CLEAN DEVELOPMENT MECHANISM

CDM-MP84-A01

Draft Large-scale Methodology

AM00XX: Energy-efficient water-grid-connected desalination plants

Version 01.0

Sectoral scope(s): 03

DRAFT

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. A request for new methodology “Energy saving through the use of the reverse osmosis technology in the water desalination process”, was submitted by ACCIONA AGUA, SA QATAR BRANCH in July 2019.

2. Purpose

2. The proposal submits a new methodology for projects that reduce energy consumption in water desalination sector by construction and operation of a greenfield energy efficient desalination plant or capacity addition or retrofit, rehabilitation (or refurbishment), replacement of an existing desalination plant that supplies water to a water-grid.

3. Key issues and proposed solutions

3. The draft methodology addresses the key issues as below;

(a) It proposes to calculate emission reductions using a novel approach of ‘water-grid emission factor’ where the effect of displaced production of potable water from the plants connected to the water grid through the operation of efficient project desalination plant(s)/unit(s) is considered. This approach optimises the amount of the monitored data at the same time as being reliable;

(b) The emissions from desalination plants depend on the power plants that supply energy for their operation. Therefore, the emission factor of the desalination plant is also the function of fuel used, age and technology of the associated power plant besides the technology used in desalination itself. For example, a new efficient desalination plant that is coupled to an old inefficient power plant with consequent adverse impacts on emissions factor is not always ruled out. The Meth Panel considered that the production of electricity takes precedence in the construction and operation of such plants and not the production of water. Therefore, additional capacities of water production are also influenced by the demand for electricity rather than water demand in isolation. In addition, as part of the management of demand and supply, desalination capacity is moved between plants on the grid over specific periods (e.g. months or seasons) in order to accommodate changes in the power demand. Divergence between power load and water loads can go as far as auxiliary fuel that is fired into waste heat recovery boilers thereby determining overall efficiency. Therefore, the efficiencies of all desalination plants are interrelated via the grid operation (how the utility instructs operator companies). The water grid has some buffering capacity inbuilt compared to the instantaneous dispatch of the power grid. The build margin in water-grid emission factor is therefore less relevant. Moreover, desalination units are not as strongly integrated as power-only plants and thus desalination units can be incrementally modified for capacity and length of operation. Further the recent energy efficient, low cost and mostly cleaner desalination plants are most likely to run continuously (being cheaper for producing electricity as well as water) and therefore less likely to be displaced by new plants. New and efficient plants are added to the water grid are therefore more likely to displace the water production in older desalination plants with higher cost and higher EF. Therefore, there is probably no strong likelihood that the project desalination plant(s)/unit(s) may displace the emissions from the newer plants, as newer plants represent likely investment for future that is displaced by project plant. Considering these issues, the Meth Panel came to the opinion that use of 'operating margin' approach is appropriate to estimate the baseline emissions; and

(c) Furthermore, in the case of retrofits, rehabilitations or replacements, the quantity of desalinated water produced by the project desalination plant is limited to the historical quantity of desalinated water produced by the entire desalination facility. In such cases, it is considered that the emission reductions will be due to reduction in fuel consumption for producing same quantity of water in the baseline and project scenario.

4. Impacts

4. The draft methodology if approved is expected allow for development of new CDM projects in the water desalination sector, which have strong relevance for reducing GHG emissions in this sector.

5. Subsequent work and timelines

5. The draft version of the methodology is recommended by the Methodologies Panel (MP) for consideration by the Board at its 110th meeting. No further work is envisaged.

6. Recommendations to the Board

6. The MP recommends that the Board adopt this new methodology, to be made effective at the time of the Board's approval.

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1. Introduction

1. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Construction and operation of a greenfield energy efficient desalination plant or capacity addition or retrofit or rehabilitation (refurbishment), or replacement of an existing desalination plant; in all cases project plant supplies water to a water-grid
Type of GHG emissions mitigation action	Energy efficiency: Displacement of more energy intensive desalination technology

2. Scope, applicability, and entry into force

2.1. Scope

2. This methodology covers greenfield project activities involving construction and operation of an energy efficient desalination plant. Capacity addition to an existing desalination plant, retrofitting, rehabilitation (refurbishment) or replacement of an existing desalination plant with an energy efficient desalination plant are also covered.

3. The desalination plants under this methodology do not operate in a stand-alone mode but are connected to other desalination plants in the region to form a water-grid.

2.2. Applicability

4. This methodology is applicable to project activities that supply desalination water to a water distribution network (water-grid) using an energy efficient desalination technology including but not limited to:

    (a) Installation of a Greenfield energy efficient desalination plant;

    (b) Capacity addition to (an) existing desalination plant(s);

    (c) Retrofit of (an) existing operating desalination plant(s);

    (d) Rehabilitation of (an) existing desalination plant(s);

    (e) Replacement in (an) existing desalination plant(s) with an energy efficient desalination plant, for example, replacement of Multi-stage flash system with Reverse Osmosis (RO)-based system.

