracy</td><td>remark</td><td>Calibration entity</td></tr><tr><td>FQIT-02 (previous)</td><td>SM-RI-X</td><td>±1.0%</td><td>Has been replaced on 03/09/2014</td><td rowspan="2">Korean Testing Certification (KTC)</td></tr><tr><td>10513238 (new)</td><td>G4000</td><td>±0.62%</td><td>installed in 03/09/2014</td></tr></table>	Tag No.	Model	Accuracy	remark	Calibration entity	FQIT-02 (previous)	SM-RI-X	±1.0%	Has been replaced on 03/09/2014	Korean Testing Certification (KTC)	10513238 (new)	G4000	±0.62%	installed in 03/09/2014
Tag No.	Model	Accuracy	remark	Calibration entity											
FQIT-02 (previous)	SM-RI-X	±1.0%	Has been replaced on 03/09/2014	Korean Testing Certification (KTC)											
10513238 (new)	G4000	±0.62%	installed in 03/09/2014												
Conclusions	CCSC confirmed that: The equipment for monitoring has an appropriate accuracy and has been controlled in accordance with the registered VCS PD. /16/ The monitoring results have been recorded consistently as per the approved frequency in the registered VCS PD QA/QC procedures have been applied in accordance with the registered VCS-PD														

Data / Parameter	NCV_i (for $AF_{i,j,y}$ calculation)
Data unit	TJ/Gg
Description	Net calorific value for fuel LNG
Value monitored	50.4
Measured /Calculated /Default:	Default value from 2006 ¹

¹ 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.

Measurement Frequency	Updated according to IPCC
QA/QC Procedures Applied, including calibration	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".
Verification Observations/Assessment	In the VCS-PD, the source of NCVi was KOREA GAS CORPORATION, but the project owner did not record the value of NCVi 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.
Conclusions	This option result in a less emission reductions accounting. Therefore, this is conservative.

Data / Parameter	EF _{AF,i}
Data unit	kgCO ₂ /TJ
Description	CO ₂ emissions factor for LNG.
Value monitored	58,300
Measured /Calculated /Default:	IPCC default values
Measurement Frequency	/
QA/QC Procedures Applied, including calibration	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".
Verification Observations/Assessment	This value sourced from IPCC which is an authoritative and credible data source.
Conclusions	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
Value monitored	0
Measured /Calculated /Default:	Measured
Measurement Frequency	Daily, aggregated annually
QA/QC Procedures Applied, including calibration	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.
Verification Observations/Assessment	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
Conclusions	There was 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.

The monitoring has been carried out (not for $EC_{PJ,y}$; but justification is acceptable) in accordance with the monitoring plan contained in the registered VCS-PD /16/. All parameters (not for $EC_{PJ,y}$; but justification is acceptable) were monitored and determined as per the monitoring plan.

4.4.2 Assessment Data and Calculation

According to the applied methodology ACM0012 version 4.0.0 “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects” /17/, the emission reductions during the monitoring period are determined as the difference between baseline emissions, project emissions and leakage: $ER_y = BE_y - PE_y - L_y$

(1) Capping factors

In accordance with Annex 3 of ACM0012 version 4.0.0 “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects” /17/ as well as the validated VCS-PD /16/, the Project may only generate VCUs where it can be demonstrated that the Project has not resulted in a decrease in waste energy utilization at the production facility (Hyundai Steel Mill) compared to a baseline. The baseline utilization for the production facility was previously validated and fixed at 39.50 %.

Energy utilization data for this purpose are monitored continuously, aggregated daily and monthly, and compiled into a monthly report /5/. A facility operator and a manager both authenticate the monthly reports.

Table1 Yearly report of energy utilization data

<i>The actual energy balance in 2013</i>						
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%

<i>The actual energy balance in 2014</i>						
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%

CCSC reviewed Energy consumption data statistics /5/ as evidence of waste gas utilization by the Project and the production facility, and confirmed that the annual waste gas utilization by the production facility was greater than 39.50%, meaning that project implementation did not decrease the internal utilization of waste gas relative to the ratio confirmed at validation, thereby conforming to the requirement.

(2) Baseline Emissions

The project has no fossil fuel used for flaring the waste gas in the baseline, thus $BE_{flst,y}=0$.

The proposed project doesn't claim GHG emission reductions from thermal energy for conservativeness.

