



Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT

Title of the project activity	Sihwa Tidal Power Plant CDM Project	
UNFCCC reference number of the project activity	0349	
Version number of the monitoring report	Ver. 01	
Completion date of the monitoring report	25/04/2016	
Monitoring period number and duration of this monitoring period	9th, 01/10/2015 ~ 31/03/2016 (first and last days included)	
Project participant(s)	Korea Water Resources Corporation(K-water)	
Host Party	Republic of Korea	
Sectoral scope(s)	Energy industries(renewable/non-renewable sources)	
Selected methodology(ies)	ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources(version 4)	
Selected standardized baseline(s)	-	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	158,152 tCO ₂ e * This amount was recalculated by multiplying the day 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 / 365 days × 183 days =158,152 tCO ₂ e)	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	-	163,914

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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- **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 located in 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 air, 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 : 163,914CO₂e**

A.2. Location of project activity

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- 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 whether 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
Switzerland		

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

A.4. Reference of applied methodology and standardized baseline

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- The applied methodology : ACM0002 – "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (version 4)

* Please refer to the below link for the further information of the methodology and the tool :

<http://cdm.unfccc.int/methodologies/DB/M0CSBFOF8RQG5I84XU5Y4WX0I5LHS1>

A.5. Crediting period of project activity

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

A.6. Contact information of responsible persons/entities

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- Last name : Kim
- First name : Deog-je
- Email : kdj@kwater.or.kr
- Telephone : +82-42-629-2988
- Fax : +82-42-629-2999

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

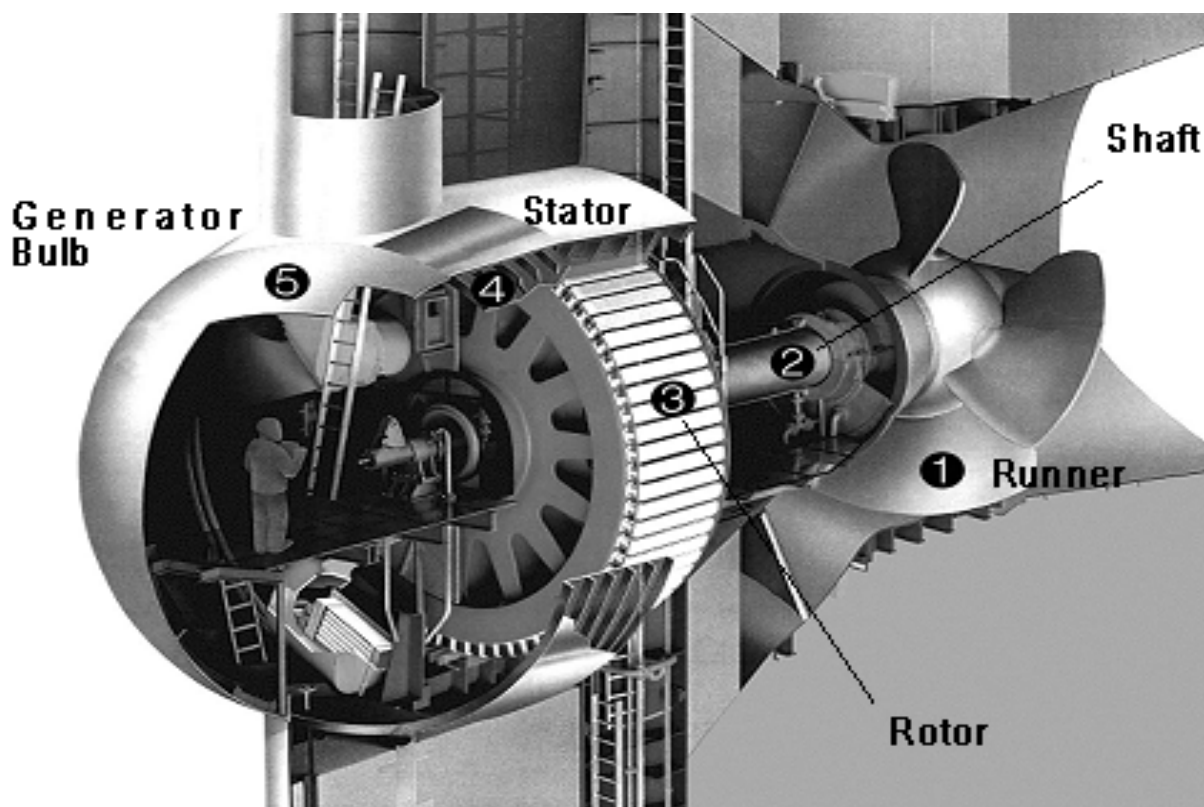
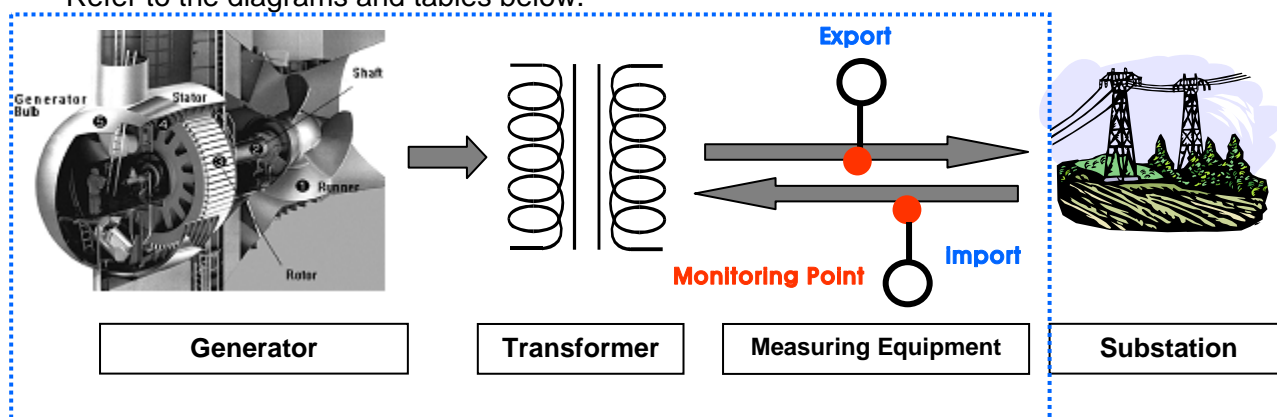
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- Technology/Measure of the project activity
Sihwa tidal power plants utilize the sea water when it is coming into Sihwa Lake which is an artificial lake made by the tide embankment, which generates electricity without emitting any GHG. The total installed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