5. This methodology is applicable under the following conditions:

    (a) There shall be an established water-grid to supply potable water to its consumers and all the desalination plants identified in the baseline scenario and the project plant are connected to this water-grid;

(b) In case of capacity addition to an existing desalination plants, the project activity processes can be demarcated operationally from other facilities coexisting at the same site such as power plants and existing desalination plants;

(c) In the case of retrofits, rehabilitations or replacements, the existing desalination plant(s) defined in the baseline emission section and used for the calculation of baseline emissions shall have started commercial operation at least three years prior to the start date of the project activity, and no retrofit, or rehabilitation of the plant has been undertaken between the start of the minimum historical reference period and the implementation of the project activity;

(d) In cases of retrofits, rehabilitations or replacements, the methodology is applicable for projects where quantity of desalinated water produced by the entire desalination facility where project activity is located, is higher than the historical quantity of desalinated water produced by the entire desalination facility as calculated using paragraph 51 below[1];

(e) Project activity delivers the equivalent service as the baseline desalination plant in terms of the quality of desalinated water produced through desalination technology in accordance with applicable local standard.

6. The applicability conditions included in the tools referred to below shall apply.

2.3. Entry into force

7. The date of entry into force is the date of the publication of the EB XX meeting report on DD Month YYYY.

2.4. Applicability of sectoral scopes

8. For validation and verification of CDM projects and programme of activities by a designated operational entity (DOE) using this methodology, application of sectoral scope 3 is mandatory.

3. Normative references

9. This baseline and monitoring methodology is proposed by ACCIONA SA.

10. This baseline and monitoring methodology is based on the following proposed new methodology:

(a) NM0377: Energy saving through the use of the reverse osmosis technology in the water desalination process.

11. This methodology also refers to the latest approved versions of the following tools:

(a) “TOOL01: Tool for the demonstration and assessment of additionality”;

[1] The stakeholder may wish to submit a new methodology for retrofits, rehabilitations or replacements cases where quantity of desalinated water produced by the desalination facility where project desalination plant(s)/unit(s) is located, is equal to the historical quantity of desalinated water produced by the entire desalination facility.

(b) “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality”;

(c) “TOOL07: Tool to calculate the emission factor for an electricity system”;

(d) “TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems”;

(e) “TOOL10: Tool to determine the remaining lifetime of equipment”;

(f) “TOOL11: Tool to assess the validity of the original/current baseline and to update the baseline at the renewal of a crediting period”.

12. For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

3.1. Selected approach from paragraph 48 of the CDM modalities and procedures

13. “Existing actual or historical emissions, as applicable”.

4. Definitions

14. The definitions contained in the Glossary of CDM terms shall apply.

15. For the purpose of this methodology, the following definitions apply:

(a) **Water grid** - is a potable water distribution network that supply desalinated water to the users;

(b) **Installed desalination capacity (or installed capacity or nameplate capacity) of a desalination plant** - is the capacity, expressed in m^3/h (cubic meters per hour) or equivalent, for which the desalination plant has been designed to operate at nominal conditions;

(c) **Greenfield desalination plant** – is a desalination plant that is constructed on a site where there is no desalination plant operating prior to the implementation of the project activity;

(d) **Capacity addition** - is an investment to increase the installed desalination capacity of (an) existing desalination plant(s) through the installation of new desalination plants besides the existing desalination plants. The existing desalination plants, in the case of capacity addition continue to operate after the implementation of the project activity;

(e) **Retrofit** - is an investment to repair or modify the existing operating desalination plants, with the purpose to increase the efficiency and performance of the plants, without adding new desalination plants. A retrofit restores the installed desalination generation capacity to or above its original level. Retrofits shall only include measures that involve capital investments and not regular maintenance or housekeeping measures;

(f) **Rehabilitation (or refurbishment)** - is an investment to restore the existing desalination plants that was severely damaged or destroyed due to foundation failure, excessive seepage, earthquake, liquefaction, or flood. The primary objective of rehabilitation or refurbishment is to restore the performances of the existing facilities. Rehabilitation may also lead to an increase in the efficiency, performance or desalination generation capacity of the existing desalination plants without adding new desalination plants;

(g) **Replacement -** is an investment in new desalination plants that replaces one or several existing units from the existing desalination plant. The new desalination plants have the same desalination generation capacity than the plants that were replaced.

5. Baseline methodology

5.1. Project boundary

16. The spatial extent of the project boundary encompasses the project desalination plant(s)/unit(s), including all the installations from the feed water capture to storage of desalinated water prior to distribution as well as all facilities that supply energy to the project activity including the electricity grid such facilities are connected to. It also includes all desalination plants connected physically to the project's water grid.

17. The greenhouse gases and emission sources included in or excluded from the project boundary are shown in Table 2.

Table 2. Emission sources included in or excluded from the project boundary

Source		Gas	Included?	Justification/explanation
Baseline	CO_2 emissions from water desalination in the baseline due to the thermal and electrical energy consumption.	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project activity	CO_2 emissions from water desalination in the project activity due to the electrical energy consumption.	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source

5.2. Identification of the baseline scenario

5.2.1. Baseline scenario for Greenfield desalination plant

18. If the project activity is the installation of a Greenfield desalination plant, the baseline scenario is the quantity of water delivered to the water-grid by the project activity would have otherwise been generated by the operation of the other desalination plants connected to the same water-grid.

5.2.2. Baseline scenario for capacity addition to an existing desalination plant

19. If the project activity is the capacity addition to an existing desalination plant, the baseline scenario is:

    (a) The existing facility that would continue to supply water to the water-grid at historical levels, until the time at which the desalination facility would likely be replaced or retrofitted ($DATE_{BaselineRetrofit}$); and

    (b) Water delivered to the water-grid by the added capacity that would have otherwise been generated by the operation of the other desalination plants connected to the same water-grid.