The baseline emission calculation is indicated as the following:

$$BE_y = BE_{En,y} + BE_{fst,y} = BE_{En,y} = BE_{Elec,y} + BE_{Ther,y} = BE_{Elec,y}$$

Where:

- BE_y** The total baseline emissions during the year y in tCO₂.
- $BE_{En,y}$** The baseline emissions from energy generated by the project activity during the year y in tCO₂.
- $BE_{fst,y}$** 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).
- $BE_{Elec,y}$** 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).

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

Where:

- $BE_{elec,y}$** Baseline emissions due to displacement of electricity during the year y (tCO₂)
- $EG_{i,j,y}$** 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 CO₂ emission factor for the electricity source i (gr for the grid), displaced due to the project activity, during the year y (tCO₂/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} of the project, it is 1 as the electricity generation is purely from use of waste energy.

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

The emission factor ($EF_{elec,i,j,y}$) in the MR (Version01) is not consistent with the one in the registered VCS-PD. Therefore, **CAR2** was raised.

It has been confirmed by checking the MR (Version 02) that the relevant information of the new flow meters has been added. Hence, **CAR2** was closed.

Baseline emissions: The total electricity generated during the verification period was multiplied by the Combined Margin CO₂ emission factor for the grid electricity displaced due to project activity (EF_y), which had been previously calculated ex-ante and approved during validation. The Combined Margin value of 0.6345 tCO₂ / MWh applied in calculations is consistent with the validated VCS PD /16/.

$$BE_y = f_{cap} \times f_{wcm} \times EG_{i,j,y} \times EF_y$$

$EG_{i,j,y}$ Quantity of electricity supplied by the project to the grid (MWh)

EF_y Combined Margin CO₂ emission factor for the grid electricity displaced due to project activity which had been previously calculated ex-ante and approved during validation.

The Calculation of Baseline emission reductions in this reporting period is shown in the following table:

Table 2 The Calculation of Baseline emission reductions

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})
01/06-31/12/2013	1	1	699,445	0.6345	0	0	443,798
2014	1	1	2,434,416	0.6345	0	0	1,544,636
2015	1	1	2,593,224	0.6345	0	0	1,645,402
2016	1	1	2,606,210	0.6345	0	0	1,653,641
01/01-30/06/2017	1	1	1,263,372	0.6345	0	0	801,610
Total	/	/	9,596,668	/	/	/	6,089,086

$$BE_y = f_{cap} \times f_{wcm} \times EG_{j,y} \times EF_y = 1 \times 1 \times 9,596,668 \text{ MWh} \times 0.6345 \text{ tCO}_{2e} / \text{MWh} = 6,089,086 \text{ tCO}_{2e}.$$

CCSC confirms that the calculation method of the baseline emission in the monitoring report and ER calculation spreadsheet /2/ is in compliance with the registered VCS PD /16/ and ACM0012 version 4.0.0 "Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects"/17/.

(3) Project Emissions

Project Emissions from LNG Consumed

The Project also combusts LNG in small quantities with waste gas to make up caloric deficiencies or to warm boilers upon startup. The quantity of LNG consumed by the Project ($AF_{i,j,y}$) was sourced from daily project monitoring data aggregated monthly. Project emissions from LNG consumption ($PE_{AF,y}$) was quantified by multiplying the total LNG consumption by the net calorific value of LNG (NCV_i), sourced from IPCC 2006 and the CO_2 emission factor for LNG ($EF_{AF,i}$), according to “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”.

The emission due to consumption of LNG ($PE_{AF,y}$) was calculated as follows:

Year	LNG Consumed (m^3)	NCV_i (TJ/Gg)	$EF_{AF,i}$ ($kgCO_2/TJ$)	$PE_{AF,y}$ (tCO_{2e})
01/06- 31/12/2013	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
01/01- 30/06/2017	224,647	50.4	58,300	471
Total	23,632,293	/	/	49,599

Total LNG consumed is verified to be 23,632,293 m^3 .

$$PE_{AF,y} = AF_{i,j,y} \times NCV \times EF_{AF,i} = 23,632,293 \times 1000 / 22.4 \times 16 \times 10^{-9} \times 50.4 \times 58.3 = 49,599 \text{ tCO}_{2e}$$

Project Emissions from electricity consumed

The Project consumes grid-connected electricity for operating waste gas processing equipment. As noted in Section 4.1, the quantity of electricity consumed by the Project ($EC_{PJ,y}$) was calculated based on the equipment rating specified by the manufacturer, and the conservative assumption is that the equipment was in non-stop operation during the entire verification period.

