



Monitoring report form for CDM project activity
(Version 07.0)

Complete this form in accordance with the instructions attached 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 PDD applicable to this monitoring report	Version 04.0	
Version number of this monitoring report	Version 01.0	
Completion date of this monitoring report	26/08/2019	
Monitoring period number	15 th monitoring	
Duration of this monitoring period	01/01/2019~30/06/2019	
Monitoring report number for this monitoring period	Not Applicable	
Project participants	Korea Water Resources Corporation(K-water)	
Host Party	Republic of Korea	
Applied methodologies and standardized baselines	ACM0002 Grid-connected electricity generation from renewable sources (version 17)	
Sectoral scopes	Sectoral scope : 1 - Energy industries (renewable / non-renewable sources)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	-	119,202
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	124,512 t CO 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, 251,089 t CO ₂ e. (251,089 tCO ₂ e / 365 days × 181 days = 124,512 t CO ₂ e)	

SECTION A. Description of project activity

A.1. General description of project activity

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

This project activity is to generate electricity and supply it to the grid by using tidal power of Sihwa Lake in Ansan city in Korea instead of the fossil fuel and contribute to mitigation of climate change & sustainable development. Moreover, the project supports the government policy that promotes development of renewable energy technology in the Republic of Korea and contributes to decrease the dependence on the electricity generated by fossil fuel-fired power plants.

K-water's 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 the 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.

- **Total GHG emission reductions achieved in this monitoring period : 119,202 t CO₂e**
- **Brief description of the installed equipment :**

This project consists of 10 units of 25.4MW turbines and generates electricity of 552.7GWh per year from the tidal power plant. The specification of the installed equipment is as the following;

Table 1. Technical Specifications of the tidal power plant

Item	The Tidal Power Plant in Sihwa
Rated Output	25,400kW × 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

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 participants

Parties involved	Project participants	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
Switzerland		

A.4. References to applied methodologies and standardized baselines

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- The applied methodology : ACM0002 – “Grid-connected electricity generation from renewable sources” (version 17)
- The methodological Tool : TOOL07-“Tool to calculate the emission factor for an electricity”(version 6.0)

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

<http://cdm.unfccc.int/methodologies/DB/8W400U6E7LFHHYH2C4JR1RJWWO4PVN>

<https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-07-v6.pdf>

A.5. Crediting period type and duration

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- Type of the crediting period : Renewable
- Duration corresponding to this monitoring period : 01/07/2018 ~ 30/06/2025

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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- **Technology/Measure of the project activity**

Sihwa tidal power plants utilize the seawater 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.

• **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

The project was under normal and continued operation status until now and the 15th monitoring period of the project is 01/01/2019 – 30/06/2019.

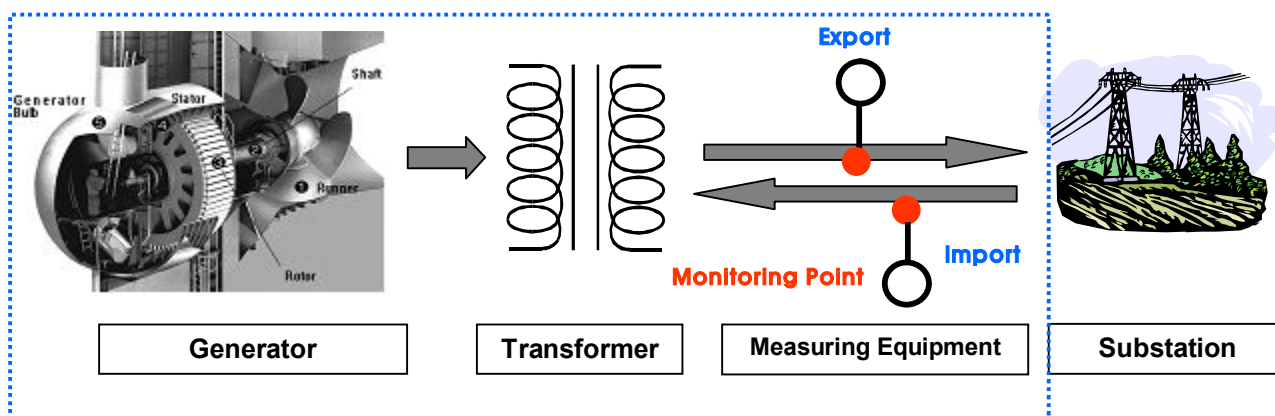
Refer to the diagrams and table below.