The project construction was started on 31/12/2004 and the project commissioning period was 28/03/2011-29/02/2012. The project was under normal and continued operation status until now.

The 9th monitoring period of the project is 01/10/2015-31/03/2016.

Refer to the diagrams and tables below.



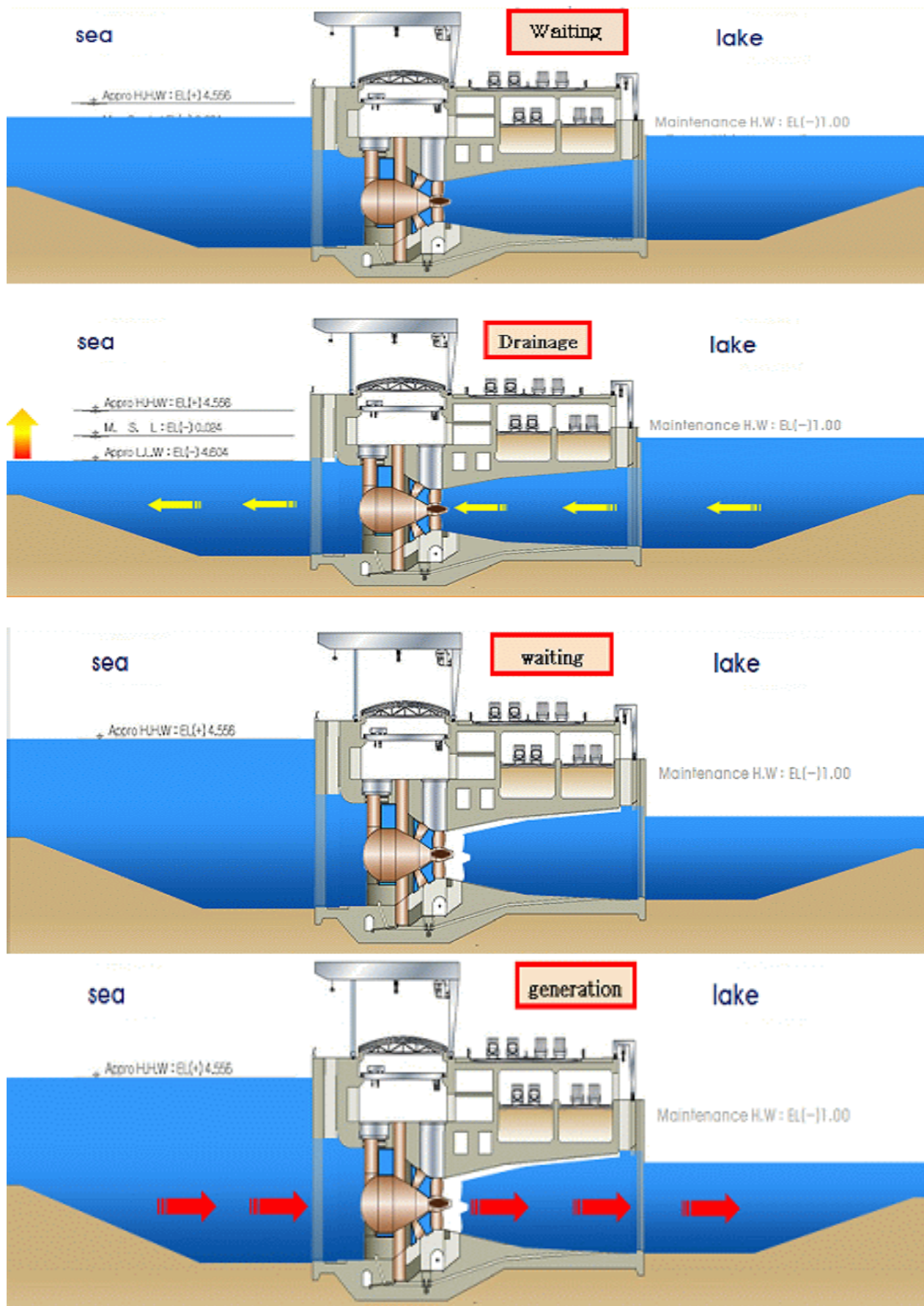


Figure 1. System Diagram of Sihwa Tidal Power Plant

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, applied methodology or applied standardized baseline**

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- Not applicable

B.2.2. Corrections

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- Not applicable

B.2.3. Changes to start date of crediting period

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

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

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- Not applicable

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

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- Not applicable

B.2.6. Changes to project design of registered project activity

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- Not applicable

B.2.7. Types of changes specific to afforestation or reforestation project activity

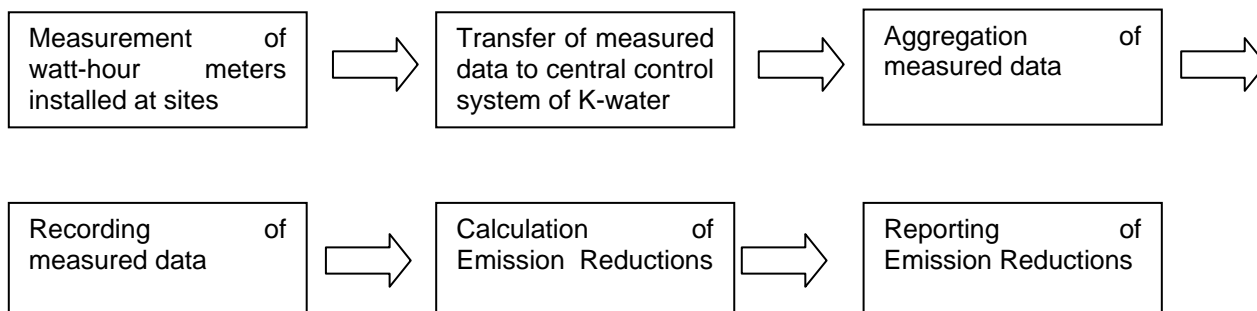
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- Not applicable

