

**MONITORING REPORT**

Version 01 – 17/01/2012

**DAEGU & SINANJEUNGDO PV(PHOTOVOLTAIC) POWER PLANT PROJECT**

Reference number : 1883

monitoring period number and dates : 01/05/2010 - 31/10/2011

**SECTION A. General description of the project activity****A.1. Brief description of the project activity: >>**

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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. While this project is proceeding, KDHC faced a technical and operational barrier which was related to monitoring and calculating the amount of electricity exported to grid in Daegu PV plant so KDHC discounted emission reductions in Daegu PV 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 and the first monitoring proceeded from 14 Jan. 2009 to 30 Apr. 2010.

KDHC achieved 1,044 tCO<sub>2</sub>e emission reductions during this monitoring period.

**A.2. Project Participants**



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Korea District Heating Corporation (KDHC)

### A.3. Location of the 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 34°59'29.50"N / 126°10'40.71"E

### A.4. Technical description of the project

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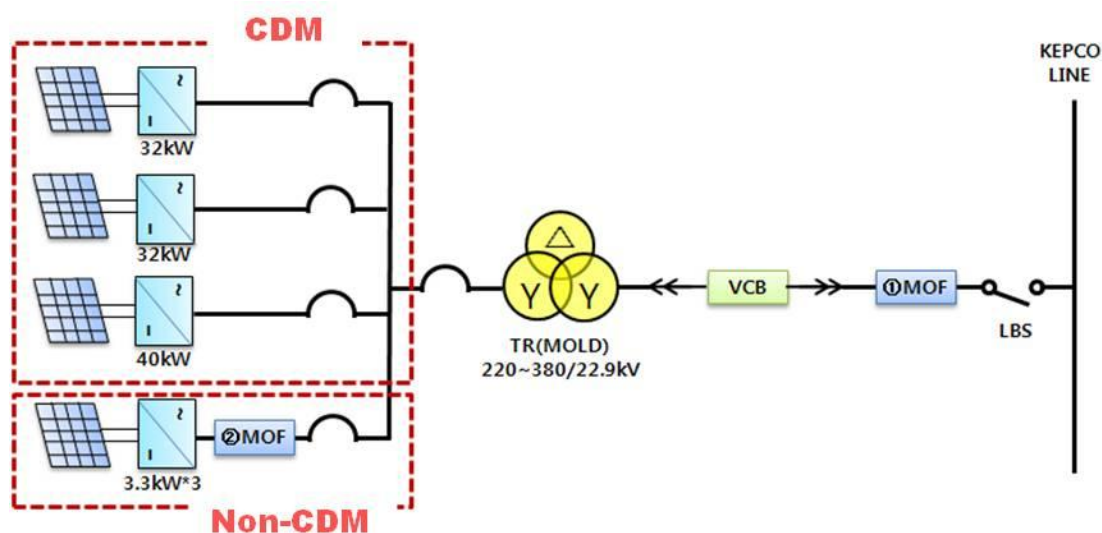
The PV power plant is the electricity generating system using Solar Cells which generate a photoelectric effect in the presence of sunlight and consists of a solar cell module array, a power conditioning system, a step-up transformer and electric power grid connecting system. The solar cell module array 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

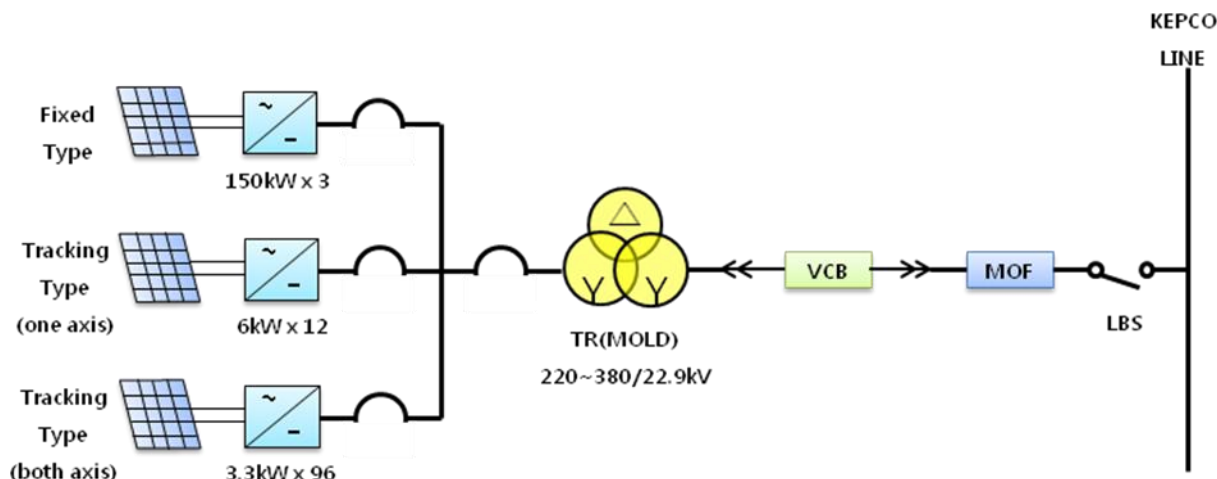
&lt;Table1&gt; The specification of PV power plants

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



<Figure 3> The diagram of SinanJeungdo PV power plant



#### A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

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AMS I.D (Version 12) : Grid connected renewable electricity generation.

