



Monitoring report form (Version 03.2)

Monitoring report

Title of the project activity	Sihwa Tidal Power Plant CDM Project
Reference number of the project activity	0349
Version number of the monitoring report	Ver. 01
Completion date of the monitoring report	22/05/2014
Registration date of the project activity	18/06/2006
Monitoring period number and duration of this monitoring period	5th, 01/10/2013 ~ 31/03/2014 (first and last days included)
Project participant(s)	Korea Water Resources Corporation(K-water)
Host Party(ies)	Republic of Korea
Sectoral scope(s) and applied methodology(ies)	1: Energy industries(renewable/non-renewable sources / ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources(version 4)
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	157,720 tCO ₂ e * This amount was recalculated by multiplying the ratio of this monitoring period over a year to the yearly estimated emission reductions in PDD, 315,440 tCO ₂ e (315,440 tCO ₂ e × 6/12 =157,720 tCO ₂ e)
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	159,835
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012(if applicable)	-
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).	159,835

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

- **Purpose of the project activity and The measures taken for GHG emission reductions**

K-water Tidal Power Plant in Ansan-si is a tidal power plant on the west side of Republic of Korea. The tidal power plant generates electricity utilizing the difference of ebb and flow of tide which emits zero greenhouse gas (hereinafter GHG) into the atmosphere, and increase of sea/inner water circulation by this activity will improve the water quality that has been decreased during Sihwa Lake's salt-to-fresh water process. The project supports the government policy which promotes development of renewable energy technology in Republic of Korea. The project also contributes to decrease the dependence on the electricity generated by fossil fuel-fired power plants.

In conclusion, the aim of this project activity is to generate electricity and to supply it to the grid by using tidal power instead of the fossil fuel, which contributes to mitigation of climate change & sustainable development.

- **Brief description of the installed technology and equipment :**

This proposed project consists in 10 units of 25.4MW turbines and generates electricity of 552.7GWh per year from the tidal power plant.

- **Relevant dates for the project activity :**

- Construction period : 31/12/2004 – 14/11/2011
- Starting date of operation : 13/04/2011
- (*commissioning period : 28/03/2011 – 29/02/2012)
- Starting date of commercial operation : 01/03/2012
- Continued operation : 13/04/2011 – Present

- **Total GHG emission reductions achieved in this monitoring period : 159,835CO₂e**

A.2. Location of project activity

- Host Party(ies) : Republic of Korea
- Region/State/ Province, etc : Gyeonggi-do
- City/Town/Community, etc : Daebudong-dong, Danwon-gu, Ansan city
- Physical/Geographical location : K-water Sihwa Tidal Power Plant
(latitude of 37°18'46"N and longitude of 126°36'36"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 (host)	Public entity : Korea Water Resources Corporation (K-water)	No

* The full name of project participant in the registered CDM-PDD is the same as of the past, "Korea Water Resources Corporation", and only its nickname was changed from "KOWACO" to "K-water" in parenthesis.

A.4. Reference of applied methodology

- The applied methodology : ACM0002 – "Consolidated baseline methodology for grid- connected electricity generation from renewable sources" (version 4)
- * In the registered CDM-PDD, ACM0002(ver. 3) was applied, in contrast, ACM0002(ver.4) was applied in the validation report and indicated on UNFCCC CDM web page. Considering the grace period having already gone by, ACM0002 (ver.4) was applied to this project activity.
- Any tools and other methodologies to which the applied methodology refers : N/A

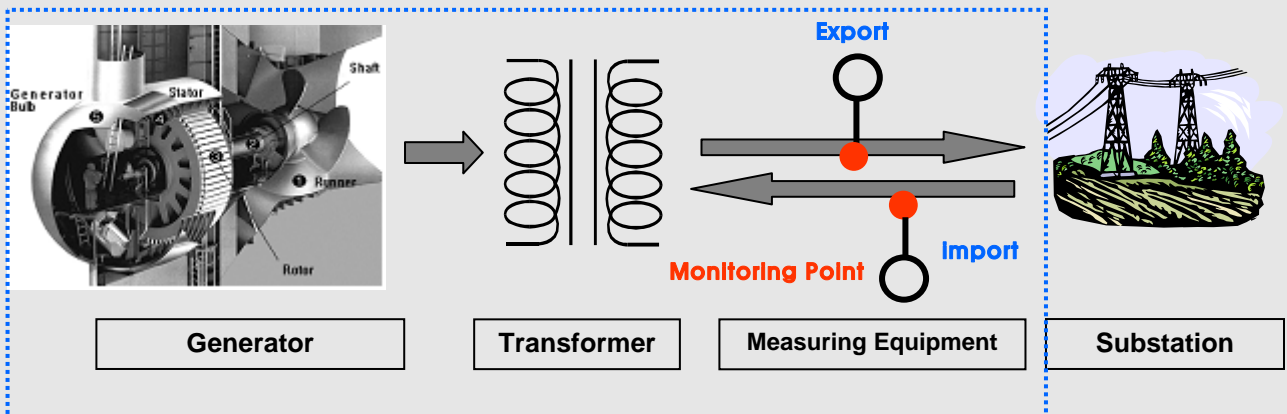
A.5. Crediting period of project activity