5.2.3. Baseline scenario for retrofit or rehabilitation or replacement of an existing desalination plant

20. If the project activity is retrofit or rehabilitation or replacement to an existing desalination plant, the baseline scenario is;

    (a) The existing facility that would continue to supply water to the water-grid at historical levels, until the time at which the desalination facility would likely be replaced or retrofitted ($DATE_{BaselineRetrofit}$); and

    (b) Water delivered to the water-grid by the added capacity due to retrofit or rehabilitation or replacement that would have otherwise been generated by the operation of the other desalination plants connected to the same water-grid.

5.3. Additionality

21. Project participants shall apply the latest version of “TOOL01: Tool for the demonstration and assessment of additionality”.

5.4. Project emissions

22. Project emissions correspond to those generated by the project desalination plant(s)/unit(s). The project emissions are calculated separately[2] for thermal (steam-based) desalination plants such as Multi-stage flash distillation (MSF), Multiple-effect distillation (MED) and Thermal vapour compression (TVC) plants and electricity-based desalination plants such as Mechanical vapour compression (MVC) and membrane-based desalination plants for example, desalination plants using Reverse Osmosis principle.

[2] In case project plant consists of both thermal and electricity based desalination plants, the project emissions are calculated as the sum of the emissions from both, calculated separately using respective methods.

5.4.1. Project emissions from thermal-based desalination plants

5.4.1.1. Option 1 – Based on actual production data of electricity and desalinated water

23. Project emissions from a water-grid connected thermal desalination plant takes into account fuel consumption for electricity and steam generation from the project desalination plant(s)/unit(s) and their corresponding emission factors.

$$PE_y = PE_{tot,PJ,y} - PE_{elect,PJ,y}$$ Equation (1)

Where:

PE_y	=	Project emissions due to water-grid connected steam-based or electricity-based desalination plants in year *y* (tCO_2)
$PE_{tot,PJ,y}$	=	Total project emissions due to fossil fuel consumption for electricity and steam generation from the project desalination plant(s)/unit(s) in year *y* (tCO_2)
$PE_{elect,PJ,y}$	=	Project emissions due to fossil fuel consumption associated with electricity generation from the project desalination plant(s)/unit(s) in year *y* (tCO_2)

24. Total project emissions due to fossil fuel consumption for electricity and steam generation from the project desalination plant(s)/unit(s) is calculated as the sum of emissions from all fossil fuels consumed by the project activity as follows;

$$PE_{tot,PJ,y} = \sum_{FF} FC_{tot,FF,PJ,y} \times EF_{FF} \times NCV_{FF,y}$$ Equation (2)

Where:

$FC_{tot,FF,PJ,y}$	=	Fossil fuel consumption for electricity and steam generation by the project desalination plant(s)/unit(s) in year *y* (volume or mass unit)
EF_{FF}	=	CO_2 emission factor of fossil fuel used to produce the steam and/or electricity supplied to the desalination plant (tCO_2/TJ)
$NCV_{FF,y}$	=	Average net calorific value of fossil fuel in year y (TJ/volume or mass unit)

25. Project emissions due to fossil fuel consumption for electricity generation from the project desalination plant(s)/unit(s) is calculated as follows:

$$PE_{elect,PJ,y} = EG_{gross,PJ,y} \times EF_{elect,PJ,y}$$ Equation (3)

Where:

$EG_{gross,PJ,y}$	=	Gross electricity generation of the project desalination plant(s)/unit(s) in year *y* (MWh)
$EF_{elect,PJ,y}$	=	Emission factor of project desalination plant(s)/unit(s) for electricity generation in year *y* (tCO_2/MWh)

26. The emission factor for electricity generated from project desalination plant(s)/unit(s) is calculated as follows;

$$EF_{elect,PJ,y} = \frac{\sum_{FF} FC_{elect,FF,PJ,y} \times EF_{FF}}{EG_{net,PJ,y}}$$ Equation (4)

Where:

$FC_{elect,FF,PJ,y}$	=	Fossil fuel consumption for electricity generation in project desalination plant(s)/unit(s) in year *y* (TJ)
$EG_{net,PJ,y}$	=	Net electricity exported to electricity grid by project desalination plant(s)/unit(s) in year y (MWh)

27. The fossil fuel consumption for electricity generation per technology *t* in project desalination plant(s)/unit(s) is calculated as follows:

$$FC_{elect,FF,PJ,y} = \sum_{t} \frac{EG_{gross,PJ,t,y} \times 0.0036}{\eta_{t,power,PJ,y}}$$ Equation (5)

Where:

$EG_{gross,PJ,t,y}$	=	Gross electricity generation per technology *t* (e.g. open cycle, combined cycle) in project desalination plant(s)/unit(s) in year *y* (MWh)
$\eta_{t,power,PJ,y}$	=	Efficiency of power generation technology *t* used in the project desalination plants(s)/unit(s). The default values as provided in the “TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems”, should be used
0.0036	=	Conversion factor MWh to TJ

