



## Monitoring report form (Version 03.1)

### Monitoring report

<b>Title of the project activity</b>	DAEGU & SINANJEUNGDO PV(PHOTOVOLTAIC) POWER PLANT PROJECT
<b>Reference number of the project activity</b>	1883
<b>Version number of the monitoring report</b>	01
<b>Completion date of the monitoring report</b>	14/04/2014
<b>Registration date of the project activity</b>	14/01/2009
<b>Monitoring period number and duration of this monitoring period</b>	- The fourth monitoring period. - 01/01/2013 ~ 31/12/2013
<b>Project participant(s)</b>	Korea District Heating Corporation(KDHC)
<b>Host Party(ies)</b>	Republic of Korea
<b>Sectoral scope(s) and applied methodology(ies)</b>	- 1 : Energy industries(renewable-/non-renewable sources) - AMS I.D(Ver. 12) : Grid connected renewable electricity generation - ACM0002(Ver. 6) : Consolidated methodology for grid-connected electricity generation from renewable sources
<b>Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD</b>	750 tCO <sub>2</sub> e
<b>Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period</b>	681 tCO <sub>2</sub> e

## SECTION A. Description of project activity

### A.1. Purpose and general description of project activity

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#### < Purpose and general description >

The purpose of this project activity is to install PV power plants which consist of Daegu PV power plant (0.1MW) and SinanJeungdo PV power plant (0.8MW) to abate GHG emissions through generated electricity by PV power plants without using fossil fuel. The PV power plant is a facility that generates electricity with solar energy instead of fossil fuel and encompasses a solar cell module array, a power conditioning system, a step-up transformer and electric power grid connecting system.

When Korea District Heating Corporation(hereafter, KDHC) designed this project for the first time it was a bundled project of two sites Daegu and SinanJeungdo but KDHC considered emission reductions only for SinanJeungdo site during monitoring period. In the middle of this project, KDHC faced a technical and operational barrier which was related to monitoring and calculating the amount of electricity exported to grid in Daegu PV power plant so KDHC discounted emission reductions in Daegu PV power plant during monitoring period as described in B.1 in detail.

Daegu and SinanJeungdo plants were constructed on 4 May 2006 and 28 Feb. 2007 respectively and then the plants were officially operated on 22 Sep. 2006 and 8 Nov. 2007 independently. The plants have been operating since their official operation. The first, the second, and the third monitoring were preceded from 14 Jan. 2009 to 30 Apr. 2010, from 1 May 2010 to 31 Oct. 2011 and from 1 Nov. 2011 to 31 Dec. 2012 respectively.

KDHC achieved 681 tCO<sub>2</sub>e emission reductions during this monitoring period.

#### < Technical description >

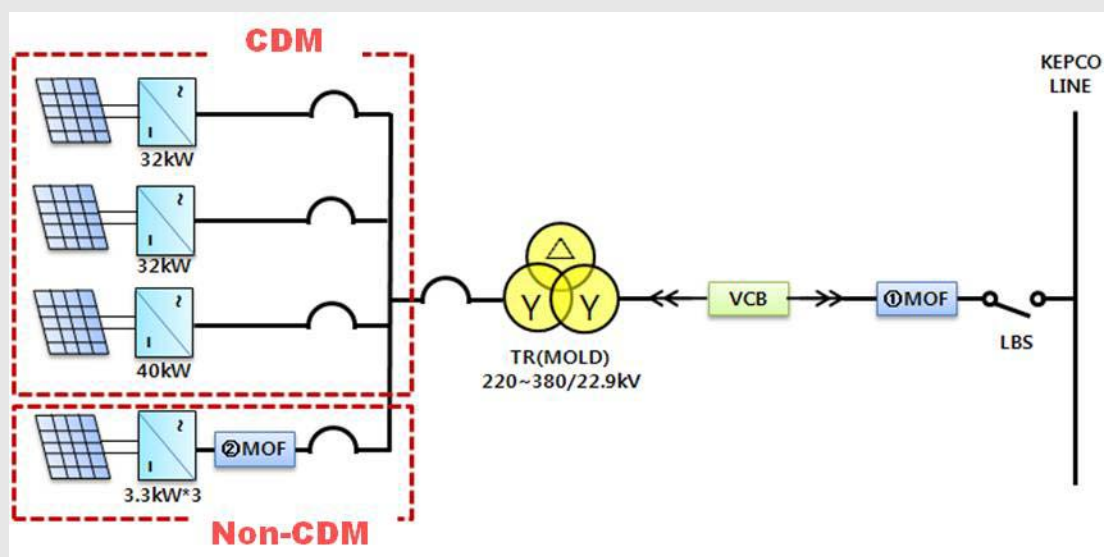
The PV power plant is the electricity generating system using Solar Cells which generate a photoelectric effect in the presence of sunlight and consists of a solar cell module array, a power conditioning system, a step-up transformer and electric power grid connecting system. The solar cell module array inverts a photovoltaic power to a direct current electricity power. The power conditioning system inverts a direct current to an alternating current. The step-up transformer increases the voltage of electric power and then the electric power is supplied to a power-transmission line.