• **Operational events of the tidal power plant**

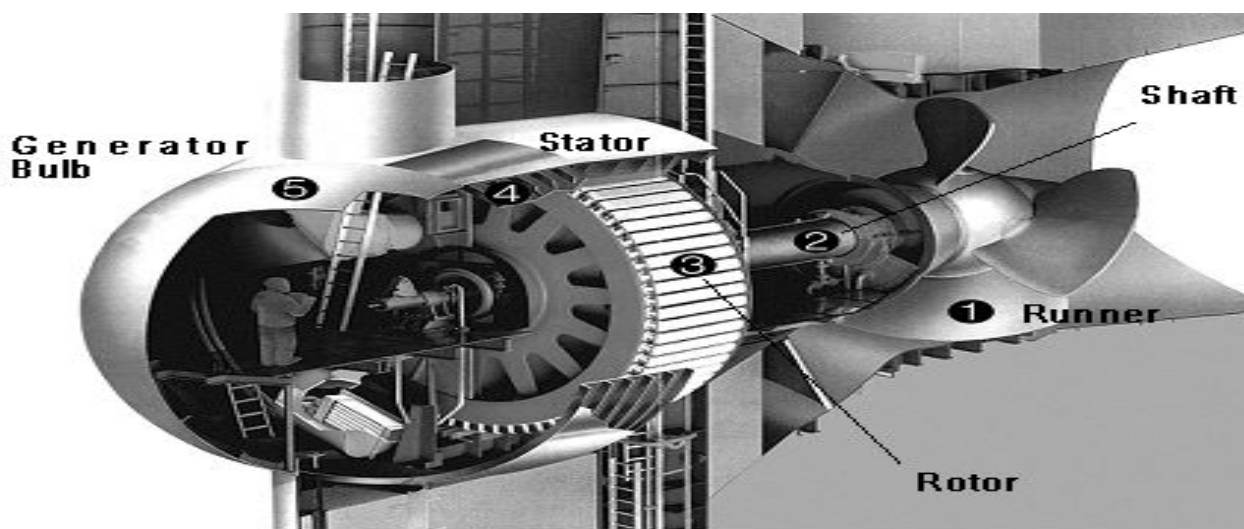
No special events occurred during this monitoring period. However during some days the generator #1~#4 or #9~#10 did not work, due to very little head drop of ebb tide. The other generator worked a little, so total exported electricity were not zero on the date. Refer to the ER calculation spreadsheets for the further information.

The operational events of sihwa tidal plant are as below.

Date	Operation events
28/04/2019~29/04/2019	Due to very little head drop of ebb tide, generator #1~#4 did not work(The data of the meter #1 was zero).
30/04/2019	Due to very little head drop of ebb tide, generator #9~#10 did not work(The data of the meter #3 was zero).



