

**MONITORING REPORT**  
Version 02 – 13/09/2010**DAEGU & SINANJEUNGDO PV(PHOTOVOLTAIC) POWER PLANT PROJECT**  
Reference number : 1883  
monitoring period number and dates : 14/01/2009 - 30/04/2010**SECTION A. General description of the project activity****A.1. Brief description of the project activity: >>**

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This project is a bundled project which consists of Daegu PV plant(0.1MW) and SinanJeungdo PV plant(0.8MW). 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. Korea District Heating Corporation (KDHC) decided to proceed this project for abating GHG emissions through generating electricity by PV power plants without using fossil fuel and started construction of Daegu(4/05/2006) & SinanJeungdo(28/02/2007) PV power plants. Daegu & SinanJeungdo PV power plants have been operated since their operation were officially started on 22 September 2006 and on 8 November 2007. KDHC achieved 853 tCO<sub>2</sub>e emission reductions during first monitoring period.

**A.2. Project Participants**


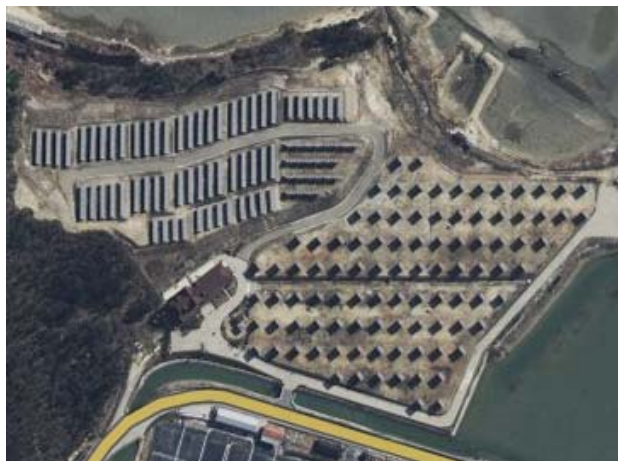
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Korea District Heating Corporation

**A.3. Location of the project activity:**

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<Figure 1> The whole view of Daegu & SinanJeungdo PV power plants

DAEGU PV POWER PLANT	SINANJEUNGDO PV POWER PLANT
	
895 Daechondong 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**

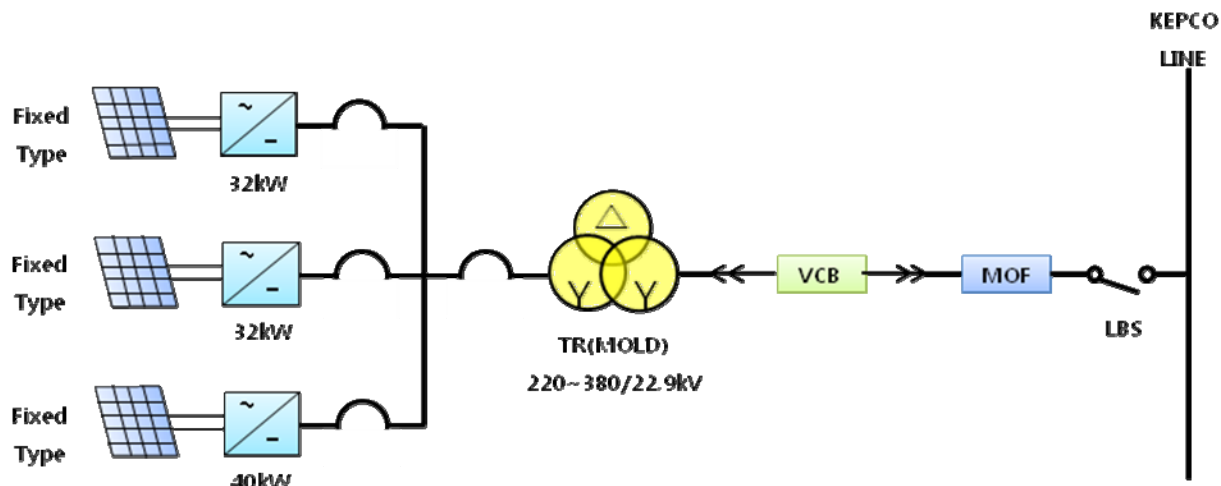
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The PV power plant is the electricity generation system using Solar Cells which generate a photoelectric effect in the presence of sunlight and consists of a solar cell module array, a power conditioning system, a step-up transformer and electric power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