5.4.1.2. Option 2 - Based on actual steam consumption

28. For a thermal desalination plant, the project participant may calculate project emissions using fuel-apportioning approach based on efficiency method as follows:

$$PE_y = \sum_{t} PE_{tot,PJ,t,y} \times \left[\frac{HG_{steam,PJ,t,y} / \eta_{t,steam,PJ,y}}{\left(HG_{steam,PJ,t,y} / \eta_{t,steam,PJ,y} \right) + \left(EG_{gross,PJ,t,y} / \eta_{t,power,PJ,y} \right)} \right]$$ Equation (6)

Where:

$PE_{tot,PJ,t,y}$	=	Total project emissions per technology *t* due to fossil fuel consumption for electricity and steam generation from the project desalination plant(s)/unit(s) in year *y*, calculated similarly as equation 2 above (tCO_2)
$HG_{steam,PJ,t,y}$	=	Total steam input per technology *t* to the project desalination plant(s)/unit(s) in year *y* (MWh)
$\eta_{t,steam,PJ,y}$	=	Efficiency of steam generation technology *t* used in the project desalination plants(s)/unit(s). The default values as provided in the “TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems” should be used

5.4.2. Project emissions from electricity-based desalination plants

29. Project emissions due to electricity supplied by an electricity grid are calculated as follows:

$$PE_y = EG_{water,PJ,y} \times EF_{grid,y} \quad \text{Equation (7)}$$

Where:

$EG_{water,PJ,y}$	=	Electricity consumption of the project desalination plant(s)/unit(s) in year *y* (MWh)
$EF_{grid,y}$	=	CO_2 emission factor of the electricity grid in year *y*, calculated as operating margin emission factor (tCO_2/MWh) following the requirements of “TOOL07: Tool to calculate the emission factor for an electricity system”

5.5. Baseline emissions

30. Baseline emissions calculation in year *y*, takes into account the water delivered to the water-grid in year *y* by the project activity and the average emission factor of this water-grid during a period covering the last 3 years (years *y*, *y-1* and *y-2*).

$$BE_y = Q_{w,PJ,y} \times EF_{WG,SimpleOM,y} \quad \text{Equation (8)}$$

Where:

BE_y	=	Baseline emissions due to production of desalinated water by project desalination plant(s)/unit(s) in year *y* (tCO_2)
$Q_{w,PJ,y}$	=	Quantity of desalinated water produced by project desalination plant(s)/unit(s) in year *y* (m^3)
$EF_{WG,SimpleOM,y}$	=	Water grid emission factor in year y (tCO_2/m^3)

5.5.1. Calculation of water-grid emission factor

31. The proposed project activity will replace the equivalent quantity of the desalinated water from the water-grid to which it is either connected or planned to be connected.

32. The emission factor of water-grid is calculated as simple operating margin (OM) emission factor based on the quantity of desalinated water generated, and an emission factor for each desalination plant for year y shall be calculated as follows;

$$EF_{WG,SimcpleOM,y} = \left. \sum_{y-2}^{y} \frac{\sum_p \left(Q_{W,p,y} \times EF_{p,y}\right)}{\sum_p Q_{W,p,y}} \right/ 3 \quad \text{Equation (9)}$$

Where:

$Q_{w,p,y}$	=	Quantity of desalinated water produced by each desalination plant *p* of in year *y* (m^3)
$EF_{p,y}$	=	Emission factor of each desalination plant *p* in year *y* (tCO_2/m^3)

33. The emission factor of each water-grid connected desalination plant is calculated using one of the following options.

5.5.1.1. Option 1 – Based on actual production data of electricity and desalinated water

34. The emission factor of each thermal and electricity-based desalination plant is calculated as follows;

$$EF_{p,y} = {BE_{w,p,y}}/{Q_{w,p,y}}$$ Equation (10)

Where:

$BE_{w,p,y}$	=	Baseline emissions of each desalination plant *p* due to production of desalinated water in year *y* (tCO_2)

35. The baseline emissions of each desalination plant *p* due to production of desalinated water is calculated as follows:

$$BE_{w,p,y} = \sum_{i} BE_{th,p,i,y} + \sum_{j} BE_{elect,p,j,y}$$ Equation (11)

Where:

$BE_{th,p,i,y}$	=	Baseline emissions of each desalination plant *p* of type *i* in year *y* (tCO_2)
$BE_{elect,p,j,y}$	=	Baseline emissions of each desalination plant *p* of type *j* in year *y* (tCO_2)
i	=	Thermal desalination plants of type *i* connected to the water-grid
j	=	Electricity-based desalination plants of type *j* connected to the water-grid

5.5.1.1.1. Baseline emissions for thermal desalination plants

36. The baseline emissions of thermal desalination plants is calculated as follows:

$$BE_{th,i,p,y} = BE_{tot,p,i,y} - BE_{elect,p,i,y}$$ Equation (12)

Where:

$BE_{tot,p,i,y}$	=	Bassline emissions of desalination plant *p* of type *i* due to fossil fuel consumption for electricity and desalinated water generation in year *y* (tCO_2)
$BE_{elect,p,i,y}$	=	Baseline emissions of the desalination plant *p* of type *i* due to fossil fuel consumption for electricity generation in year *y* (tCO_2)

37. Total baseline emissions due to fossil fuel consumption for electricity and steam generation from the desalination plants is calculated as follows;

$$BE_{tot,p,i,y} = \sum_{FF} FC_{tot,FF,p,i,y} \times EF_{FF} \times NCV_{FF,y}$$ Equation (13)