- Type : Renewable Energy
- Start date of the first crediting period: 01/07/2011
- Length of the crediting period corresponding to this monitoring period : 7 years (01/07/2011 ~ 30/06/2018)

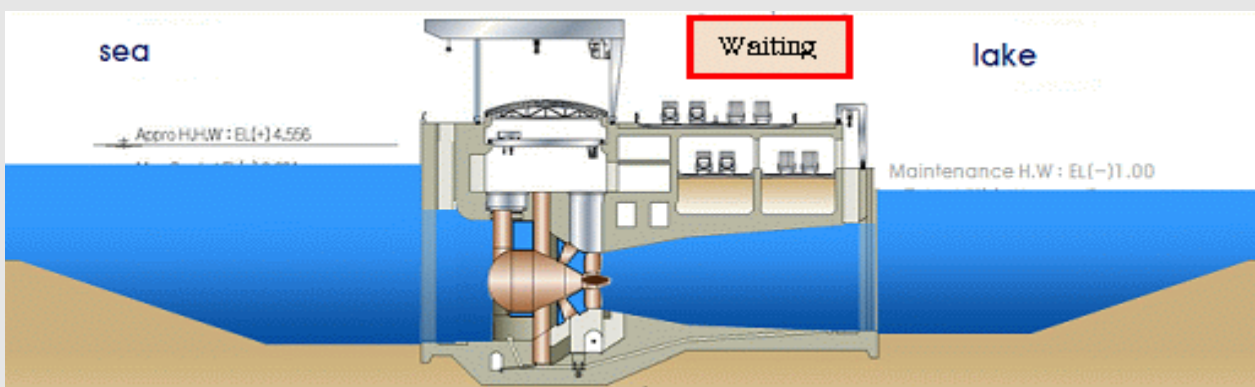
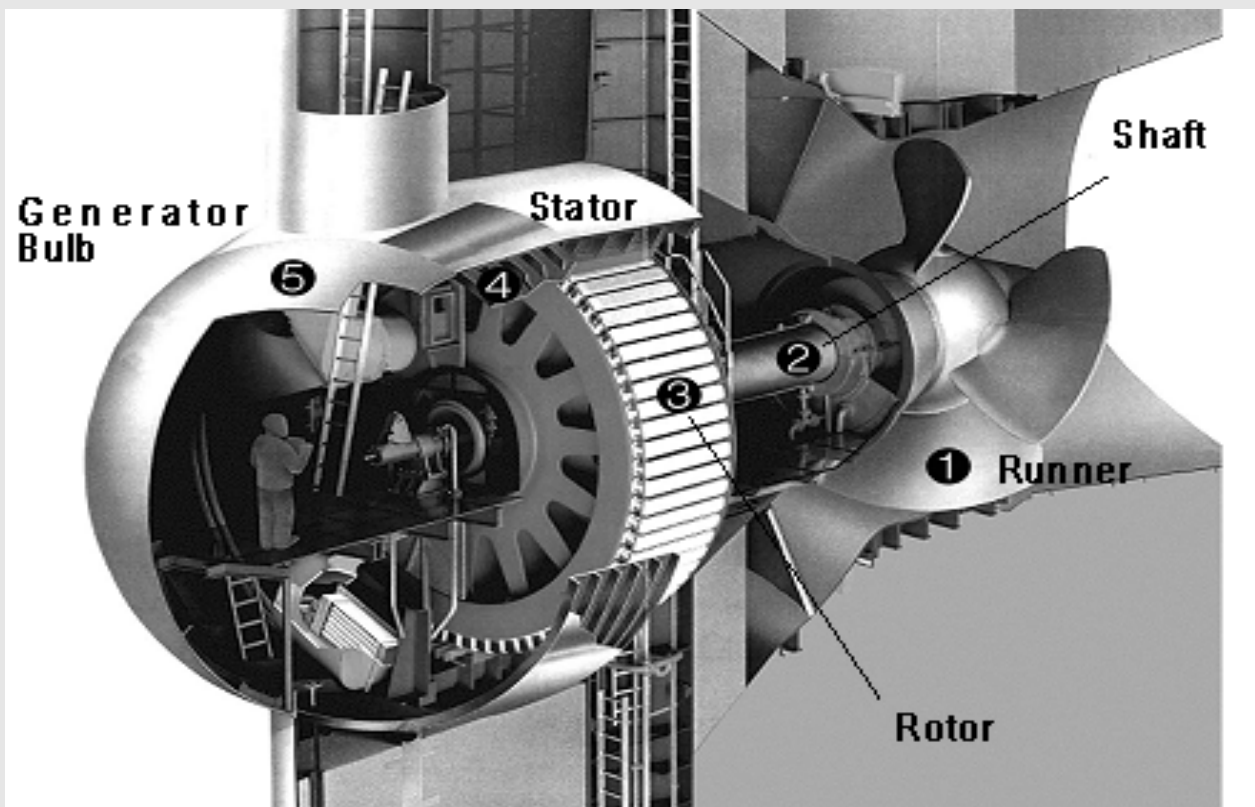
* changed from 01/07/2009~30/06/2016 to 01/07/2011 ~ 30/06/2018