Project Boundary



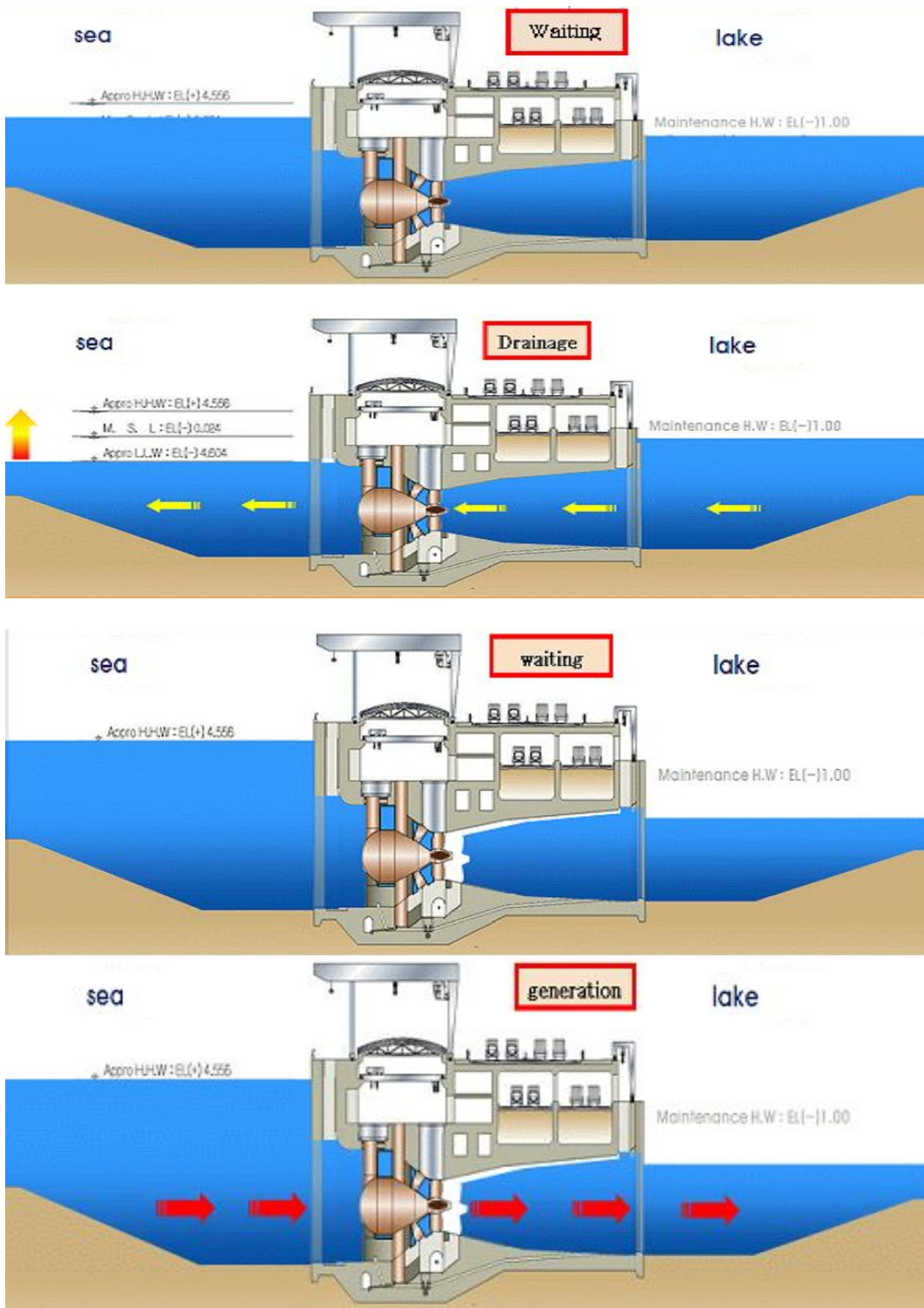


Figure 1. System Diagram of Sihwa Tidal Power Plant

B.2. Post-registration changes**B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents**

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- **PRC-0349-005 (Approval date : 01/03/2019)**
 - K-water changed monitoring method of parameter GEN_y and EF_{BM} .

