22. Water and Waste Management / Non Revenue Water

1. Typical Project Outline

- In order to reduce non-revenue water[1], implement projects to improve water supply infrastructure and enhance efficiency of the water supply.

2. Applicability

(1) In order to reduce non-revenue water, implement measures to improve water supply infrastructure, such as water supply pipes and distribution pipes.

(2) In order to reduce non-revenue water, implement measures to improve operation of the water supply system.

3. Methodology of Emission Reduction Calculation

The emission reduction from the project activity is determined as the differences between the GHG emissions of baseline scenario (without the project) and project scenario (with the project)[2]. GHG emissions are associated with electricity consumption in the water supply processes, and by reducing water leakage through measures to reduce non-revenue water, GHG emissions associated with the supply of excess water at the baseline will be reduced.

In addition to conduct measures on reducing non-revenue water, in case if the project involves measures on energy efficiency through improvement of the water supply infrastructure, GHG emission reductions for the improvement of equipment such as pumps can be estimated by applying the methodology "7. Energy Saving / Energy Efficiency of Facilities".

In the following calculation, it is assumed that the distribution volume of water after the project would be the same as before the project (current situation).

Details of sources of each data in the following formulae are provided in "4. Data and Parameters for the Estimation".

$$ER_y = BE_y - PE_y$$

ER_y : Emission reduction through the project in a year y (t-CO_2e/y)

BE_y : GHG emission from the baseline scenario in a year y (t-CO_2e/y)

PE_y : GHG emission from the project scenario in a year y (t-CO_2e/y)

(1) Calculation of Baseline Emission

The baseline emission is calculated by multiplying following parameters:

- Volume of water distributed after the project implementation assuming that the non-revenue water measures would not have implemented (= Baseline distribution volume[3]: under the situation of "without the project", the distribution volume of water to obtain the same volume of the effective water as the project, under the current water leakage rate[4]).
- Electricity consumption per 1m^3 of the water distributed;
- Grid electricity CO_2 emission factor.

[1] "water that was distributed but not billed" (International Water Association). Unbilled Authorised Consumption, Commercial Loss and Physical Loss out of System Input Volume are deemed as non-revenue water. (Source: The final report of JICA's Project Research Key Points on Non-Revenue Water Reduction Projects. February 2020)

[2] The target year shall be a representative year under average operation or an annual average of multiple years.

[3] Different from "Distribution volume of water before the project (current situation)"

[4] Use non-revenue water rate, in case the water leakage rate is not available.

The baseline distribution volume is calculated by following steps:

1) Define the distribution volume after the project: assume as same as the volume before the project (current situation);

2) Calculate the effective volume after the project: calculate using the distribution volume and leakage rate after the project;

3) Set the baseline effective volume: assume as same as the effective volume of water after the project;

4) Calculate the baseline distribution volume: calculate using the baseline effective volume and current leakage rate.

$$BE_y = \frac{ARW_y}{1-RNR_{BL}} \times SEC \times EF_{elec} \times 10^{-3} = AW \times \frac{1-RNR_{PJ}}{1-RNR_{BL}} \times SEC \times EF_{elec} \times 10^{-3}$$

$$ARW_y = AW_y \times (1 - RNR_{PJ})$$

$$AW_y = AW$$

ARW_y : Effective volume of water after the project (m^3/y)

AW_y : Distribution volume of water after the project (m^3/y): assume as same as the volume before the project (current situation)

AW : Distribution volume of water before the project (current situation) (m^3/y)

RNR_{BL} : Water leakage rate before the project (e.g. 0.30)

RNR_{PJ} : Water leakage rate after the project (e.g. 0.20)

SEC : Electricity consumption per $1m^3$ of the water distributed (kWh/m^3)

EF_{elec} : Grid electricity CO_2 emission factor (t-CO_2/MWh)

(2) Calculation of Project Emission

The baseline emission is calculated by multiplying following parameters:

- Distribution volume of water after the project
- Electricity consumption per $1m^3$ of the water distributed;
- Grid electricity CO_2 emission factor.

$$PE_y = AW_y \times SEC \times EF_{elec} \times 10^{-3} = AW \times SEC \times EF_{elec} \times 10^{-3}$$

AW_y : Distribution volume of water after the project (m^3/y)

SEC : Electricity consumption per $1m^3$ of the water distributed (kWh/m^3)

EF_{elec} : Grid electricity CO_2 emission factor (t-CO_2/MWh)

4. Data and Parameters for the Estimation

Data	Description	Data Sources	
		For baseline emission calculation	For baseline emission calculation
AW	Distribution volume of water before the project (current situation) (m^3/y)	A monitored value	A monitored value
AW_y	Distribution volume of water after the project (m^3/y)	Assume as same as the volume before the project (current situation) (=AW)	Assume as same as the volume before the project (current situation) (=AW)
RNR_{BL}	Water leakage rate	A monitored value or estimated value	N/A

	before the project (e.g. 0.30)		
RNR_{PJ}	Water leakage rate after the project (e.g. 0.20)	A planned value	
SEC	Electricity consumption per $1m^3$ of the water distributed (kWh/m^3)	From the following sources in the order of priority i) A project specific value: use values of the project ii) Literature value which can be applied to the project iii) Default value (0.459 kWh/m^3 provided in "The final report of the Study on Development of Low Carbon Water Supply System. Ministry of Health, Labour and Welfare, and Nihon Suido Consultants Co., Ltd. June 2020.")	
EF_{elec}	Grid electricity CO_2 emission factor ($t\text{-}CO_2/MWh$)	A default value (Table 3, "Energy Consumption", Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	

5. Others

(1) Project Boundary

The project boundary is the target water service facility or whole network of the water service.

(2) Leakage

No significant leakage identified.

(3) Comparison with existing methodologies

The final report of the JICA's Project Research on Quantification of GHG emission reductions is referred in developing this methodology. The report refers the CDM methodology AM0020 "Baseline methodology for water pumping efficiency improvements".

(4) Revision history

Version	Year/Month	Revisions
4.0	March 2023	• Newly developed.
5.0	March 2024	• Corrected a typographical error in the calculation formula for baseline emissions (10^{-6} -> 10^{-3})