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

- Technology/Measure of the project activity
Sihwa tidal power plants utilize the sea water when it is coming into Sihwa Lake which is an artificial lake made by the tide embankment, which generates electricity without emitting any GHG. The total installed capacity is 254MW. Refer to the diagrams and tables below.



Project Boundary



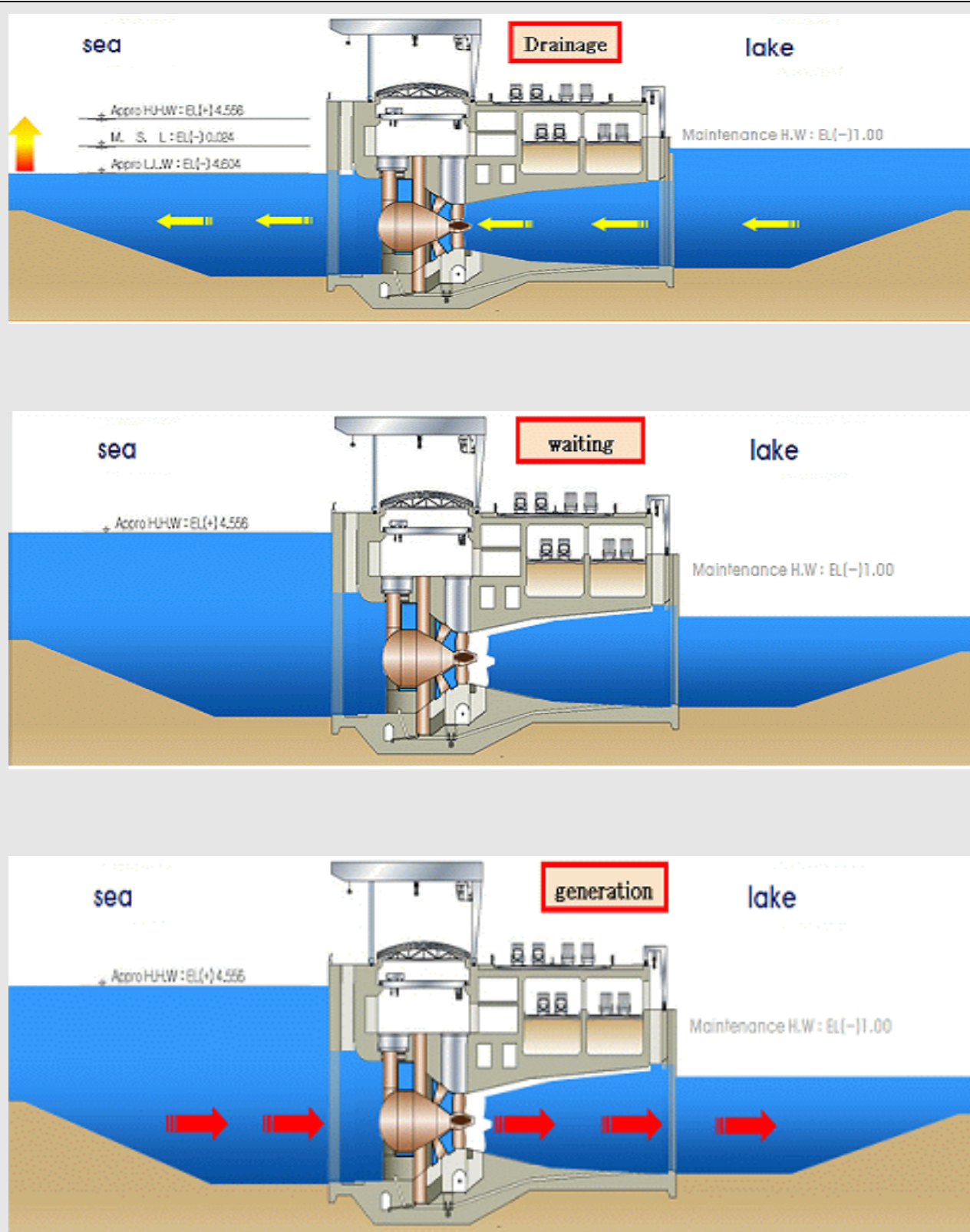


Figure 1. System Diagram of Sihwa Tidal Power Plant

Table 1. Technical Specifications of the tidal power plant

Item	The Tidal Power Plant in Sihwa
Rated Output	25,400kW X 10 (Generator)
Bulb Diameter	8.2m
Runner Diameter	7.5m