B.2.2. Corrections

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- **PRC-0349-001 (Approval date : 23/11/2012)**
 - K-water updated the project participant because of withdrawal of Ecoeye (consulting company).
 - K-water changed the abbreviation of Korea Water Resources Corporation from KOWACO to K-water.
 - K-water corrected the version number of the applied methodology (ACM0002) from version 3 to version 4.
- **PRC-0349-002 (Approval date : 03/05/2013)**
 - K-water corrected the geo-coordination of the power plant as follows:
Latitude: 126°4'W → 37°18'46"N
Longitude: 37°2'N → 126°36'36"E
- **PRC-0349-003 (Approval date : 30/10/2014)**
 - K-water corrected the abbreviation of Korea Water Resources Corporation from KOWACO to K-water.
 - K-water updated the monitoring structure according to the changes of role and responsibility of related monitoring departments.

B.2.3. Changes to the start date of the crediting period

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- Changed from 01/07/2009 to 01/07/2011 (Approval date of the change: 26/04/2011)
(Applied only to the first crediting period)

B.2.4. Inclusion of monitoring plan

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- Not applicable

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

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- **PRC-0349-001 (Approval date : 23/11/2012)**
 - K-water changed the type of watt-hour meters from bidirectional meters to unidirectional meters.
 - K-water changed the calibration frequency of watt-hour meters for measuring imported electricity from 2 years to 7 years.
- **PRC-0349-004 (Approval date : 04/01/2019)**
 - K-water changed the monitoring plan of energy meters for exported and imported electricity to be calibrated properly in accordance with the national regulations.

B.2.6. Changes to project design

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- Not applicable

B.2.7. Changes specific to afforestation or reforestation project activity

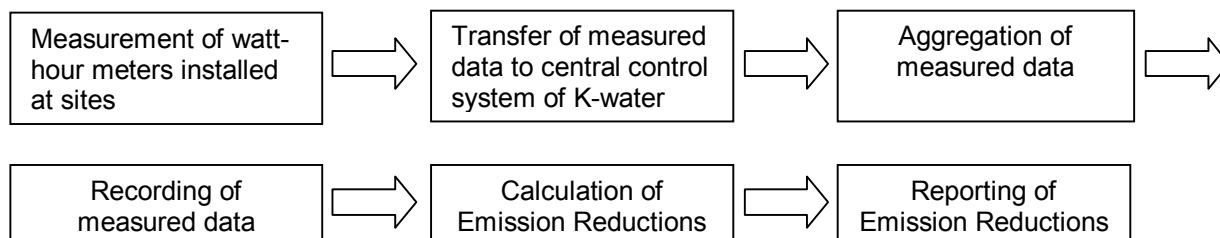
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- Not applicable

SECTION C. Description of monitoring system

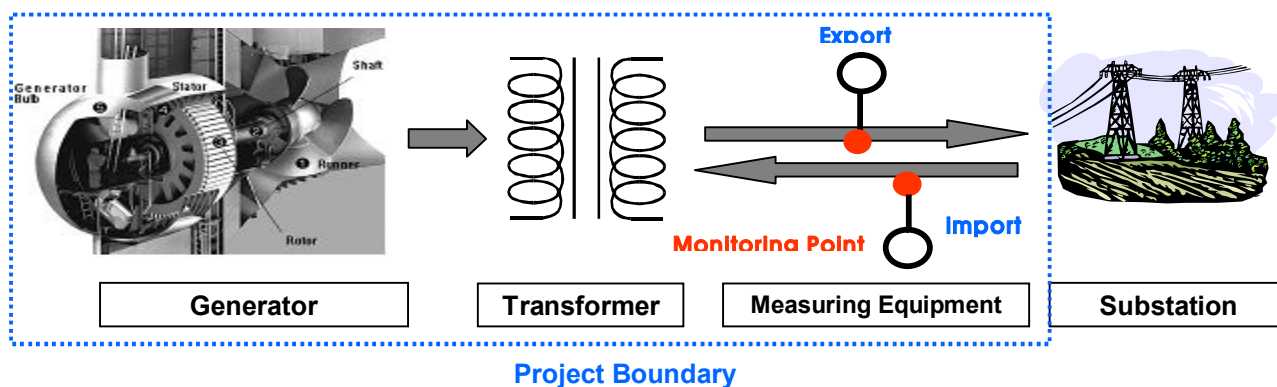
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- There are total 10 watt-hour meters installed for the monitoring system. All of watt-hour meters are installed at the project site. The watt-hour meters for SEND, a total of 6 meters, are installed in main line (154 kV). M1, M3 and M5 are the main 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
Data Measuring	kWh	Electronically	Continuously
Measured Data Transfer	kWh	Electronically	Exported electricity : Daily Imported electricity : Monthly
Measured Data Aggregation	kWh	Electronically	Exported electricity : Weekly Imported electricity : Monthly
Measured Data Recording	kWh	Electronically	Monthly
Emission Reductions Calculation	tCO ₂	Manual	After the related monitoring periods
Emission Reductions Reporting	tCO ₂	Manual	After the related monitoring periods