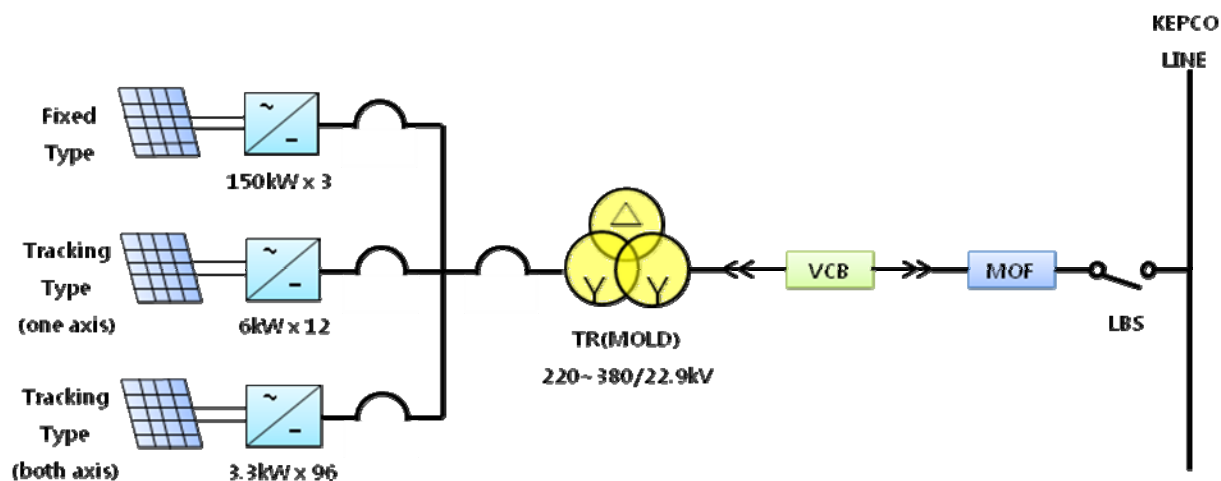
&lt;Table1&gt; The specification of PV power plants

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

<Figure 2> 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(Version12) : 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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Tel : +82-31-780-4444, Fax : +82-31-702-5084

**SECTION B. Implementation of the project activity****B.1. Implementation status of the project activity**

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**<Daegu PV power plant>**

Daegu plant has been operated since its operation was officially started on 22 September 2006. KDHC implements overhaul every 2 years for preventing 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 16 October 2009 to 29 October 2009.

Apart from Daegu PV power plant KDHC had constructed another PV power plant next to the project site for generating more electricity using renewable energy in empty space of Daegu Branch. The latter PV power plant is not included in CDM activity but its generated electricity is metered with electricity generation of Daegu PV power plant together through a same electricity meter. So the latter PV power plant (non-CDM Daegu PV power plant) has to be monitored during crediting period because the electricity generation of non-CDM Daegu PV power plant has to be subtracted from total amount that is metered through a common electricity meter. But even though KDHC has monitored non-CDM Daegu PV power plant KDHC concluded that the monitored level doesn't satisfy the monitoring plan's level of PDD. So KDHC decided not to claim emission reductions for Daegu PV power plant during first monitoring period and planned for monitoring improvement. For the details of monitoring improvement plan refer to the D.2 of this monitoring report. The capacity of non-CDM Daegu PV power plant is 9.45kWp and it has been operated from 11 September 2008.

**<SinanJeungdo PV power plant>**

SinanJeungdo plant has been operated since its operation was officially started on 8 November 2007. KDHC implements overhaul every 2 years for preventing 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. The PV plant completed in November 2007 so KDHC didn't implement the overhaul during first monitoring period and implemented in June 2010.

**B.2. Revision of the monitoring plan**

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**B.3. Request for deviation applied to this monitoring period**

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**B.4. Notification or request of approval of changes**

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

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**Data collection and storage****<Daegu PV power plant>**