#### A.6. Registration date of the project activity:

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14/01/2009

#### A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

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14/01/2009 ~ 13/01/2019

#### A.8. Name of responsible person(s)/entity(ies):

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### SECTION B. Implementation of the project activity

#### B.1. Implementation status of the 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 electricity 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 electricity 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 (for the first monitoring period) and KDHC achieved 853 tCO<sub>2</sub>e emission reductions.

KDHC implements overhaul every 2 years to prevent the breakdown of equipment and stable generation of electricity with renewable energy after a year that the supplier of PV power plant take charge of all the service to be required for the repairing. During this monitoring period the overhaul was implemented from 7 Jun. 2010 to 11 Jun. 2010 for the SinanJeungdo PV power plant.

An incident which can affect the productivity of electricity generated by SinanJeungdo PV power plant was occurred, especially for the solar tracking type with both axis. The 6 inverters out of 96 ones that were installed to PV power plant were damaged by lightning on 13 Aug. 2010 and these inverters were replaced properly with new ones on 30 Oct. 2010.

<b>B.2. Revision of the monitoring plan</b>
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N/A

<b>B.3. Request for deviation applied to this monitoring period</b>
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N/A

<b>B.4. Notification or request of approval of changes</b>
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N/A

**SECTION C. Description of the monitoring system**

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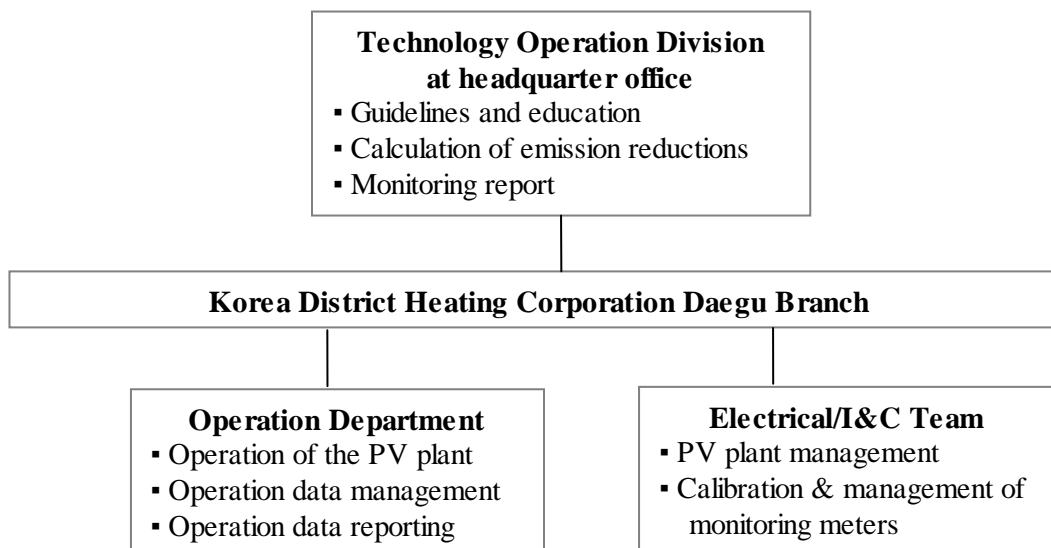
**Data collection and storage**

&lt; SinanJeungdo PV power plant &gt;

The amount of electricity supplied to the grid is measured by the electricity 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 plant operation & management, monitoring data collection & management) are practiced by Operation Department and Electrical/I&C Team of Daegu Branch. Technology Operation Division at headquarter office takes charge of the calculation of emission reductions and the preparation of monitoring report

**SECTION D. Data and parameters**

&lt; SinanJeungdo PV power plant &gt;

There are two electricity 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 September 2009 and 23 August 2011 after initial calibration and it

turned out to be valid with a margin of error in the range of  $\pm 0.18\%$  and  $\pm 0.23\%$ . Although the latter is owned by KEPCO that is a supplier of electricity with grid, KDHC implemented the calibration to fulfil the calibration cycle specified in Project Design Document(PDD) on 31 August 2010 and 23 August 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 electricity meter guaranteed. But KDHC missed the appropriate period to calibrate the electricity meter. Thus KDHC applied the maximum permissible error of instrument to the measured value during delayed calibration period (May 2010 ~ August 2010) according to the EB 52<sup>nd</sup> meeting report Annex 60.