SECTION C. Description of monitoring system

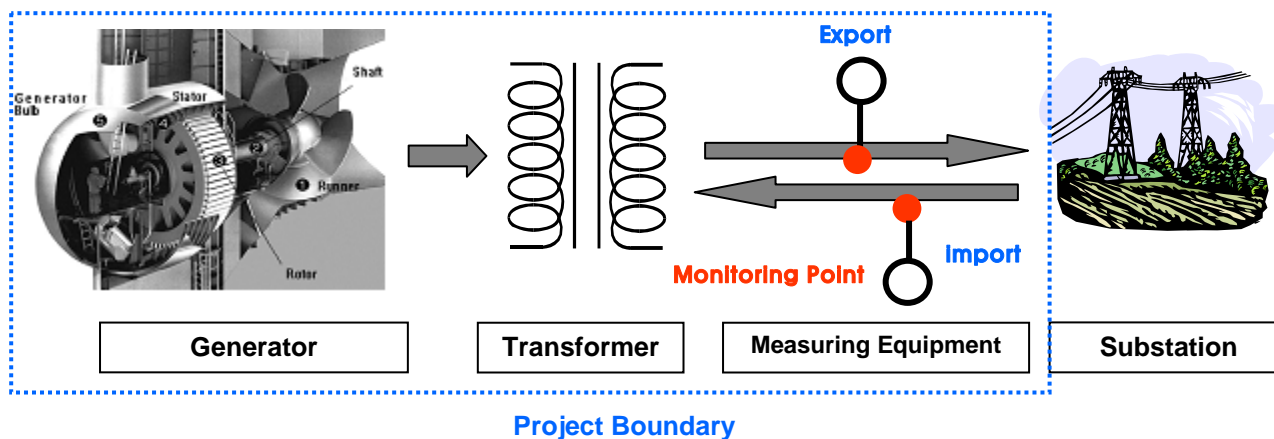
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- There are total 10 watt-hour meters installed for the monitoring system. All of watt-hour meters are installed at the project site. The watt-hour meters for SEND, a total of 6 meters, are installed in main line(154 kV). M1, M3 and M5 are the main watt-hour meters with accuracy range $\pm 0.2\%$. M2, M4 and M6 are the sub watt-hour meters with accuracy range $\pm 0.5\%$. The watt-hour meters for RECEIVE, a total of 4 meters, are installed with accuracy range $\pm 0.5\%$. M7, M8 and M9 are installed in main line(154 kV) and M10 is installed in back-up line(22.9 kV).