Unlike the Daegu Project with only fixed type, the SinanJeungdo Project use both solar tracking type and fixed type. The instantaneous electricity generation data of both PV power plants transfers to dedicated PC of Daegu Branch Central Control Room and the amount of electricity exported to grid is collected through a LAN or a modem so KDHC can recognize and treat properly when some problems occur at PV power plants.

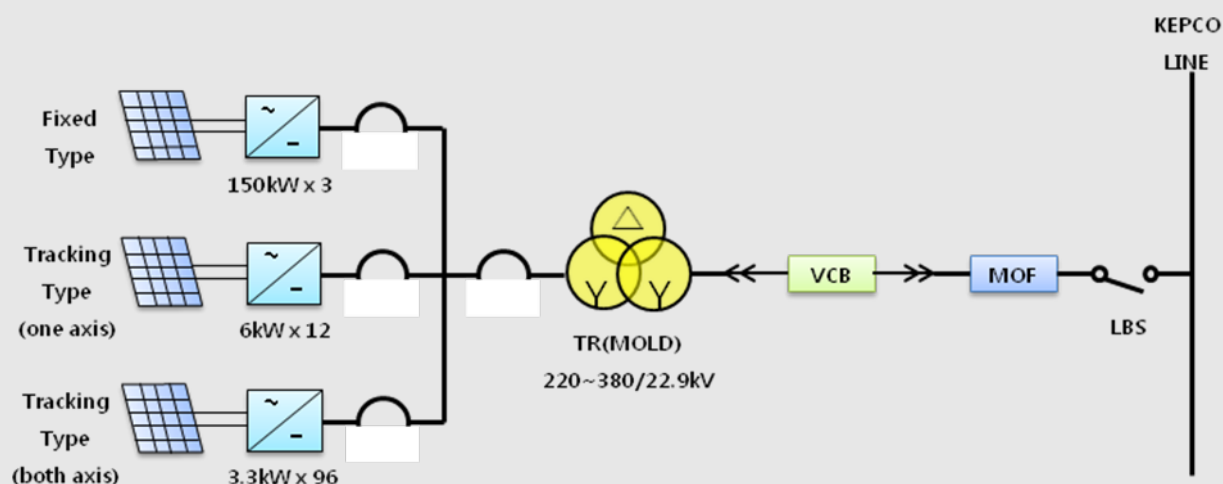
&lt;Table1&gt; The specification of PV power plants