The total electricity consumed during the verification period was multiplied by the CO_2 emission factor for the grid (EF_y), which had been previously calculated ex-ante and approved during validation, and the average transmission and distribution loss factor ($TDL_{j,y}$) to determine the quantity of project emissions from electric consumption ($PE_{EL,y}$), as per “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.

Project emissions from electricity consumption ($PE_{EL,y}$) in this monitoring period is calculated as follows:

Year	$EC_{PJ,y}$ (MWh)	$EF_{EL,j,y}$ (tCO ₂ /MWh)	$TDL_{j,y}$	$PE_{EL,y}$ (tCO _{2e})
01/06-31/12/2013	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
01/01-30/06/2017	4,993	0.6345	0.2	3,802
Total	40,778	/	/	31,048

The Calculation of Project emission reduction (PE_y) is shown as follows:

Year	$PE_{AF,y}$ (tCO _{2e})	$PE_{EL,y}$ (tCO _{2e})	PE_y (tCO _{2e})
01/06-31/12/2013	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
01/01-30/06/2017	471	3,802	4,273
Total	49,599	31,048	80,648

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

$EC_{PJ,y}$ Project consumes grid-connected electricity for operating waste gas processing equipment (MWh)

$TDL_{j,y}$ 20%, average transmission and distribution loss factor (%)

$$PE_{EL,y} = EC_{PJ,y} \times EF_y (1 + TDL_{j,y}) = 40,778 \times 0.6345 (1 + 20\%) = 31,048 \text{ tCO}_2\text{e}$$

Thus, total $PE_y = PE_{EL,y} + PE_{AF,y} = 31,048 + 49,599 = 80,648 \text{ tCO}_2\text{e}$

Leakage

There are no leakages that need to be considered in applying the methodology **ACM0012 version 4.0.0** “**Consolidated baseline** methodology for GHG emission reductions from waste energy recovery projects”.

Emission reduction

Therefore, the emission reductions in this monitoring period are:

$$ER_y = BE_y - PE_y - L_y = 6,089,086 - 80,648 - 0 = 6,008,438 \text{ tCO}_2\text{e}.$$

4.5 Quality of Evidence to Determine GHG Emission Reductions and Removals

Based on the document review and physical site inspection, CCSC can confirm that all necessary documents were collected, referenced and aggregated and were easily accessible in hard-copy and electronic format. Measurements are performed by calibrated equipment, and the key data were cross-checked via other sources. No assumptions are used that have any material influence on reported emission reductions.

In summary, all necessary documentation is collected, referenced and is easily accessible in hard-copy or electronic format. The data pertaining to the monitored parameters are maintained in the identified internal records and consistent with the values stated in the Monitoring Report (version 02) /1/. Key data have been cross-checked via external sources, such as ETNs.

4.6 Non-Permanence Risk Analysis

During on-site visit, the verification team observed that the monitoring personnel are well trained, /14/ which demonstrate that they have sufficient competence to carry out the relevant monitoring tasks.

The routine requirements and log of the internal training for operating and maintaining the equipment were provided by the project owner /13/. During the on-site visit, it has been observed that the maintenance staffs have performed the routine equipment maintenance in accordance with the internal requirements for equipment tour inspection of the company.

CCSC can confirm that the personnel training and the equipment maintenance have been implemented properly by checking the training and maintenance records /13/ /14/, and by interviewing with site personnel.

All monitored data will be archived in electronic form and be kept for at least 2 years after the end of the last crediting period or till the last issuance of VERs for the project activity whichever occurs later.

5 VERIFICATION CONCLUSION

CCSC has carried out the verification of the project “*The Hyundai Steel Waste Energy Recovery Co-generation Project Phase II*”. The verification was performed based on the requirements set by Voluntary Carbon Standard (VCS) Version 4.0 /18/, as well as criteria provide for consistent project operations, monitoring and reporting. This verification covers the period from 01/06/2013 to 30/06/2017 inclusive.

In the course of the verification, 2 Corrective Action Request (CAR) were raised and successfully closed. The verification is based on the VCS-MR (version01), the revised VCS-MR (version02) /1/, the registered VCS-PD /16/, the validation report /15/, ER calculation spread sheet /2/ and supporting documents available to CCSC.