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



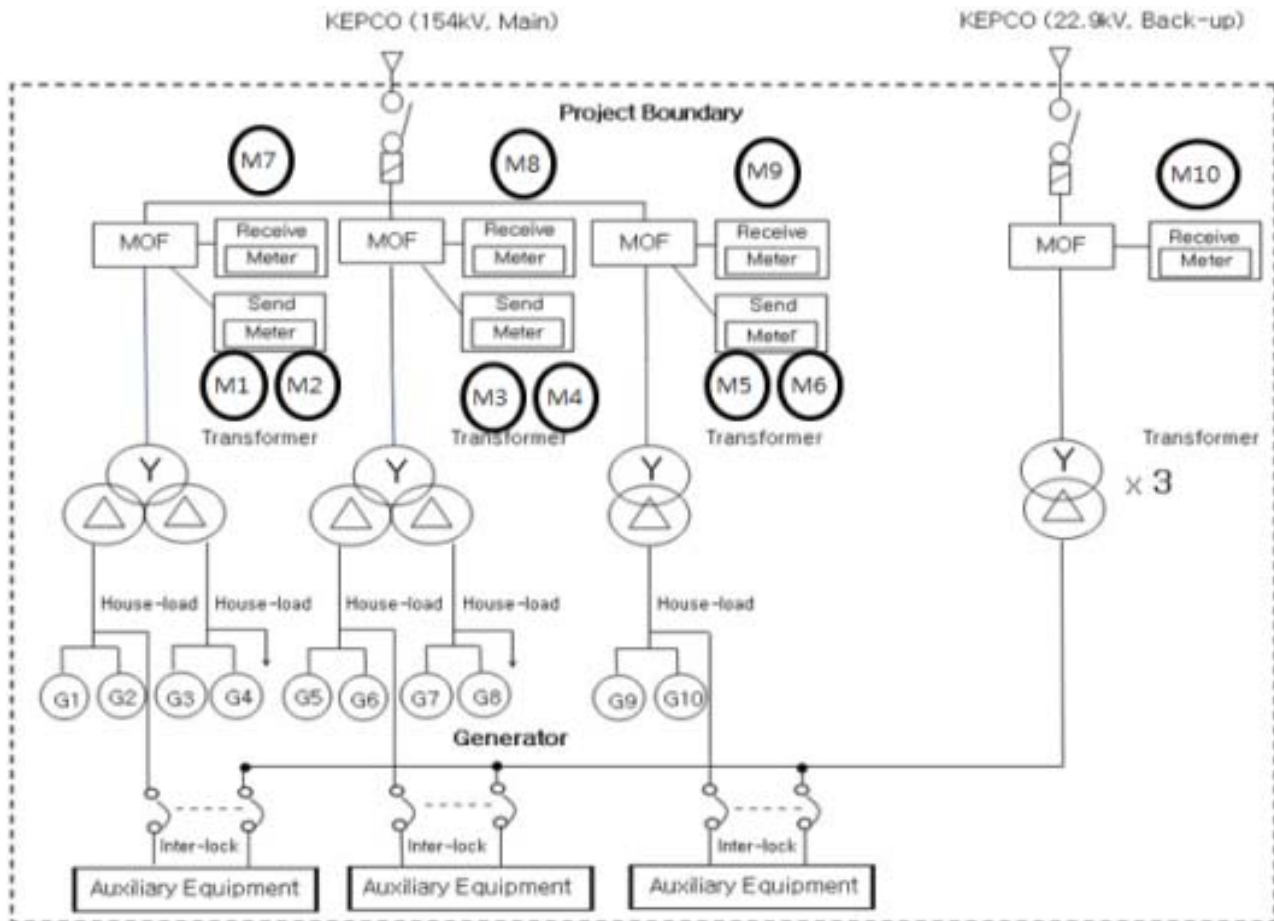


Figure 2. Skeleton diagram of the tidal power plant

- **QA/QC procedures**

(Monitoring equipment)

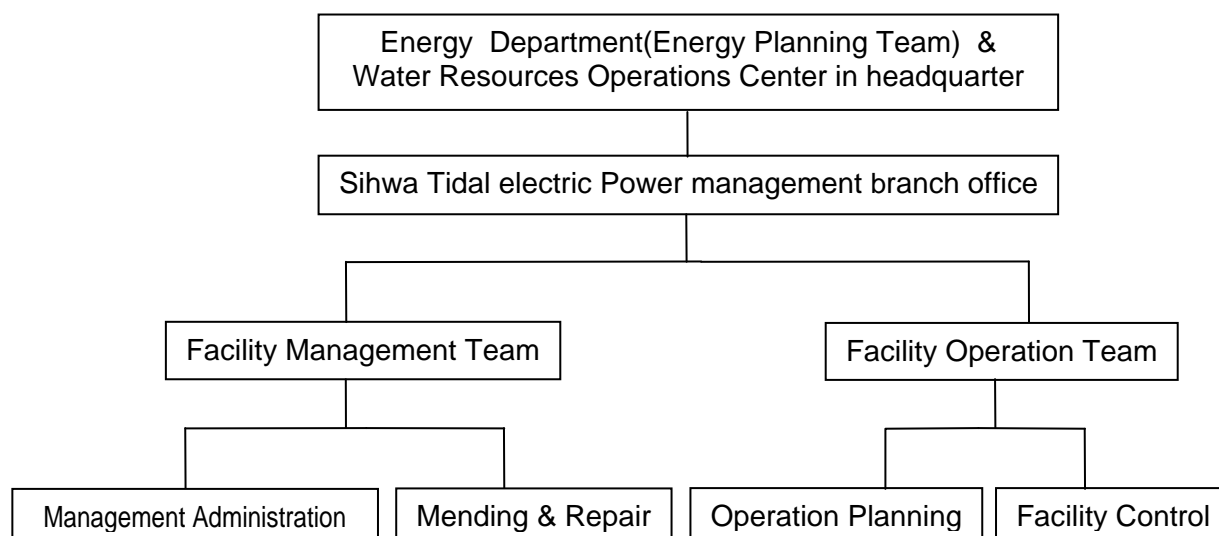
- Measuring meter of electricity exported to the grid was set up transparently in accordance with “Law regarding measurement” and “Act on operation of electricity market” then sealed after affirmation of Korea Power Exchange (“KPX”).
- The meters for exported electricity were calibrated when they were installed and those were supposed to be re-calibrated every two years after installation.
- The meters for imported electricity are under Korea Electric Power Corporation’s (hereinafter “KEPCO”) control and calibrated or replaced with new one by KEPCO 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 KPX.
- 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 KPX.