Specification		Daegu PV power plant	SinanJeungdo PV power plant
Module	Model	SolarWorld SW 165 mono ST	SolarWorld SW 175 mono ST
	Peak power	165Wp	175Wp
	Solar cell	Monocrystalline silicon	Monocrystalline silicon
	Capacity	Fixed : 100kWp(165Wp*612)	Fixed : 450kWp(175Wp*2,592) Tracking : 50kWp(175Wp*288) 300kWp(175Wp*1,728)
Inverter	Model	Fronius IG400 Fronius IG500	Fixed : SMA SC 150 Tracking : SMA SMC 6000A SMA SB 3000
	Output Power	32kW*2 40kW*1	Fixed : 150kW*3 Tracking : 6kW*12(one axis) 3.3kW*96(both axis)
	Output Voltage	380V	Fixed : 380V Tracking : 220V
	Efficiency	93%	93%
Transformer		ABB 150kVA 380V/22900V 60Hz	ABB 800kVA 380V/22900V 60Hz

&lt;Figure 2&gt; The diagram of Daegu PV power plant





&lt;Figure 3&gt; The diagram of SinanJeungdo PV power plant



## A.2. Location of project activity

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&lt;Figure 1&gt; The whole view of Daegu &amp; SinanJeungdo PV power plants

DAEGU PV POWER PLANT	SINANJEUNGDO PV POWER PLANT
	
895 Daecheondong Dalseogu Daegu city 35°49'50.00"N / 128°29'26.76"E / 27m	4-1 Daechori Jeungdomyeon Sinangun JeollaNamdo 34°59'29.50"N / 126°10'40.71"E

## A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Korea	Private entity : Korea District Heating Corporation	No

**A.4. Reference of applied methodology**

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AMS I.D(Version12) : Grid connected renewable electricity generation.

**A.5. Crediting period of project activity**

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14/01/2009 ~ 13/01/2019

**SECTION B. Implementation of project activity****B.1. Description of implemented registered project activity**

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As mentioned in A.1., KDHC originally designed this project as a bundled project of two sites Daegu and SinanJeungdo but the emission reductions of Daegu site were discounted during monitoring period because of technical and operational barrier which was so difficult to come up with a practical alternative.

Apart from Daegu PV power plant, KDHC had constructed another PV power plant with 9.45 kWp next to the project site to generate more electricity using renewable energy in the empty space of Daegu Branch and it has been operated from 11 Sep. 2008. The new constructed PV power plant is not included in CDM activity but affects to the CDM activity. The electricity generated from non-CDM Daegu PV power plant is metered with that of Daegu PV power plant through a same watt-hour meter. Thus non-CDM Daegu PV power plant has to be monitored in accordance with the procedure of the CDM PV power plant during crediting period to subtract the generated electricity of non-CDM Daegu PV power plant from total amount that is metered through a common watt-hour meter. In spite of the efforts of KDHC to monitor non-CDM Daegu PV power plant properly, KDHC concluded that the monitored level didn't satisfy the monitoring plan's level of PDD so decided not to claim emission reductions for Daegu PV power plant during this monitoring period.

SinanJeungdo plant has been operated since its official operation started on 8 November 2007. It had previously been monitored from 14 Jan. 2009 to 30 Apr. 2010, from 1 May 2010 to 31 Oct. 2011 and from 1 Nov. 2011 to 31 Dec. 2012 for the first, the second and the third monitoring period. During three monitoring periods KDHC achieved 853 tCO<sub>2</sub>e, 1,044 tCO<sub>2</sub>e and 695 tCO<sub>2</sub>e emission reductions respectively.

After a year when the supplier of PV power plant take charge of all the service to be required for the repairing, KDHC implements overhaul every 2 years to prevent the breakdown of equipment and for stable generation of electricity with renewable energy. Because the last overhaul was implemented from 29 May 2012 to 1 Jun. 2012 for the SinanJeungdo PV power plant, there was no overhaul during this monitoring period.

**B.2. Post registration changes****B.2.1. Temporary deviations from registered monitoring plan or applied methodology**

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N/A

**B.2.2. Corrections**

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N/A

**B.2.3. Permanent changes from registered monitoring plan or applied methodology**

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In the third monitoring report, calibration frequency of watt-hour meters for imported and exported electricity was changed from every 2 years to every 7 years on the basis of national law. The revised calibration frequency was approved by EB and will be kept continuously.