Rated Head Drop	5.82 m (Max. 7.5m, Min. 1.0m) * Spring range - 7.804m, Mean range – 5.570m Neap range -3.336m
Rated Voltage	10,200V
Velocity	64.29rpm
Rotation Direction	Clockwise rotation looking at the sea

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

Not applicable

B.2.2. Corrections

Not applicable

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

Not applicable

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

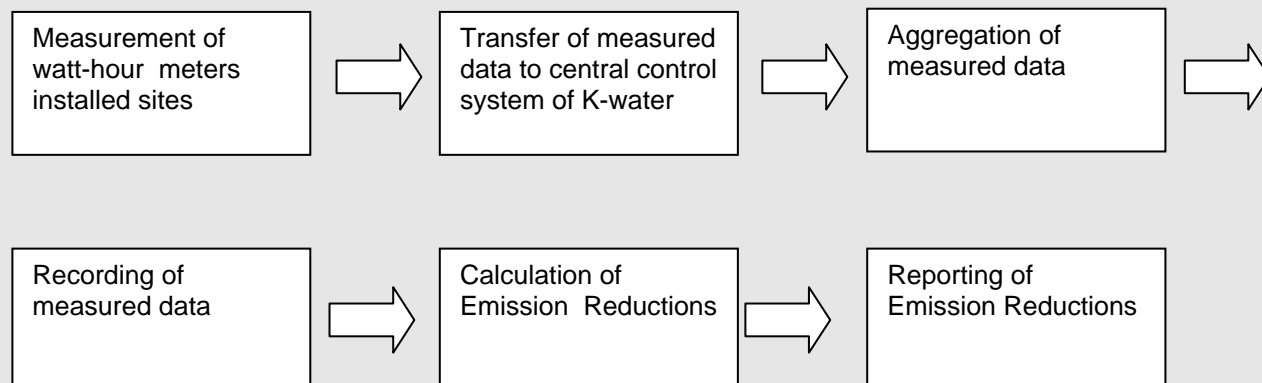
Not applicable

B.2.5. Changes to start date of crediting period

Changed from 01/07/2009 to 01/07/2011

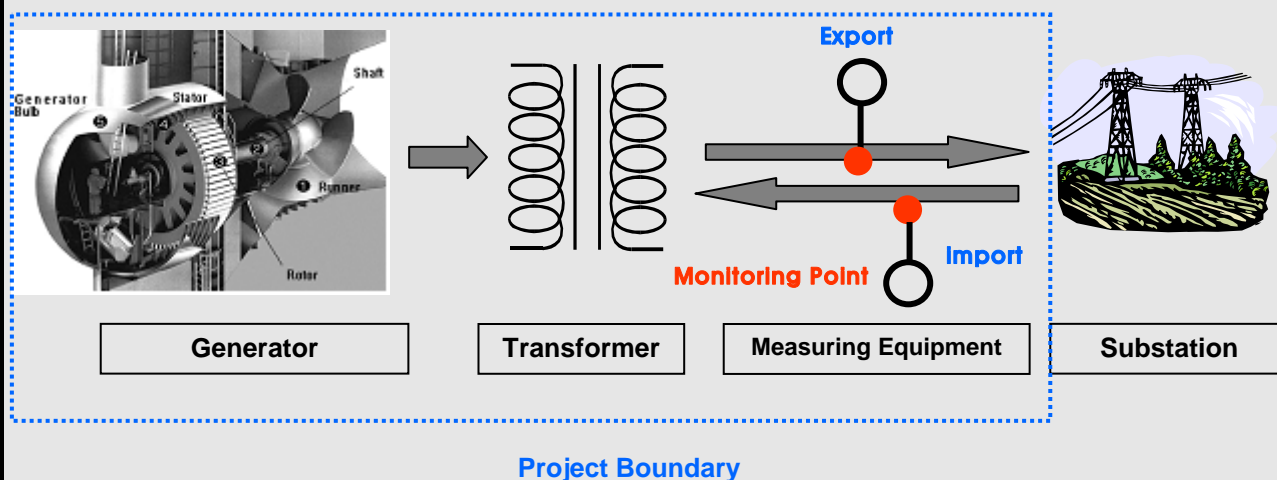
B.2.6. Types of changes specific to afforestation or reforestation project activity