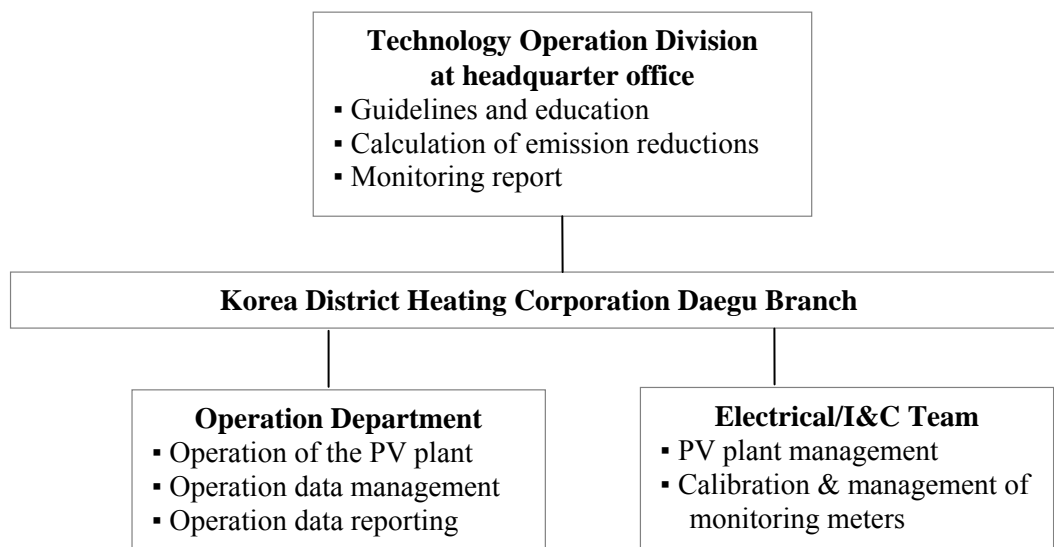
The amount of electricity supplied to the grid is measured by the meter. The measured data is transferred to Electric Power Trading System of KDHC and recorded hourly. In case of non-CDM Daegu PV power plant the measured data has been recorded daily by operators on site because it doesn't belong to CDM boundary. But because the measured data from non-CDM Daegu PV power plant is used for calculating emission reductions it will be recorded hourly following the monitoring plan of PDD after first monitoring period. All electricity generated on Daegu site is supplied to the grid directly and is sold to KEPCO(Korea Electric Power Corporation). The supplied amount is confirmed monthly by the invoice sent to KEPCO. The collected data related with Daegu PV power plant operation will be kept up for a period of 2 years from the end of the crediting period.

**<SinanJeungdo PV power plant>**

The amount of electricity supplied to the grid is measured by the 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 showed 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 preparing the monitoring report



**SECTION D. Data and parameters****Calibration of monitoring equipment****<Daegu PV power plant>**

Calibration frequency specified in Project Design Document (PDD) is 2 year. In case of Daegu PV plant after initial calibration 2 years and a half had been passed before second calibration. Even though the calibration had been delayed, the electricity meter of Daegu PV Plant turned out to be valid with a margin of error in the range of  $\pm 0.21\%$ . The margin of error is less than  $\pm 0.5\%$  that the maker of electricity meter guaranteed. Thus according to the EB 52th meeting report Annex 60 applied the maximum permissible error of the instrument to the measured values during delayed calibration (14 January, 2009 ~ 12 March, 2009).

**<SinanJeungdo PV power plant>**

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 within 2 years after initial calibration and it turned out to be valid with a margin of error in the range of  $\pm 0.18\%$ . The latter is owned by KEPCO that is a supplier of electricity with grid, so that it isn't calibrated according to the monitoring plan. But KDHC concluded that the electricity meter owned by KEPCO has to be calibrated by monitoring plan after site checking for verification. So KDHC calibrated the electricity meter on 31 August, 2010 and it turned out to be valid with a margin of error in the range of  $\pm 1.08$ . The margin of error is less than  $\pm 2.0\%$  that the maker of electricity meter guaranteed. Thus according to the EB 52th meeting report Annex 60 applied the maximum permissible error of the instrument to the measured values during delayed calibration (August, 2009 ~ April, 2010). From now on it will be also managed according to monitoring plan.

**D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors**

<b>Data / Parameter:</b>	<b>EF<sub>y</sub></b>
<b>Data unit:</b>	<b>tCO<sub>2</sub></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

**D.2. Data and parameters monitored**

<b>Data / Parameter:</b>	<b>EE<sub>daegu-Total</sub></b>
<b>Data unit:</b>	<b>kWh</b>
<b>Description:</b>	The amount of electricity exported to grid by Daegu PV Power Plant and non-CDM Daegu PV power plant in Daegu Branch
<b>Measured /Calculated /Default:</b>	Measured



Source of data:	Electricity meter
Value(s) of monitored parameter:	-
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	<b>EE<sub>daegu-Total</sub></b> is used for <b>EG<sub>daegu</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 : electronic Accuracy class : 0.5 Serial number : 6063950 Calibration frequency : every 2 years Date of last calibration : 12 March, 2009 Validity : 0.21
Measuring/ Reading/ Recording frequency:	<b>EE<sub>daegu-Total</sub></b> is measured and recorded hourly.
Calculation method (if applicable):	-
QA/QC procedures applied:	The electricity meter is calculated every 2 years