**B.2.4. Changes to project design of registered project activity**

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N/A

**B.2.5. Changes to start date of crediting period**

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N/A

**B.2.6. Types of changes specific to afforestation or reforestation project activity**

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N/A

**SECTION C. Description of monitoring system**

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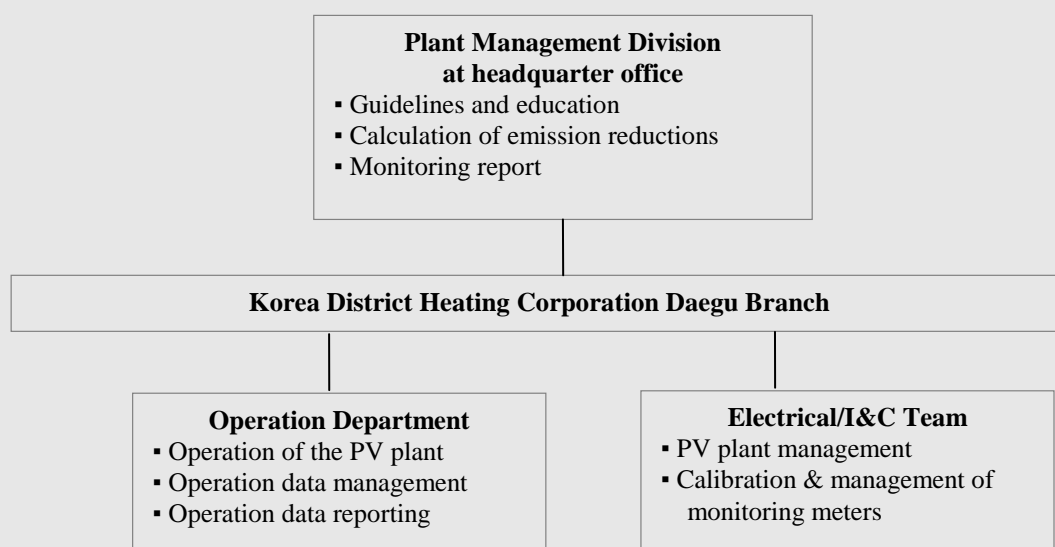
**Data collection and storage**

< SinanJeungdo PV power plant >

The amount of electricity supplied to the grid is measured by the watt-hour meter. The measured data is transferred to Electric Power Trading System of KDHC and E-power Market of KPX(Korea Power Exchange) which purchase all electricity generated. The transferred data is recorded hourly and the amount of electricity supplied to the grid is crosschecked by both of them. The amount of electricity imported from grid for SinanJeungdo PV power plant operation is confirmed by the invoice from KEPCO. The collected data related with SinanJeungdo PV power plant operation will be kept up for a period of 2 years from the end of the crediting period.

**CDM monitoring structure**

As shown in the figure below, direct monitoring and its management (PV power plant operation & management, monitoring data collection & management) are practiced by Operation Department and Electrical/I&C Team of Daegu Branch. Plant Management Division at headquarter office takes charge of the calculation of emission reductions and the preparation of monitoring report



## SECTION D. Data and parameters

### D.1. Data and parameters fixed ex ante or at renewal of crediting period

< SinanJeungdo PV power plant >

There are two watt-hour meters that have to be monitored in SinanJeungdo site. One is a meter for measuring electricity exported to grid and the other is a meter for measuring electricity imported from grid. The former was calibrated on 16 Sep. 2009, 23 Aug. 2011 and 13 Aug. 2013 after initial calibration and it turned out to be valid with a margin of error in the range of  $\pm 0.18\%$ ,  $\pm 0.23\%$  and  $\pm 0.25\%$ . Although the latter is owned by KEPCO that is a supplier of electricity with grid, KDHC implemented the calibration to fulfil the calibration frequency specified in Project Design Document(PDD) on 31 Aug. 2010 and 23 Aug. 2011. And then it turned out to be valid with a margin of error in the range of  $\pm 1.08$  and  $\pm 0.98$ . The margin of error is less than  $\pm 2.0\%$  that the maker of watt-hour meter guaranteed.