Where:

$FC_{tot,FF,p,i,y}$	=	Fossil fuel consumption for electricity and steam generation of desalination plant *p* of type *i* in year *y* (volume or mass unit)

38. The baseline emissions due to fossil fuel consumption for electricity generation in desalination plants is calculated as follows:

$$BE_{elect,p,i,y} = EG_{gross,p,i,y} \times EF_{elect,p,i,y}$$ Equation (14)

Where:

$EG_{gross,p,i,y}$	=	Gross electricity generation of desalination plant *p* of type *i* in year *y* (MWh)
$EF_{elect,p,i,y}$	=	Emission factor of desalination plant *p* of type *i* for electricity generation in year *y* (tCO_2/MWh)

39. The emission factor for electricity generated from desalination plant is calculated as follows;

$$EF_{elect,p,i,y} = \frac{\sum FC_{est,FF,p,i,y} \times EF_{FF}}{EG_{net,p,i,y}}$$ Equation (15)

Where:

$FC_{est,p,i,y}$	=	Estimated fossil fuel consumption in desalination plant *p* of type *i* for electricity generation in year y (TJ)
$EG_{net,p,i,y}$	=	Net electricity exported to grid by desalination plant *p* of type *i* in year y (MWh).

40. The fossil fuel consumption for electricity generation in desalination plants is calculated as follows:

$$FF_{con,est,p,i,y} = \sum_{t} \frac{EG_{gross,p,i,t,y} \times 0.0036}{\eta_{t,power,p,i,y}}$$ Equation (16)

Where:

$EG_{gross,p,i,t,y}$	=	Gross electricity generation by technology *t* (e.g. open cycle, combined cycle) in desalination plant *p* of type *i* in year y (MWh)
$\eta_{t,power,p,i,y}$	=	Efficiency of power generation of technology *t* in desalination plant *p* of type *i*. The default values as provided in the “TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems”, should be used
0.0036	=	Conversion factor MWh to TJ

5.5.1.1.2. Baseline emissions for electricity-based desalination plants

41. Baseline emissions of electricity-based desalination plants is calculated as follows:

$$BE_{elect,p,j,y} = EG_{water,p,j,y} \times EF_{grid,y}$$ Equation (17)

Where:

$EG_{water,p,jy}$	=	Electricity consumption by desalination plant *p* of type *j* for producing desalinated water in year y (MWh)
$EF_{grid,y}$	=	Emission factor of the electricity grid calculated as operating margin emission factor (tCO_2/MWh) following the requirements of "TOOL07: Tool to calculate the emission factor for an electricity system"

5.5.1.2. Option 2 - Based on actual steam production

42. If the water-grid consists of only thermal desalination plants the emission factor of each desalination plant connected to water-grid is calculated as follows:

$$EF_{p,i,y} = BE_{th,p,i,y}/Q_{w,p,i,y}$$ Equation (18)

Where:

$EF_{i,p,y}$	=	Emission factor of desalination plant *p* of type *i* in year *y* (tCO_2/m^3)
$BE_{th,p,i,y}$	=	Baseline emissions due to steam generation in desalination plant *p* of type *i* for production of desalinated water in year *y* (tCO_2)
$Q_{w,p,i,y}$	=	Quantity of desalinated water generated by desalination plant *p* of type *i* (m^3)

43. The baseline emissions due to steam generation in desalination plant *p* for production of desalinated water is calculated as follows:

$$BE_{th,p,i,y} = \sum_t BE_{tot,p,i,t,y} \times \left[\frac{HG_{steam,p,i,t,y}/\eta_{t,steam,p,i,y}}{\left(HG_{steam,p,i,t,y}/\eta_{t,steam,p,i,y}\right) + \left(EG_{gross,p,i,t,y}/\eta_{t,power,p,i,y}\right)} \right]$$ Equation (19)

Where:

$BE_{tot,p,i,t,y}$	=	Bassline emissions of desalination plant *p* of type *i* having technology *t* due to fossil fuel consumption for electricity and desalination water generation in year *y*, calculated as per equation 13 above (tCO_2)
$HG_{steam,p,i,t,y}$	=	Total steam input to the desalination plant *p* of type *i* having technology *t* in year *y* (MWh)
$\eta_{t,steam,p,i,y}$	=	Efficiency of steam generation of technology *t* in desalination plant *p* of type *i*. The default values as provided in the "TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems", should be used

5.5.2. Calculation of quantity of desalinated water produced by the project desalination plant(s)/unit(s)

44. The calculation of $Q_{w,PJ,y}$ is different for Greenfield plants, capacity additions, retrofits or rehabilitations or replacements. These cases are described as follows:

5.5.2.1. Greenfield desalination plants

45. In case of greenfield desalination plant the quantity of desalinated water produced by the project desalination plant(s)/unit(s) shall be directly metered as:

$$Q_{w,PJ,y} = Q_{w,project\ plant,y} \quad \text{Equation (20)}$$

Where:

$Q_{w,project\ plant,y}$	=	Quantity of desalinated water produced by the project desalination plant(s)/unit(s) in year *y* (m^3)