Not applicable

SECTION C. Description of monitoring system

Procedure	Unit	Methods	Frequency	Remarks
Data Measuring	kWh	Electronically	Continuously	
Measured Data Transfer	kWh	Electronically	Daily	
Measured Data Aggregation	kWh	Electronically	Weekly	
Measured Data Recording	kWh	Electronically	Monthly	
Emission Reductions Calculation	tCO ₂ e	Manual	After the related monitoring periods	
Emission Reductions Reporting	tCO ₂ e	Manual	After the related monitoring periods	

- Monitoring Points for the Project**



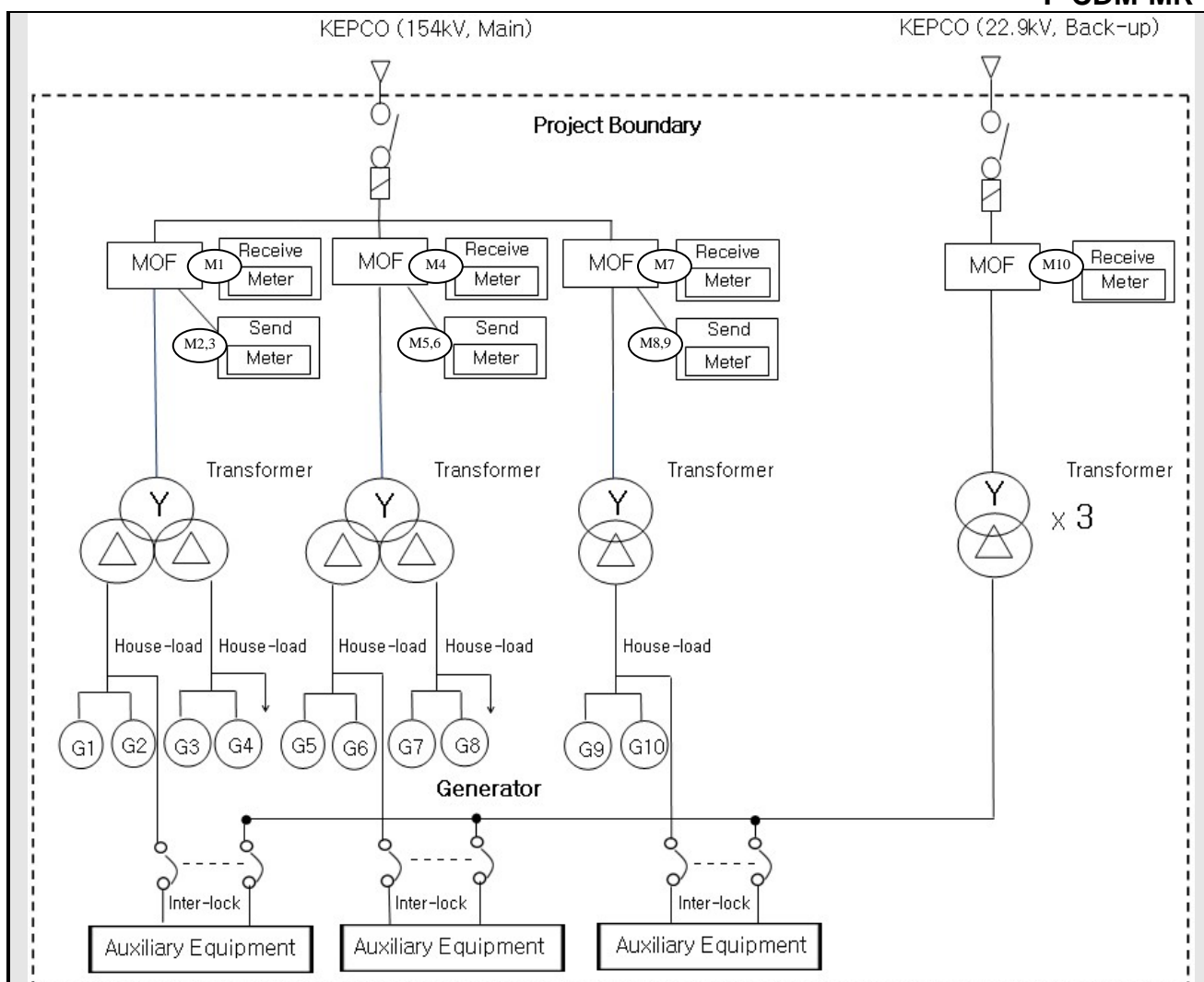


Figure 2. Skeleton diagram of the tidal power plant

Monitoring Points are located at the tidal power plant. Electricity monitored by watt-hour meter with accuracy range $\pm 0.2\%$ (sub-meter : $\pm 0.5\%$) is delivered to the grid by the project. Electricity imported from the grid is measured by watt-hour meter with accuracy range $\pm 0.5\%$.