- **Monitoring Points for the Project**



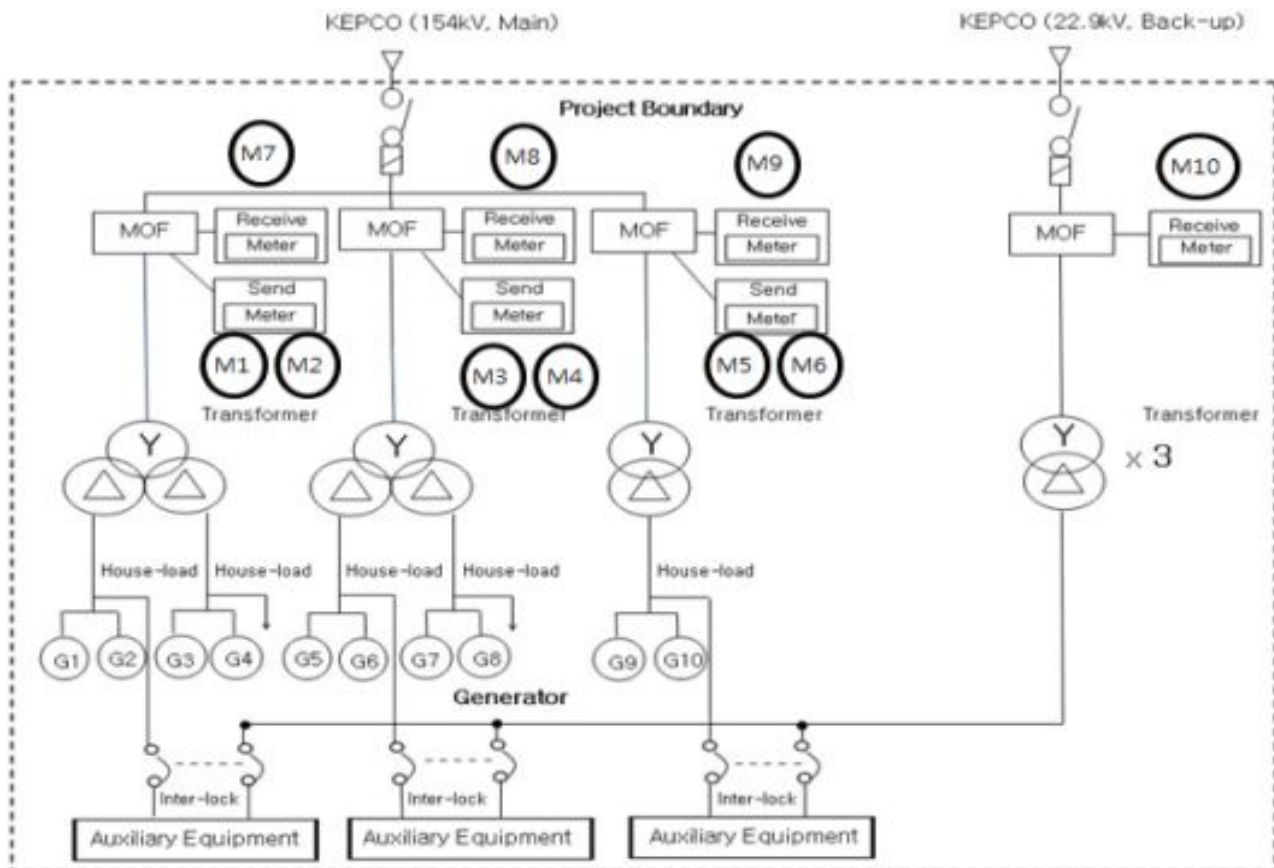


Figure 2. Skeleton diagram of the tidal power plant

- **QA/QC procedures**

(Monitoring equipment)

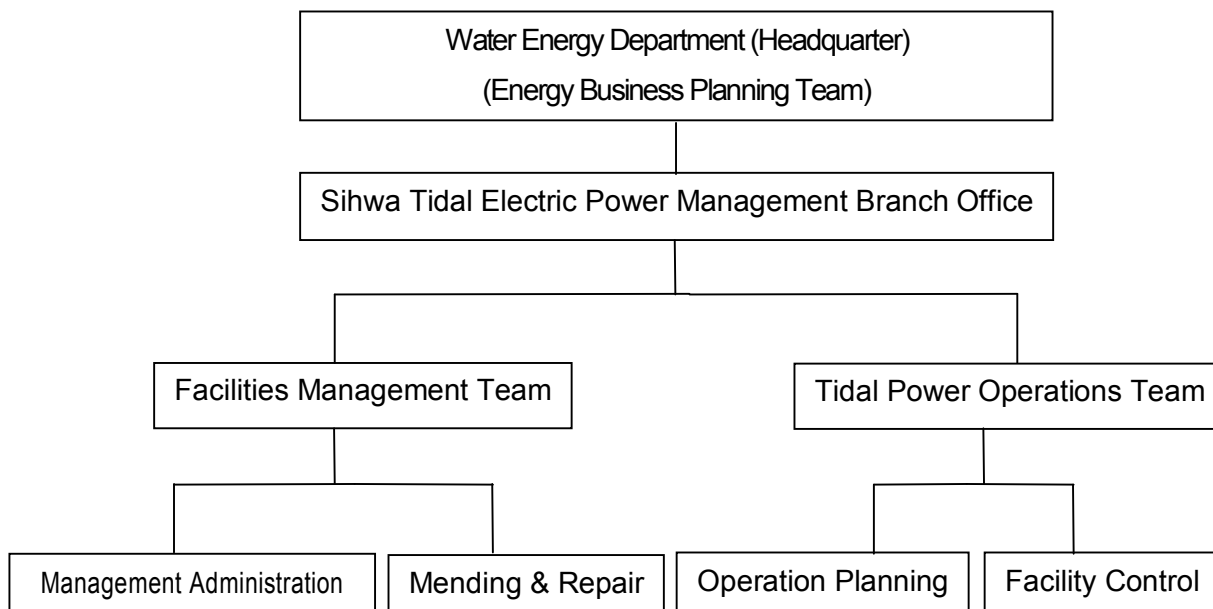
- Measuring meter of electricity exported to the grid was set up transparently in accordance with “Measures Act” and “Rules on the Operation of the Electricity Market” then sealed after affirmation of Korea Power Exchange (“KPX”).
- The meters for exported electricity were calibrated when they were installed and those were supposed to be re-calibrated every four years according to the national law after installation. (Previously, calibration frequency of electricity meters for export was every two years, but it was revised every 3.5years \pm 6months to follow national law during the second crediting period.)
- 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. 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:
Tidal Power Operations Team Member in Sihwa Tidal Power Office
- R & R to collect and record electricity data and to calculate emission reductions:
The person in charge of CDM in Water 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 adjustment of electricity trading in Water Energy Department

* 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 Business 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 Energy Department and KPX in accordance with "Rules on the Operation of the Electricity Market".