<b>Data / Parameter:</b>	<b>EE<sub>daegu-nonCDM</sub></b>
Data unit:	<b>kWh</b>
Description:	The amount of electricity exported to grid by non-CDM Daegu PV power plant
Measured /Calculated /Default:	Measured
Source of data:	Electricity meter
Value(s) of monitored parameter:	-
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	<b>EE<sub>daegu-nonCDM</sub></b> is used for <b>EG<sub>daegu</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 : electronic Accuracy class : 1.0 Serial number : 0187797 Calibration frequency : every 2 years Date of last calibration : since the electricity meter was installed, it has not been calibrated Validity : -
Measuring/ Reading/ Recording frequency:	<b>EE<sub>daegu-nonCDM</sub></b> is measured and recorded daily.
Calculation method (if applicable):	-
QA/QC procedures applied:	The electricity meter doesn't belong to CDM project boundary so it isn't managed according to monitoring plan. But because the electricity meter is related with baseline emission calculations, it will be replaced by new one with higher accuracy class ( $\pm 0.5$ ) and calibrated every 2 years. The measured data by a new meter will be recorded hourly also.



<b>Data / Parameter:</b>	<b>EG<sub>daegu</sub></b>
Data unit:	<b>MWh</b>
Description:	Net amount of electricity supplied to grid by Daegu PV Power Plant
Measured /Calculated /Default:	Calculated
Source of data:	Electricity meter
Value(s) of monitored parameter:	-
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	<b>EG<sub>daegu</sub></b> is used for baseline emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Refer to the Data/Parameter tables of <b>EE<sub>daegu-Total</sub></b> and <b>EE<sub>daegu-nonCDM</sub></b>
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	<b>EG<sub>daegu</sub> = EE<sub>daegu-Total</sub> – EE<sub>daegu-nonCDM</sub></b>
QA/QC procedures applied:	The electricity meter that measures <b>EE<sub>daegu-Total</sub></b> for <b>EG<sub>daegu</sub></b> calculation is calibrated every 2 years. The electricity meter that measures <b>EE<sub>daegu-nonCDM</sub></b> for <b>EG<sub>daegu</sub></b> calculation will be managed according to QA/QC procedures plan of upper table.

<b>Data / Parameter:</b>	<b>EE<sub>sinan</sub></b>
Data unit:	<b>kWh</b>
Description:	The amount of electricity exported to grid by SinanJeungdo PV Power Plant
Measured /Calculated /Default:	Measured
Source of data:	Electricity Meter
Value(s) of monitored parameter:	1405941
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	<b>EE<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 : electronic Accuracy class : 0.5 Serial number : 3873427 Calibration frequency : every 2 years Date of last calibration : 16 September, 2009 Validity : 0.18
Measuring/ Reading/ Recording frequency:	<b>EE<sub>sinan</sub></b> is measured and recorded hourly.
Calculation method (if applicable):	-





QA/QC procedures applied:	The electricity meter is calculated every 2 years
<b>Data / Parameter:</b>	<b>EI<sub>sinan</sub></b>
Data unit:	<b>MWh</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:	60867
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 : 31 August, 2010 Validity : 1.08
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.

<b>Data / Parameter:</b>	<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:	1345.074
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	<b>EG<sub>sinan</sub></b> is used for baseline emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Refer to the Data/Parameter tables of <b>EE<sub>sinan</sub></b> and <b>EI<sub>sinan</sub></b>
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  $tCO_2/MWh$ ) time 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

#### <Daegu Project>

Electricity consumed in Daegu PV power plant site is used from the own photovoltaic power generation so  $EI_{\text{daegu}}$  is zero

$$BE_{\text{daegu}} = ((EE_{\text{daegu-Total}} - EE_{\text{daegu-nonCDM}}) - EI_{\text{daegu}}) * EF_y$$

#### <SinanJeungdo Project>

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

$$BE_{\text{sinan}} = (EE_{\text{sinan}} - EI_{\text{sinan}}) * EF_y = (1405.941 - 60.867) * 0.6349 = 853 \text{ tCO}_2\text{e.}$$

### 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 between baseline emissions( $BE_y$ ), project emissions ( $PE_y$ ) and emissions due to leakage( $L_y$ ), as follows:

$$ER_y = BE_y - PE_y - L_y$$

**<Daegu Project>**

As mentioned at B.1. of this monitoring report emission reductions for Daegu PV power plant during first monitoring period isn't claimed

**<SinanJeungdo Project>**

$$ER_y = BE_y - PE_y - L_y = 853 - 0 - 0 = 853 \text{ tCO}_2\text{e.}$$

In the first monitoring period (JAN. 2008 - APR. 2010), the actual emission reduction is 853 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+23) tCO <sub>2</sub> SinanJeungdo (750+220) tCO <sub>2</sub>	Daegu 0tCO <sub>2</sub> SinanJeungdo 853tCO <sub>2</sub>

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

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In 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 15.51%. 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. As the result the difference between ex-ante emission reductions and actual emission reductions was occurred.