5.5.2.2. Capacity addition to an existing desalination plant

46. In case of capacity addition, it is assumed that the addition of the desalination plant(s)/unit(s) does not significantly affect the quantity of desalinated water produced by existing plant(s)/(units). In this case, quantity of desalinated water produced by the project desalination plant(s)/unit(s) shall be directly metered as:

$$Q_{w,PJ,y} = Q_{w,PJ\_Add,y} \quad \text{Equation (21)}$$

Where:

$Q_{w,PJ\_Add,y}$	=	Quantity of desalinated water produced by the project desalination plant(s)/unit(s) that has been added to existing desalination plants in year *y* (m^3)

5.5.2.3. Retrofit or rehabilitation or replacement of an existing desalination plant

47. If the project activity is the retrofit or rehabilitation or replacement of an existing desalination plant, the methodology uses historical data related to desalinated water generation to determine the desalinated water generation by the existing plant in the baseline scenario, assuming that the historical situation observed prior to the implementation of the project activity would continue.

48. The use of few historical years to establish the baseline desalination water generation may involve a significant uncertainty due to fluctuation in demand and operating practices. The methodology addresses the uncertainty related to estimation of desalinated water by adjusting the historical desalinated water generation by its standard deviation. This ensures that the baseline desalinated water generation is established in a conservative manner and that the calculated emission reductions are attributable to the project activity. Without this adjustment, the calculated emission reductions could mainly depend on the natural variability observed during the historical period rather than the effects of the project activity.

49. $Q_{w,PJ,y}$ is calculated as follows:

$$Q_{w,PJ,y} = Q_{w,facility,y} - \left(Q_{w,historical} + \sigma_{historical}\right); until\ DATE_{BaselineRetrofit}$$ Equation (22)

and

$$Q_{w,PJ,y} = 0; \text{on/after } DATE_{BaselineRetrofit}$$ Equation (23)

Where:

$Q_{w,facility,y}$	=	Quantity of desalinated water produced by the entire desalination facility where the project desalination plant(s)/unit(s) is located in year y (m^3)
$Q_{w,historical}$	=	Annual average historical desalinated water generation delivered to the water-grid by the existing desalination plants/units that was operated at the project site prior to the implementation of the project activity (m^3/year)
$\sigma_{historical}$	=	Standard deviation of the annual average historical desalinated water generation delivered to the water-grid by the existing desalination plants/units that were operated at the project site prior to the implementation of the project activity (m^3/year)
$DATE_{BaselineRetrofit}$	=	Point in time when the existing equipment would need to be replaced in the absence of the project activity (date). This only applies to retrofit or replacement projects

50. In case $Q_{w,facility,y} < \left(Q_{w,historical} + \sigma_{historical}\right)$ in a year *y* then:

$$Q_{w,PJ,y} = 0$$ Equation (24)

51. To determine $Q_{w,historical}$, project participants may choose between two historical periods. This allows some flexibility: the use of the longer time period may result in a lower standard deviation and the use of the shorter period may allow a better reflection of the (technical) circumstances observed during the more recent years.

52. Project participants may choose among the following two-time spans of historical data to determine $Q_{w,historical}$:

(a) The five last calendar years prior to the implementation of the project activity; or

(b) The time period from the calendar year following $DATE_{hist}$, up to the last calendar year prior to the implementation of the project, as long as this time span includes at least five calendar years, where $DATE_{hist}$ is latest point in time between:

(i) The commissioning of the plant/unit;

(ii) If applicable: the last capacity addition to the plant/unit; or

(iii) If applicable: the last retrofit or rehabilitation of the plant/unit.

53. In case of rehabilitation where the desalinated plant/unit did not operate for last five calendar years before the rehabilitation starts, $Q_{w,historical}$ is equal to zero.

5.5.3. Calculation of $DATE_{BaselineRetrofit}$

54. In order to estimate the point in time when the existing equipment would need to be replaced/retrofitted in the absence of the project activity ($DATE_{BaselineRetrofit}$), project participants may take into account the typical average technical lifetime of the type equipment, which shall be determined and documented as per "TOOL10: Tool to determine the remaining lifetime of equipment".

55. The point in time when the existing equipment would need to be replaced/retrofitted in the absence of the project activity should be chosen in a conservative manner that is, if a range is identified, the earliest date should be chosen.

5.6. Leakage

56. No leakage emissions are considered. The emissions potentially arising from project activity construction, upstream emissions from fossil fuel use (e.g. extraction, processing, transport etc.) and membrane manufacturing, cleaning and replacement are neglected.

5.7. Emission reductions

57. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \qquad \text{Equation (25)}$$

Where:

ER_y	=	Emission reductions in year *y* (tCO_2e)
BE_y	=	Baseline emissions in year y (tCO_2)
PE_y	=	Project emissions in year y (tCO_2)

5.8. Changes required for methodology implementation in 2nd and 3rd crediting periods

58. Refer to the latest approved version of the "TOOL11: Assessment the validity of the original/current baseline and to update the baseline at the renewal of a crediting period".

5.9. Data and parameters not monitored

59. The provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / Parameter table 1.

Data / parameter:	$DATE_{BaselineRetrofit}$
Data unit:	date
Description:	Point in time when the existing equipment would need to be replaced in the absence of the project activity
Source of data:	Project activity site

Measurement procedures (if any):	Project participants may take into account the typical average technical lifetime of the type equipment, which shall be determined and documented as per "TOOL10: Tool to determine the remaining lifetime of equipment". The point in time when the existing equipment would need to be replaced/retrofitted in the absence of the project activity should be chosen in a conservative manner that is, if a range is identified, the earliest date should be chosen.
Any comment:	This parameter only applies to retrofit or rehabilitation or replacement project activities

Data / Parameter table 2.