SECTION D. Data and parameters**D.1. Data and parameters fixed ex ante**

Data/Parameter	$EF_{grid,CM,y}$
Unit	tCO ₂ /MWh
Description	Combined margin CO ₂ emission factor for the project electricity system in year y
Source of data	2015, 2016, 2017 Statistics of Electric Power in Korea (2016, 2017, 2018) (KEPCO) and “2017 Status of Generation Facility (2018)” (KPX).
Value(s) applied	0.5197
Choice of data or measurement methods and procedures	This value was calculated according to the “Tool to calculate the emission factor for an electricity system” (version 06.0). The applied value was derived from “2015, 2016, 2017 Statistics of Electric Power in Korea (2016, 2017, 2018)” (KEPCO) and “2017 Status of Generation Facility (2018)” (KPX).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	This value will be applied during the crediting period.

Data/Parameter	$EF_{grid,OM,y}$
Unit	tCO ₂ /MWh
Description	Operating margin CO ₂ emission factor for the project electricity system in year y
Source of data	2015, 2016, 2017 Statistics of Electric Power in Korea (2016, 2017, 2018) (KEPCO) and “2017 Status of Generation Facility (2018)” (KPX).
Value(s) applied	0.7043
Choice of data or measurement methods and procedures	This value was calculated according to the “Tool to calculate the emission factor for an electricity system” (version 06.0). The applied value was derived from “2015, 2016, 2017 Statistics of Electric Power in Korea (2016, 2017, 2018)” (KEPCO) and “2017 Status of Generation Facility (2018)” (KPX).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	This value will be applied during the crediting period.

Data/Parameter	$EF_{grid,BM,y}$
Unit	tCO ₂ /MWh
Description	Build margin CO ₂ emission factor for the project electricity system in year y
Source of data	2015, 2016, 2017 Statistics of Electric Power in Korea (2016, 2017, 2018) (KEPCO) and “2017 Status of Generation Facility (2018)” (KPX).
Value(s) applied	0.4582
Choice of data or measurement methods and procedures	This value was calculated according to the “Tool to calculate the emission factor for an electricity system” (version 06.0). The applied value was derived from “2015, 2016, 2017 Statistics of Electric Power in Korea (2016, 2017, 2018)” (KEPCO) and “2017 Status of Generation Facility (2018)” (KPX).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	This value will be applied during the crediting period.

D.2. Data and parameters monitored

Data/Parameter	$EG_{PJ,y}$
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	<p>Net electricity generation is 229,367.616 MWh</p> <ul style="list-style-type: none"> - Total electricity transmitted to the grid is 231,358.512 MWh - Total imported electricity is 1,990.896 MWh
Monitoring equipment	<p>1. Exportation</p> <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</p> <ul style="list-style-type: none"> - Number of meters : 3 meters - Calibration Frequency : within 3.5 years ± 6 months - Date of last calibration : 04/10/2018 (previous : 11/10/2016) - Validity period : 04/10/2018 – 03/10/2022* <p>▪ The below is the information of additional 3 sub-meters</p> <p>Accuracy : Allowable error range $\pm 0.5\%$ Serial Number : 53048162, 53048163, 53048164 Calibration information</p> <ul style="list-style-type: none"> - Number of meters : 3 meters - Calibration Frequency : within 3.5 years ± 6 months - Date of last calibration : 04/10/2018 (previous : 11/10/2016) - Validity period : 04/10/2018 – 03/10/2022* <p>* According to the national law “Rules on the Operation of the Electricity Market”, frequency of calibration is 3.5 years ± 6 months. Thus, these meters are calibrated every 4 years since the first calibration (04/10/2018) within second crediting period. (Approved by PRC-0349-004 on 04/01/2019)</p> <p>2. Importation</p> <p>Measurement equipment : Watt-hour meter Accuracy : Allowable error range $\pm 0.5\%$ Serial number : 8175017820, 8175017821, 8175017822 Calibration information</p> <ul style="list-style-type: none"> - Number of meters : 3 meters - Calibration Frequency : within 7 years - Date of last calibration : 04/04/2017 - Validity period : 04/04/2017 – 30/04/2024** <p>▪ The below is the information of the one sub watt-hour meter to measure the imported electricity from 22.9kV transmission line in emergency.</p> <p>Accuracy : Allowable error range $\pm 0.5\%$ Serial Number : 25162020294 Calibration information</p> <ul style="list-style-type: none"> - Number of meters : 1 meter - Calibration Frequency : within 7 years - Date of last calibration : 08/12/2016 - Validity period : 08/12/2016 – 31/12/2023** <p>** These meters are recalibrated every 7 years. They were replaced by KEPCO as new meters before expiry date of calibration validity, the last day of the month conducting previous calibration, according to the national law “Measures act”.</p>
Measuring/reading/recording frequency	<p>Measuring : Continuously Reading : Daily 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. The amount of imported electricity from the grid was double-checked against receipt of sales.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