*(Copy this table for each piece of data and parameter.)*

<b>Data / Parameter:</b>	$EF_y$
<b>Unit:</b>	tCO <sub>2</sub> /MWh
<b>Description:</b>	Baseline emission factor
<b>Source of data:</b>	$EF_y$ was calculated based on the version 6 of the ACM0002. Required values for the calculation were referred to the Statistics of Electric Power provided by the Korea Electric Power Corporation.
<b>Value(s) applied:</b>	0.6349
<b>Purpose of data:</b>	$EF_y$ is used for baseline emission calculations
<b>Additional comment:</b>	For the details of the calculations refer to PDD, Annex 3

### D.2. Data and parameters monitored

*(Copy this table for each piece of data and parameter.)*

<b>Data / Parameter:</b>	$EE_{\text{sinan}}$
<b>Unit:</b>	MWh
<b>Description:</b>	The amount of electricity exported to grid by SinanJeungdo PV Power Plant

Measured/ Calculated / Default:	Measured
Source of data:	Watt-hour meter
Value(s) of monitored parameter:	1,114.5158
Monitoring equipment:	Type : electronic Accuracy class : 0.5 Serial number : 3873427 Calibration frequency : every 7 years Date of last calibration : 13 August 2013 Validity : 0.25
Measuring/ Reading/ Recording frequency:	<b>EE<sub>sinan</sub></b> is measured and recorded hourly.
Calculation method (if applicable):	-
QA/QC procedures:	The watt-hour meter is calibrated every 7 years
Purpose of data:	<b>EE<sub>sinan</sub></b> is used for <b>EGy<sub>sinan</sub></b> calculations. Consequently it is used for baseline emission calculations
Additional comment:	-

<b>Data / Parameter:</b>	<b>EI<sub>sinan</sub></b>
Unit:	<b>MWh</b>
Description:	The amount of electricity imported from grid for SinanJeungdo PV Power Plant
Measured/ Calculated / Default:	Measured
Source of data:	Watt-hour meter
Value(s) of monitored parameter:	42.5770
Monitoring equipment:	Type : mechanical Accuracy class : 2.0 Serial number : PS350075792 Calibration frequency : every 7 years Date of last calibration : 23 August, 2011 Validity : 0.98
Measuring/ Reading/ Recording frequency:	<b>EI<sub>sinan</sub></b> is measured and recorded monthly by KEPCO.
Calculation method (if applicable):	-
QA/QC procedures:	The watt-hour meter is calibrated every 7 years .
Purpose of data:	<b>EI<sub>sinan</sub></b> is used for <b>EGy<sub>sinan</sub></b> calculations. Consequently it is used for baseline emission calculations
Additional comment:	-



<b>Data / Parameter:</b>	<b>EG<sub>y sinan</sub></b>
<b>Unit:</b>	<b>MWh</b>
<b>Description:</b>	Net amount of electricity supplied to grid by SinanJeungdo PV power plant
<b>Measured/ Calculated / Default:</b>	Calculated
<b>Source of data:</b>	Watt-hour meter
<b>Value(s) of monitored parameter:</b>	1,071.9388
<b>Monitoring equipment:</b>	Refer to the Data/Parameter tables of EE <sub>sinan</sub> and EI <sub>sinan</sub>
<b>Measuring/ Reading/ Recording frequency:</b>	-
<b>Calculation method (if applicable):</b>	-
<b>QA/QC procedures:</b>	The watt-hour meters related with EG <sub>y sinan</sub> calculation are calibrated every 7 years
<b>Purpose of data:</b>	EG <sub>y sinan</sub> is used for baseline emission calculations
<b>Additional comment:</b>	-

### D.3. Implementation of sampling plan

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N/A

## SECTION E. Calculation of emission reductions or GHG removals by sinks

### E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

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The baseline emissions (BE<sub>y</sub> in tCO<sub>2</sub>) are the product of the baseline emissions factor (EF<sub>y</sub> in tCO<sub>2</sub>/MWh) multiplied by the electricity supplied by the project activity to the grid (EG<sub>y</sub> in MWh).