Data / Parameter:	**$DATE_{hist}$**
Data unit:	date
Description:	Point in time from which the time span of historical date for retrofit, rehabilitation or replacement project activities may start
Source of data:	Project activity site
Measurement procedures (if any):	$DATE_{hist}$ is the latest point in time between: (a) The commercial commissioning of the plant/unit; (b) If applicable: the last capacity addition to the plant/unit; or (c) If applicable: the last retrofit or rehabilitation of the plant/unit
Any comment:	This parameter only applies to retrofit or rehabilitation or replacement project activities

Data / Parameter table 3.

Data / Parameter:	**EF_{FF}**
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of fossil fuel used to produce the steam and/or electricity supplied to the desalination plant

<table>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:

<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source.</td></tr>
<tr><td>(b) Measurements by the project participants</td><td>If (a) is not available</td></tr>
<tr><td>(c) Regional or national default values</td><td>If (a) and (b) are not available These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If none of the above options are available</td></tr>
</table>
</td></tr>
<tr><td>Measurement procedures (if any):</td><td>For (a) and (b): Measurements should be undertaken in line with national or international fuel standards. For (a): if the fuel supplier does provide the NCV value and the CO2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO2 factor should be used. If another source for the CO2 emission factor is used or no CO2 emission factor is provided, Options (b), (c) or (d) should be used</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

Data / Parameter table 4.

Data / Parameter:	$Q_{w,historical}$
Data unit:	m^3/year
Description:	Annual average historical desalinated water generation delivered to the water-grid by the existing desalinated plant that was operated at the project site prior to the implementation of the project activity
Source of data:	Project activity site
Measurement procedures (if any):	Water flow meters
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$\sigma_{historical}$
Data unit:	m^3/year
Description:	Standard deviation of the annual average historical net desalinated water generation delivered to the water-grid by the existing desalination plants/units that were operated at the project site prior to the implementation of the project activity

Source of data:	Calculated from data used to establish $Q_{w,historical}$
Measurement procedures (if any):	Parameter to be calculated as the standard deviation of the annual generation data used to calculate $Q_{w,historical}$ for retrofit, or rehabilitation or replacement project activities
Any comment:	-

6. Monitoring methodology

60. All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred per cent of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

6.1. Data and parameters monitored

Data / Parameter table 6.

Data / parameter:	**$FC_{tot, FF,PJ,y}$**
Data unit:	Volume or mass unit
Description:	Fossil fuel consumption for electricity and or steam generation by the project desalination plant(s)/unit(s) in year y in year y
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using volume flow meters or using weighing scales
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The volume meter or weighing scale should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 7.

<table>
<tr><th>Data / parameter:</th><th>$NCV_{FF,y}$</th></tr>
<tr><td>Data unit:</td><td>TJ/volume or mass unit</td></tr>
<tr><td>Description:</td><td>Average net calorific value of fossil fuel consumed by the project desalination plant(s)/unit(s) in year y</td></tr>
<tr><td>Source of data:</td><td>
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source.</td></tr>
<tr><td>(b) Measurements by the project participants</td><td>If (a) is not available</td></tr>
<tr><td>(c) Regional or national default values</td><td>If (a) and (b) are not available. These sources can only be used for liquid fuels and should be based on well documented,</td></tr>
</table>
</td></tr>
</table>

	reliable sources (such as national energy balances)
(d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If none of the above options are available

Measurement procedures (if any):	For (a) and (b): Measurements should be undertaken in line with national or international fuel standards

Monitoring frequency:	For (a) and (b): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated.
	For (c): Review appropriateness of the values annually.
	For (d): Any future revision of the IPCC Guidelines should be taken into account

QA/QC procedures:	Verify if the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards
Any comment:	---

Data / Parameter table 8.

Data / parameter:	$EG_{gross,PJ,y}$
Data unit:	MWh
Description:	Gross electricity generation in the project desalination plant(s)/unit(s) in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using bi-directional energy meter
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 9.

Data / parameter:	$EG_{net,PJ,y}$
Data unit:	MWh
Description:	Net electricity generation of the project desalination plant(s)/unit(s) in year y
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be either monitored using bi-directional energy meter or calculated as difference between (a) the quantity of

	electricity supplied by the project plant/unit to the grid; and (b) the quantity of electricity delivered to the project plant/unit from the grid. In case it is calculated then the following parameters shall be measured: (a) The quantity of electricity supplied by the project plant/unit to the grid; and (b) The quantity of electricity delivered to the project plant/unit from the grid
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 10.

Data / parameter:	**$EG_{gross,PJ,t,y}$**
Data unit:	MWh
Description:	Gross electricity generation per technology *t* (e.g. open cycle, combined cycle) in the project desalination plant(s)/unit(s) in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using bi-directional energy meter
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 11.

Data / parameter:	**$\eta_{t,power,PJ,y}$**
Data unit:	-
Description:	Efficiency of power generation of technology *t* used in the project desalination plant(s)/unit(s)
Source of data:	Default efficiency values as provided under “TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems”
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 12.