As the result of the verification, CCSC confirms that:

- The project activity has been implemented and operated as per the registered VCS-PD and that all physical features (technology, project equipment, and monitoring and metering equipment) of the project are in place;
- The VCS-MR and other supporting documents provided are complete in accordance with the latest applicable version of the VCS Registration & Issuance Process /20/ and in accordance with the additional requirements stated by the VCS Association (VCSA);
- The actual monitoring systems and procedures comply with the monitoring systems and procedures described in the monitoring plan and the approved methodology i.e. *ACM0012 (Version 4.0.0)* /17/;
- The GHG emission reductions are calculated without material misstatements and in a conservative and appropriate manner.

Based on the evidence and information that are considered necessary to guarantee that GHG emission reductions are appropriately calculated, CCSC confirms the following statement:

Verification period: from 01/06/2013 to 30/06/2017

Verified GHG emission reductions and removals in the above verification period:

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2013	443,798	21,994	0	421,804

(01/06-31/12)				
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 (01/01-30/06)	801,610	4,273	0	797,336
Total	6,089,086	80,648	-	6,008,438

APPENDIX A: REFERENCE

/1/	VCS Monitoring report of The Hyundai Steel Waste Energy Recovery Co-generation Project Phase II Version 01 dated 13/02/2020, Version 03 dated 07/03/2021 The monitoring period is from 01/06/2013 to 30/06/2017.
/2/	ER calculation spreadsheet for the period from 01/06/2013 to 30/06/2017
/3/	Monthly aggregation record of the electricity supplied to the grid, from 01/06/2013 to 30/06/2017
/4/	Monthly aggregation record of the LNG gas consumed, from 01/06/2013 to 30/06/2017
/5/	Energy consumption data statistics
/6/	Specifications of rated power of LDG fans
/7/	Specifications of rated power of COG fans
/8/	KPX: Electricity Transaction Notes (ETNs) , from 01/06/2013 to 30/06/2017
/9/	NG supplier: Monthly invoice of LNG consumption for the monitoring period
/10/	VCS Monitoring Manual for The Hyundai Steel Waste Energy Recovery Co-generation Project Phase II
/11/	Calibration records of electricity meters (M1-M8)
/12/	LNG supply contract
/13/	Operation and maintenance record
/14/	VCS training records
/15/	First Environment, Inc.: VCS Validation report for the Hyundai Steel Waste Energy Cogeneration Project, version 1.1 dated 17/12/2014. https://www.vcsprojectdatabase.org/#/project_details/1146
/16/	CERPD Inc.:VCS Project Description (VCS-PD) for the The Hyundai Steel Waste Energy Recovery Co-generation Project Phase II, Version 3.6, dated 26/11/2014.

	https://www.vcsprojectdatabase.org/#/project_details/1146
/17/	CDM Executive Board: Approved baseline methodology “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”, ACM0012 version 4.0.0. http://cdm.unfccc.int/methodologies/PAmethodologies/approved .
/18/	VCS Standard, Version 4.0, dated 19/09/2019 https://verra.org/wp-content/uploads/2019/09/VCS_Standard_v4.0.pdf
/19/	VCS Validation and Verification Manual, Version 3.2, dated 19/10/2016 http://database.v-c-s.org/sites/vcs.benfredaconsulting.com/files/VCS_Validation_Verification_Manual_v3.2.pdf
/20/	VCS Registration & Issuance Process, Version 4.0, dated 19/09/2019 https://verra.org/wp-content/uploads/2019/09/Registration_and_Issuance_Process_v4.0.pdf

APPENDIX B: RESOLUTION OF CORRECTIVE ACTION REQUESTS AND CLARIFICATION REQUESTS

No.	CAR/CL/FAR	Response by Project Participants/ CCSC's conclusion of assessment
CAR1	The calibration date of electricity meter is not accurate to the exact date, moreover, the calibration date does not cover the entire monitoring period.	<u>Response by Project Participants:</u> <u>It has been updated in Monitoring Report ver. 02</u> <u>CCSC's conclusion of assessment:</u> By checking the revised MR and the Calibration Records for the electricity meters /11/, CCSC can confirm that the meter information in the updated MR (Version 02) is consistent with the calibration record and the real situation confirmed by the site visit. Hence, CAR1 was closed.
CAR2	The emission factor in the MR version 01 is not consistent with the one in the registered VCS-PD.	<u>Response by Project Participants:</u> <u>The Emission factor has been corrected in the revised in the MR (Version 02).</u> <u>CCSC's conclusion of assessment:</u> It has been confirmed by checking the MR (Version 02) that the relevant information of the new flow meters has been added. Hence, CAR2 was closed.