The baseline emissions are calculated as follows.

$$BE_y = EG_y * EF_y$$

Where:

**EG<sub>y</sub>** net amount of electricity supplied to the grid by project activity

**EF<sub>y</sub>** the baseline emission factor

Electricity consumed in the project site is imported from the grid. EG<sub>y</sub> is net amount of electricity supplied to the grid calculated by subtracting electricity imported from grid from electricity exported to grid by project activity.

$$EG_y = EE_y - EI_y$$

Where:

$EE_y$  the amount of electricity exported to grid by project activity

$EI_y$  the amount of electricity imported from grid for project activity

Electricity consumed in SinanJeungdo PV power plant site is obtained from the grid

$$BE_y = (EE_{\text{sinan}} - EI_{\text{sinan}}) * EF_y = (1,114.5158 - 42.5770) * 0.6349 \div 681 \text{ tCO}_2\text{e.}$$

## E.2. Calculation of project emissions or actual net GHG removals by sinks

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$PE_y$  are considered as 0.

## E.3. Calculation of leakage

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$L_y$  are considered as 0.

## E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO <sub>2</sub> e)	Project emissions or actual net GHG removals by sinks (t CO <sub>2</sub> e)	Leakage (t CO <sub>2</sub> e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO <sub>2</sub> e)
<b>Total</b>	681	0	0	681

The emission reduction  $ER_y$  by the project activity during a given year  $y$  is the difference among baseline emissions( $BE_y$ ), project emissions ( $PE_y$ ) and emissions due to leakage( $Ly$ ), as follows.

$$ER_y = BE_y - PE_y - L_y$$

$$ER_y = BE_y - PE_y - L_y = 681 - 0 - 0 = 681 \text{ tCO}_2\text{e.}$$

In the fourth monitoring period (1 Jan. 2013 ~ 31 Dec. 2013), the actual emission reductions are 681 tCO<sub>2</sub>e.

&lt;Table3&gt; Monthly emission reduction data

Year	Month	ER <sub>y</sub> (tCO <sub>2</sub> )	BE <sub>y</sub> (tCO <sub>2</sub> )	PE <sub>y</sub> (tCO <sub>2</sub> )	L <sub>y</sub> (tCO <sub>2</sub> )
2013	JAN	37.5422	37.5422	0	0
	FEB	45.3683	45.3683	0	0
	MAR	73.8569	73.8569	0	0
	APR	68.1268	68.1268	0	0
	MAY	72.4275	72.4275	0	0
	JUN	61.5380	61.5380	0	0
	JUL	50.4970	50.4970	0	0
	AUG	70.8237	70.8237	0	0
	SEP	60.1748	60.1748	0	0
	OCT	65.2459	65.2459	0	0
	NOV	38.2221	38.2221	0	0
	DEC	36.7506	36.7506	0	0
Total		681	681	0	0

#### E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
<b>Emission reductions or GHG removals by sinks (t CO<sub>2</sub>e)</b>	Daegu 77 tCO <sub>2</sub> e SinanJeungdo 750 tCO <sub>2</sub> e	Daegu 0 tCO <sub>2</sub> e SinanJeungdo 681 tCO <sub>2</sub> e

#### E.6. Remarks on difference from estimated value in registered PDD

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The actual emission reduction amounts are 681 tCO<sub>2</sub>e, which are less than those estimated in the CDM-PDD (827 tCO<sub>2</sub>e) by 17.7%. It is due to following reasons.

When the ex-ante emission reductions were calculated KDHC didn't consider the electricity imported from grid for PV power plant operation and climatic influences affected the difference.

#### E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
<b>Emission reductions or GHG removals by sinks (t CO<sub>2</sub>e)</b>	0	681

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## Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.
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Document Type: Form		
Business Function: issuance		
Keywords: monitoring report, performance monitoring		