(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)

The role and responsibility of the respective monitoring departments and persons are as follows :

- R & R to measure the input-output electricity and maintain watt hour meters :
Sihwa Tidal Electric power management branch office and Facility Operation Team Member
- R & R to collect and record electricity data and to calculate BM emission factor :
The person in charge of CDM in Energy Department
- R & R to check and correct the transmitted electricity by comparing the data of K-water and KPX :
The person in charge of Power Plant Operations in Water Resources Operations Center

* 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(Energy Planning 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 of K-water's Water Resources Operations Center and KPX.

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

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

Data/parameter:	EF _{OM}
Unit	tCO ₂ /MWh
Description	operating margin emission factor
Source of data	calculated
Value(s) applied)	0.7710
Choice of data or measurement methods and procedures	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)

Purpose of data	Calculation of baseline emissions or baseline net GHG removals by sinks - This value is used for CO ₂ emissions factor of grid (EF).
Additional comments	This value is supposed to be calculated once at the time of PDD submission.

D.2. Data and parameters monitored

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

Data/parameter:	EF _{BM}
Unit	tCO ₂ /MWh
Description	build margin emission factor
Measured/calculated/default	Calculated
Source of data	Calculated by referring Statistics of Electric Power in KOREA (2014) (KEPCO) And States of Generation facility (2014) (KPX)
Value(s) of monitored parameter	0.5461
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Yearly
Calculation method (if applicable):	This value was calculated as $[\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}]/[\sum_m GEN_{m,y}]$ over recently built power plants defined in the baseline methodology according to ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" version 4.
QA/QC procedures:	N/A
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 (2014) (KEPCO) and States of Generation facility (2014) (KPX). - This value is used for CO ₂ emissions factor of grid (EF).
Additional comments:	This value is updated according to methodology ACM0002(ver.4) every year.

Data/parameter:	F _{i,y}
Unit	Mass or Volume
Description	Amount of each fossil fuel consumed by each power plant i : bituminous, heavy oil, diesel oil, LNG y : year
Measured/calculated/default	Default
Source of data	Statistics of Electric Power in Korea (2014)
Value(s) of monitored parameter	N/A
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Yearly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Calculation of baseline emissions
Additional comments:	N/A

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
Measured/calculated/default	Default
Source of data	Statistics of Electric Power in Korea (2014)
Value(s) of monitored parameter	N/A
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Yearly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Calculation of baseline emissions
Additional comments:	This value will be applied during the crediting period.

Data/parameter:	COEF _i
Unit	tCO ₂ /GJ
Description	CO ₂ emission coefficient factor of fuel <i>i</i> <i>i</i> : bituminous, heavy oil, diesel oil, LNG
Measured/calculated/default	Default
Source of data	IPCC default values provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of Revised 2006 IPCC Guidelines for National Greenhouse Gas Inventories were used
Value(s) of monitored parameter	N/A
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Yearly
Calculation method (if applicable):	This value was calculated as [NCVi · EFco _{2i} · OXID _i] according to ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" version 4 and was derived from "2002, 2003, 2004 Statistics of Electric Power in Korea(2003, 2004, 2005)"(KEPCO)
QA/QC procedures:	N/A
Purpose of data:	Calculation of baseline emissions
Additional comments:	This value will be applied during the crediting period.

Data/parameter:	EF _y
Unit	tCO ₂ /MWh
Description	CO ₂ emissions factor of grid
Measured/calculated/default	Calculated
Source of data	Calculated
Value(s) of monitored parameter	0.6585
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Yearly
Calculation method (if applicable):	This value was calculated according to methodology ACM0002(ver.4). Applied value was calculated by referring Statistics of Electric Power in KOREA (KEPCO).
QA/QC procedures:	N/A
Purpose of data:	Calculation of baseline emissions - This value is used for baseline emission calculations