D.3. Implementation of sampling plan

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- Not applicable

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

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- According to the formula below, baseline emissions for this project is **119,202 t CO₂e**

$$BE_y = EG_{PJ,y} \times EF_{grid,y}$$

BE _y	=	Baseline emissions(tCO ₂)
EG _{PJ,y}	=	Net electricity generation(MWh)
EF _{grid,y}	=	Baseline emission factor(tCO ₂ /MWh)

Year	Month	Electricity (kWh)	Baseline Emission Factor (tCO ₂ /MWh)	Emission Reductions (tCO ₂ e)
2019	1	38,842,977	0.5197	20,186.695
2019	2	38,571,521	0.5197	20,045.619
2019	3	39,569,005	0.5197	20,564.011
2019	4	38,812,941	0.5197	20,171.085
2019	5	38,920,936	0.5197	20,227.210
2019	6	36,641,132	0.5197	19,042.396
Total Electricity exported to the grid(A)		231,358,512		120,237.016
2019	1	362,880	0.5197	188.588
2019	2	309,120	0.5197	160.649
2019	3	339,360	0.5197	176.365
2019	4	300,720	0.5197	156.284
2019	5	336,096	0.5197	174.669
2019	6	342,720	0.5197	178.111
Electricity imported from the grid(B)		1,990,896		1,034.666
Net electricity generation (A-B)		229,367,616	0.5197	119,202.350

E.2. Calculation of project emissions or actual net removals

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

E.3. Calculation of leakage emissions

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- No leakage occurs in accordance with ACM0002 (ver17)
 $LE_y = 0$

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	119,202	-	-	-	119,202	119,202

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante for this monitoring period in the PDD (t CO ₂ e)
119,202	124,512

E.5.1. Explanation of calculation of “amount estimated ex ante for this monitoring period in the PDD”

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- 124,512 t CO₂e was recalculated by multiplying the day of this monitoring period over a year to the yearly estimated emission reductions in PDD, 251,089 t CO₂e.
 $(251,089 \text{ tCO}_2 \text{ e} / 365 \text{ days} \times 181 \text{ days} = 124,512 \text{ t CO}_2 \text{ e})$

E.6. Remarks on increase in achieved emission reductions

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- This project was estimated to reduce 124,512 t CO₂e according to the registered CDM-PDD for the relevant monitoring period. However, actual reduction is 119,202 t CO₂e and the net electricity supplied to the grid was 229,367,616 kWh. This shows that actual value was lower by 5,310 t CO₂e than the estimated value in CDM-PDD with the result of the decrease of electricity due to unexpected tidal difference activity.

E.7. Remarks on scale of small-scale project activity

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- Not applicable

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
07.0	31 May 2019	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
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 (EB 70, 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).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

<i>Version</i>	<i>Date</i>	<i>Description</i>
Decision Class: Regulatory Document Type: Form Business Function: Issuance Keywords: monitoring report		