- **QA/QC procedures**

- (Monitoring equipment)

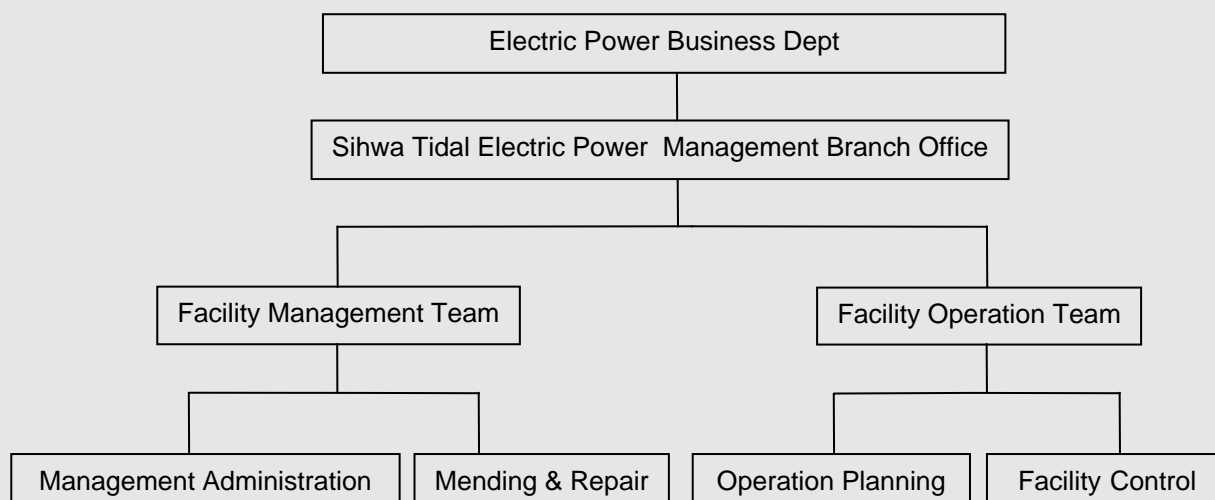
- Measuring meter of electricity exported to the grid was set up transparently in accordance with “Law regarding measurement” and “Act on operation of electricity market” then sealed after affirmation of Korea Power Exchange.
 - The meters for exported electricity were calibrated when they were installed and those were supposed to be re-calibrated every two years after installation.
 - The meters for imported electricity (under KEPCO's (Supplier) control) are calibrated every seven years according to the national law.
 - The data of sub meter are transferred to the “Renewable energy metering information system” at the head office through a modem. And when the watt hour meter is not operating well, the data of sub meter are used.

- (Monitoring of electricity amount)

- The amount of electricity exported to the grid is measured electronically by installed meters.
 - The measured data is simultaneously transferred to central control system of K-water and Korea Power Exchange.
 - The measured amount of electricity is collected daily, weekly, and monthly and is archived in electronic way. The collected data of electricity exported to the grid was double checked with those of Korea Power Exchange.

(Management of monitoring and electricity safety)

- The person in charge of monitoring and electricity safety are appointed by the final decision-maker and in the case of absence of the responsible person, the second responsible person shall be selected.

(Monitoring organization structure, roles and responsibilities)

Department in charge of monitoring for the project and responsible department are as follows :

- Sihwa Tidal Electric Power Management Branch Officer : Department and Position in charge of monitoring (including Operation & Maintenance of facilities--etc.)
- Renewable Energy Business Team Manager : Responsible Department and Position (project management, Emission Reductions calculation and reporting)
- * The name of department , team or position in charge can be changed according to reorganization in K-water.

(Emergency procedure)

- In case unexpected accident which affects Emission Reductions is occurred, the person in charge of monitoring should report to the responsible department(Renewable Energy Management Team) and act according to the internal manual, namely, "Sihwa Tidal Power Plant Operation Manual" in emergency.
- In case measuring meters of the electricity exported to the grid are improperly operated or the transfer of data is in error, internal investigation and correction procedure shall be followed and certified by the final decision-maker and Korea Power exchange.