<b>D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors</b>	
<b>Data / Parameter:</b>	<b>EF<sub>y</sub></b>
<b>Data unit:</b>	<b>tCO<sub>2</sub>/MWh</b>
<b>Description:</b>	Baseline emission factor
<b>Source of data used:</b>	EF <sub>y</sub> 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) :</b>	0.6349
<b>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</b>	EF <sub>y</sub> is used for baseline emission calculations
<b>Additional comment:</b>	For the details of the calculations refer to PDD, Annex 3

<b>D.2. Data and parameters monitored</b>	
<b>Data / Parameter:</b>	<b>EE<sub>sinan</sub></b>
<b>Data unit:</b>	<b>kWh</b>
<b>Description:</b>	The amount of electricity exported to grid by SinanJeungdo PV Power Plant
<b>Measured /Calculated /Default:</b>	Measured
<b>Source of data:</b>	Electricity Meter
<b>Value(s) of monitored parameter:</b>	1,715,098
<b>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</b>	EE <sub>sinan</sub> is used for EG <sub>sinan</sub> calculations. Consequently it is used for baseline emission calculations
<b>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</b>	Type : electronic Accuracy class : 0.5 Serial number : 3873427 Calibration frequency : every 2 years Date of last calibration : 23 August 2011 Validity : 0.23
<b>Measuring/ Reading/ Recording frequency:</b>	EE <sub>sinan</sub> is measured and recorded hourly.



Calculation method (if applicable):	-
QA/QC procedures applied:	The electricity meter is calculated every 2 years

D.2. Data and parameters monitored	
Data / Parameter:	<b>EI<sub>sinan</sub></b>
Data unit:	<b>kWh</b>
Description:	The amount of electricity imported from grid for SinanJeungdo PV Power Plant
Measured /Calculated /Default:	Measured
Source of data:	Electricity Meter
Value(s) of monitored parameter:	70,074
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	<b>EI<sub>sinan</sub></b> is used for <b>EG<sub>sinan</sub></b> calculations. Consequently it is used for baseline emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type : mechanical Accuracy class : 2.0 Serial number : PS350075792 Calibration frequency : every 2 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 applied:	The electricity meter is calibrated every 2 years even though it isn't owned by KDHC and 3.5years are reasonable as calibration period according to the domestic law.

D.2. Data and parameters monitored	
Data / Parameter:	<b>EG<sub>sinan</sub></b>
Data unit:	<b>MWh</b>
Description:	Net amount of electricity supplied to grid by SinanJeungdo PV power plant
Measured /Calculated /Default:	Calculated
Source of data:	Electricity Meter
Value(s) of monitored parameter:	1,645.024
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	<b>EG<sub>sinan</sub></b> is used for baseline emission calculations





calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Refer to the Data/Parameter tables of $EE_{\text{sinan}}$ and $EI_{\text{sinan}}$
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	$EG_{\text{sinan}} = EE_{\text{sinan}} - EI_{\text{sinan}}$
QA/QC procedures applied:	The electricity meters related with $EG_{\text{sinan}}$ calculation are calibrated every 2 years

## SECTION E. Emission reductions calculation

### E.1. Baseline emissions calculation

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The baseline emissions ( $BE_y$  in  $tCO_2$ ) are the product of the baseline emissions factor ( $EF_y$  in  $tCO_2/MWh$ ) multiplied by the electricity supplied by the project activity to the grid ( $EG_y$  in  $MWh$ ). The baseline emissions are calculated as follows.

$$BE_y = EG_y * EF_y$$

Where:

$EG_y$  net amount of electricity supplied to the grid by project activity

$EF_y$  the baseline emission factor

Electricity consumed in the project site is imported from the grid.  $EG_y$  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

$$BE_{\text{sinan}} = (EE_{\text{sinan}} - EI_{\text{sinan}}) * EF_y = (1,715.098 - 70.074) * 0.6349 = 1,044 \text{ tCO}_2\text{e.}$$

**E.2. Project emissions calculation**

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 $PE_y$  are considered as 0.**E.3. Leakage calculation**

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 $L_y$  are considered as 0.**E.4. Emission reductions calculation / table**

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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( $L_y$ ), as follows.

$$ER_y = BE_y - PE_y - L_y$$

$$ER_y = BE_y - PE_y - L_y = 1,044 - 0 - 0 = 1,044 \text{ tCO}_2\text{e}.$$

In the second monitoring period (May 2010 ~ October 2011), the actual emission reduction is 1,044 tCO<sub>2</sub>e.

**E.5. Comparison of actual emission reductions with estimates in the CDM-PDD**

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Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO <sub>2</sub> e)	Daegu (77+39)tCO <sub>2</sub> e SinanJeungdo (750+378)tCO <sub>2</sub> e	Daegu 0tCO <sub>2</sub> e SinanJeungdo (697+347)tCO <sub>2</sub> e

**E.6. Remarks on difference from estimated value in the PDD**

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In the case of SinanJeungdo PV power plant, the ex-ante emission reductions of PDD were calculated with 16.85% efficiency rate but the actual efficiency rate was appeared lower than efficiency rate of PDD as 16.27%. Furthermore, when the ex-ante emission reductions were calculated the electricity imported from grid for PV power plant operation ( $EI_{\text{sinan}}$ ) was not considered.

In the case of Daegu PV power plant, KDHC discounted the emission reductions as mentioned above.

As the result, the difference between ex-ante emission reductions and actual emission reductions was occurred.