Additional comments:	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 0.6585
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Data/parameter:	EG_y
Unit	MWh
Description	Net amount of electricity transmitted to the grid excluding electricity consumed in the sihwa tidal power plant
Measured/calculated/default	Measured and Calculated
Source of data	Watt-hour meter
Value(s) of monitored parameter	Net electricity generation is 248,921.052MWh - Total electricity generation is 250,955.604MWh. - Total imported electricity is 2,034.552MWh.
Monitoring equipment	<p>1. Generation</p> <p>Measurement equipment: Watt-hour meter</p> <p>Accuracy: Allowable error range $\pm 0.2\%$</p> <p>Serial Number : PT-0909A407-01, PT-0909A408-01, PT-0909A409-01</p> <p>Calibration information</p> <ul style="list-style-type: none"> - Number of meters : 3 meters* - Calibration Frequency : within 2 years - Date of last calibration : 22/10/2015 - Validity period : 22/10/2015 – 21/10/2017 <p>* The below is the information of additional 3 sub-meters</p> <p>Accuracy : Allowable error range $\pm 0.5\%$</p> <p>Serial Number : 53048162, 53048163, 53048164</p> <p>Calibration information</p> <ul style="list-style-type: none"> - Number of meters : 3 meters - Calibration Frequency : within 2 years - Date of last calibration : 22/10/2015 - Validity period : 22/10/2015 – 21/10/2017
Monitoring equipment	<p>2. Importation</p> <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 be recalibrated every 7 years according to the national law</p>
Measuring/reading/recording frequency:	Measuring : Continuously Reading : hourly Recording : monthly
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 comments:	N/A

Data/parameter:	GENy
Unit	MWh/each plant
Description	Electricity generation of each power plant
Measured/calculated/default	Default
Source of data	Statistics of Electric Power in Korea (2014)
Value(s) of monitored parameter	100,796,231MWh
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Yearly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Calculation of baseline emissions
Additional comments:	N/A

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

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- According to the formula below, baseline emissions for this project is **163,914CO₂e**

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

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)
2015	10	44,946,450	0.6585	29,597,237
2015	11	41,351,594	0.6585	27,230,024
2015	12	41,739,938	0.6585	27,485,749
2016	1	40,428,082	0.6585	26,621,891
2016	2	40,435,258	0.6585	26,626,617
2016	3	42,054,282	0.6585	27,692,744
Total Electricity exported to the grid(A)		250,955,604		165,254,262
2015	10	341,112	0.6585	224,622
2015	11	359,520	0.6585	236,743
2015	12	371,280	0.6585	244,487
2016	1	342,720	0.6585	225,681
2016	2	300,720	0.6585	198,024
2016	3	319,200	0.6585	210,193
Electricity imported from the grid(B)		2,034,552		1,339,750
Net electricity generation (A-B)		248,921,052		163,914

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

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- GHG emissions due to the project activity are not occurred.
Project emission is zero;
PE = 0

E.3. Calculation of leakage

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- No leakage occurs in accordance with ACM0002 (ver4)
L = 0

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

- $ER_y = BE_y - PE_y - L_y$

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)	GHG emission reductions or net GHG removals by sinks (t CO ₂ e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	163,914	-	-	-	163,914	163,914

E.5. Comparison of actual emission reductions or net 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)	158,152	163,914

* 315,440 tCO₂e , yearly emission reductions in the registered PDD was recalculated on a daily basis and resulted in 158,152 tCO₂e for this monitoring period. (315,440 tCO₂ / 365 days × 183 days = 158,152 tCO₂e)

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

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- This project was estimated to reduce 158,152tCO₂e according to the registered CDM-PDD for the relevant monitoring period. However, actual reduction is 163,914tCO₂e and the net electricity supplied to the grid was 248,921,052kWh. This shows that actual value was higher by 5,762tCO₂e than the estimated value in CDM-PDD with the result of the increase of BM factor.

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input checked="" type="checkbox"/> Person/entity responsible for completing the CDM-MR-FORM
Organization name	Korea Water Resources Corporation(K-water)
Street/P.O. Box	200 Sintanjin-Ro, Daedeok-Gu
Building	K-water
City	Daejeon
State/region	
Postcode	306-711
Country	Republic of Korea
Telephone	+82-42-629-2988
Fax	+82-42-629-2999
E-mail	kdj@kwater.or.kr
Website	www.kwater.or.kr
Contact person	Kim Deog-je
Title	Manager
Salutation	Mr.
Last name	Kim
Middle name	-
First name	Deog-je
Department	Energy Dept
Mobile	+82-10-8604-7335
Direct fax	+82-42-629-2999
Direct tel.	+82-42-629-2988
Personal e-mail	kdj@kwater.or.kr

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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • Editorial improvement.
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 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		