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

Data / Parameter:	EF _{OM}
Unit:	tCO ₂ /MWh
Description:	operating margin emission factor
Source of data:	calculated
Value(s) applied:	0.77100
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks - This value was calculated according to methodology ACM0002(ver.4). Applied value was calculated by referring Statistics of Electric Power in KOREA (2002, 2003, 2004) (from Korea Electric Power Corporation, hereinafter, "KEPCO") - This value is used for CO ₂ emissions factor of grid (EF).
Additional comment:	This value is supposed to be calculated once at the time of PDD submission.

D.2. Data and parameters monitored

Data / Parameter:	EF_{BM}
Unit:	tCO ₂ /MWh
Description:	build margin emission factor
Source of data:	calculated
Value(s) applied:	0.5331
Purpose of data:	Calculation of baseline emissions - This value was calculated according to methodology ACM0002(ver.4). Applied value was calculated by referring Statistics of Electric Power in KOREA (2012) (KEPCO). - This value is used for CO ₂ emissions factor of grid (EF).
Additional comment:	This value is updated according to methodology ACM0002(ver.4) every year.

Data / Parameter	$FC_{i,m,y}$
Unit	Mass: Bituminous, LNG Volume: Heavy oil, Diesel
Description	Amount of fossil fuel type i consumed by power plant m in year y i : bituminous, heavy oil, diesel, LNG m : sample group consisting of power plant capacity additions that comprises 20% of system generation and that have been built most recently. y : year
Source of data	Statistics of Electric Power in Korea (2012)
Value(s) applied	-
Choice of data or Measurement methods and procedures	The applied value was derived from "Statistics of Electric Power in Korea (2012)" (KEPCO)
Purpose of data	Calculation of baseline emissions
Additional comment	- This value will be applied during the crediting period.

Data / Parameter	$NCV_{i,y}$
Unit	kcal/ mass or volume unit
Description	Net calorific value of fuel i : bituminous, heavy oil, diesel oil, LNG y : year
Source of data	Statistics of Electric Power in Korea (2012)
Value(s) applied	-
Choice of data or Measurement methods and procedures	The applied value was derived from "Statistics of Electric Power in Korea (2012)" (KEPCO)
Purpose of data	Calculation of baseline emissions
Additional comment	- This value will be applied during the crediting period.

Data / Parameter	$EF_{CO_2,i,y}$
Unit	tCO ₂ /GJ
Description	CO ₂ emission factor of fuel i i : bituminous, heavy oil, diesel oil, LNG y : year
Source of data	Revised 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Value(s) applied	-
Choice of data or Measurement methods and procedures	IPCC default values provided in table 1.4 of Chapter 1 of Vol.2 (Energy) were used.
Purpose of data	Calculation of baseline emissions
Additional comment	- This value will be applied during the crediting period.

Data / Parameter	OXID_i
Unit	-
Description	Oxidation factor of fuel i <i>i</i> : bituminous, heavy oil, diesel oil, LNG
Source of data	Default value on Revised 1996 IPCC Guidelines
Value(s) applied	Coal : 0.98 Oil and Oil products : 0.99 Gas : 0.995
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter:	EF _y
Unit:	tCO ₂ /MWh
Description:	CO ₂ emissions factor of grid
Source of data:	calculated
Value(s) applied:	0.65206
Purpose of data:	Calculation of baseline emissions - This value was calculated according to methodology ACM0002(ver.4). Applied value was calculated by referring Statistics of Electric Power in KOREA (KEPCO). - This value is used for baseline emission calculations
Additional comment:	This value is supposed to be calculated at the time of PDD submission and recalculated at the time of this monitoring due to the update of EF _{BM} * changed from 0.6214 to 0.65206

Data / Parameter:	EG _y
Unit:	MWh
Description:	Electricity exported to the grid from Sihwa Tidal Power Plant
Measured/ Calculated / Default:	Measured and Calculated
Source of data:	Watt-hour meter
Value(s) of monitored parameter:	Total electricity generation is 247,033.300MWh.

Monitoring equipment:	<p>Measurement equipment: Watt-hour meter Accuracy: Allowable error range $\pm 0.2\%$ Serial Number : PT-0909A407-01, PT-0909A408-01, PT-0909A409-01 Calibration information - Number of meters : 3 meters* - Calibration Frequency : within 2 years - Date of last calibration : 01/11/2011 - Validity period : 01/11/2011 – 30/10/2013 * The below is the information of additional 3 sub-meters Accuracy : Allowable error range $\pm 0.5\%$ Serial Number : 53048162, 53048163, 53048164 Calibration information - Number of meters : 3 meters - Calibration Frequency : within 2 years - Date of last calibration : 01/11/2011 - Validity period : 01/11/2011~30/10/2013</p>
Measuring/ Reading/ Recording frequency:	<p>Measuring : Continuously Reading : hourly Recording : monthly</p>
Calculation method (if applicable):	N/A
QA/QC procedures:	The amount of electricity transmitted to the grid was electronically measured and transferred to Korea Power Exchange (KPX) and K-water, so it was double checked by both entities.
Purpose of data:	Calculation of baseline emissions
Additional comment:	
Data / Parameter:	El_y
Unit:	MWh
Description:	Electricity imported by the grid for Sihwa tidal power plant
Measured/ Calculated / Default:	Measured and Calculated
Source of data:	Watt-hour meter (* owned by KEPCO)
Value(s) of monitored parameter:	Total imported electricity is 1,909.080MWh.

Monitoring equipment:	<p>Measurement equipment : Watt-hour meter</p> <p>Accuracy : Allowable error range $\pm 0.5\%$</p> <p>Serial number : 9000071, 9000072, 9000073</p> <p>Calibration information</p> <ul style="list-style-type: none"> - Number of meters : 3 meters - Calibration Frequency : within 7 years* - Date of last calibration : N/A (Manufacturing date : Oct. 2010) - Validity period : Oct. 2010– Sep. 2017 <p>* The below is the information of the one sub watt-hour meter to measure the imported electricity from 22.9kV T/L in emergency.</p> <p>Accuracy : Allowable error range $\pm 0.5\%$</p> <p>Serial Number : 25102001711</p> <p>Calibration information</p> <ul style="list-style-type: none"> - Number of meters : 1 meter - Calibration Frequency : within 7 years - Date of last calibration : N/A (Manufacturing date : Nov. 2010) - Validity period : Nov. 2010 ~ Oct. 2017 <p>* These meters will not be recalibrated every 2 years in the CDM-PDD but every 7 years according to the national law</p>
Measuring/ Reading/ Recording frequency:	<p>Measuring : Continuously</p> <p>Reading : hourly</p> <p>Recording : monthly</p>
Calculation method (if applicable):	N/A
QA/QC procedures:	The amount of electricity transmitted to the grid was electronically measured and transferred to Korea Power Exchange (KPX) and K-water, so it was double checked by both entities.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

D.3. Implementation of sampling plan

Not applicable

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

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

According to the formula below, baseline emissions for this project is **159,835tCO₂e**

$$BE_y = EG_y^* \times EF_y$$

BE_y	=	Baseline emissions(tCO ₂ e)
EG_y^*	=	Net electricity generation(MWh) : $EG_y - EI_y$
EF_y	=	Baseline emission factor(tCO ₂ e/MWh)

Year	Month	Electricity (kWh)	Baseline Emission Factor (tCO ₂ e /MWh)	Emission Reductions (tCO ₂ e)
2013	10	41,120,317	0.65206	26,812.900
2013	11	39,094,128	0.65206	25,491.700

2013	12	41,716,875	0.65206	27,201.900
2014	1	44,079,216	0.65206	28,742.200
2014	2	37,022,482	0.65206	24,140.800
2014	3	44,000,282	0.65206	28,690.800
Total Electricity exported to the grid(A)		247,033,300		161,080.300
2013	10	327,600	0.65206	213.600
2013	11	317,040	0.65206	206.700
2013	12	332,640	0.65206	216.900
2014	1	327,600	0.65206	213.600
2014	2	286,548	0.65206	186.800
2014	3	317,652	0.65206	207.100
Electricity imported from the grid(B)		1,909,080		1,244.700
Net electricity generation (A-B)		245,124,220		159,835

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

GHG emissions due to the project activity are not occurred.

Project emission is zero;

PE = 0

E.3. Calculation of leakage

No leakage occurs in accordance with ACM0002 (ver4)

PL = 0.

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

$$-ER_y = BE_y - PE_y - LE_y$$

Item	Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO ₂ e)
Total	159,835	-	-	159,835

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
Emission reductions or GHG removals by sinks (t CO ₂ e)	157,720	159,835

* 315,440 tCO₂e , yearly emission reductions in the registered PDD was recalculated by month, resulting in 157,720 tCO₂e for this monitoring.
(315,440 tCO₂ x6/12 =157,720 tCO₂e)

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

This project was estimated to reduce 157,720tCO₂e according to the registered CDM-PDD for the relevant monitoring period. However, actual reduction is 159,835 tCO₂e and the net electricity supplied to the grid was 245,124,220kWh. This shows that actual value was higher by 2,115tCO₂e than the estimated value in CDM-PDD with the result of the increase of BM factor and of unexpected tidal difference activity.

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
Emission reductions or GHG removals by sinks (tCO ₂ e)	-	159,835

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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.2	5 November 2013	Editorial revision to correct table in page 1.
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.
Decision Class: Regulatory		
Document Type: Form		
Business Function: issuance		
Keywords: monitoring report, performance monitoring		