Data / parameter:	$\mathbf{HG_{steam,PJ,t,y}}$
Data unit:	ton
Description:	Total steam input per technology *t* from the project desalination plant(s)/unit(s) in year y
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using volume flow meters
Monitoring frequency:	Continuous monitoring, hourly measurement and at least daily recording. To calculate the annual steam flow, the daily average value of steam flow should be used
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	Convert the steam flow value into MWh for calculation purpose using enthalpy of the steam

Data / Parameter table 13.

Data / parameter:	$\boldsymbol{\eta_{t,steam,PJ,y}}$
Data unit:	-
Description:	Efficiency of steam generation of technology *t* used in the project desalination plant(s)/unit(s)
Source of data:	Default efficiency values as provided under "TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems"
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 14.

Data / parameter:	$\mathbf{EG_{water,PJ,y}}$
Data unit:	MWh
Description:	Electricity consumption of the project desalination plant(s)/unit(s) in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using bi-directional energy meter
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 15.

Data / Parameter:	**$EF_{grid,y}$**
Data unit:	tCO_2/MWh
Description:	CO_2 emission factor of the grid electricity in year *y*
Source of data:	-
Measurement procedures (if any):	As per the requirements in “TOOL07: Tool to calculate the emission factor for an electricity system”
Any comment:	-

Data / Parameter table 16.

Data / parameter:	**$Q_{w,PJ,y}$ / $Q_{project\ plant,y}$**
Data unit:	m^3
Description:	Quantity of desalinated water produced by project desalination plant(s)/unit(s) in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using volume flow meters
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 17.

Data / parameter:	**$Q_{w,p,y}$ / $Q_{w,p,i,y}$**
Data unit:	m^3
Description:	Quantity of desalinated water produced by each desalination plant *p* of in year *y*
Source of data:	-
Measurement procedures (if any):	This parameter should be monitored using volume flow meters
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 18.

Data / parameter:	**$FC_{tot,FF,p,i,y}$**
Data unit:	Volume or mass unit
Description:	Fossil fuel consumption for electricity and or steam generation of desalination plant *p* of type *i* in year y

Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using volume flow meters or using weighing scales
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The volume meter or weighing scale should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 19.

Data / parameter:	$EG_{gross,p,i,y}$
Data unit:	MWh
Description:	Gross electricity generation of desalination plant *p* of type *i* in year y
Source of data:	-
Measurement procedures (if any):	This parameter should be monitored using bi-directional energy meter
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 20.

Data / parameter:	$EG_{net,p,i,t,y}$
Data unit:	MWh
Description:	Net electricity generation of desalination plant *p* of type *i* in year y
Source of data:	-
Measurement procedures (if any):	This parameter should be either monitored using bi-directional energy meter or calculated as difference between (a) the quantity of electricity supplied by the project plant/unit to the grid; and (b) the quantity of electricity delivered to the project plant/unit from the grid. In case it is calculated then the following parameters shall be measured: (a) The quantity of electricity supplied by the project plant/unit to the grid; and (b) The quantity of electricity delivered to the project plant/unit from the grid
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 21.

Data / parameter:	**$EG_{gross, p,i,t,y}$**
Data unit:	MWh
Description:	Gross electricity generation by technology *t* in desalination plant *p* of type *i* in year y
Source of data:	-
Measurement procedures (if any):	This parameter should be monitored using bi-directional energy meter
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 22.

Data / parameter:	**$\eta_{t,power,p,i,y}$**
Data unit:	-
Description:	Efficiency of power generation of technology *t* used in desalination plant *p* of type *i* in year *y*
Source of data:	Default efficiency values as provided under “TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems”
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 23.

Data / parameter:	**$EG_{water,p,j,y}$**
Data unit:	MWh
Description:	Electricity consumption of the desalination plant *p* of type *j* in year *y*
Source of data:	-
Measurement procedures (if any):	This parameter should be monitored using bi-directional energy meter
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 24.

Data / parameter:	$HG_{steam,p,i,t,y}$
Data unit:	ton
Description:	Total steam input to the desalination plant *p* of type *i* having technology *t* in year *y*
Source of data:	Total steam input to the project desalination plant(s)/unit(s) *p* in year y
Measurement procedures (if any):	This parameter should be monitored using volume flow meters
Monitoring frequency:	Continuous monitoring, hourly measurement and at least daily recording. To calculate the annual steam flow, the daily average value of steam flow should be used
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	Convert the steam flow value into MWh for calculation purpose using enthalpy of the steam

Data / Parameter table 25.

Data / parameter:	$\eta_{t,steam,p,i,y}$
Data unit:	-
Description:	Efficiency of steam generation of technology *t* used in desalination plant *p* of type *i* in year y
Source of data:	Default efficiency values as provided under “TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems”
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 26.

Data / parameter:	$Q_{w,PJ\_Add,y}$
Data unit:	m^3
Description:	Quantity of desalinated water produced by the project desalination plant(s)/unit(s) that has been added to existing desalination plants in year y
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using volume flow meters
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording

QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

Data / Parameter table 27.

Data / parameter:	$Q_{w,facility,y}$
Data unit:	m^3
Description:	Quantity of desalinated water produced by the entire desalination facility where the project desalination plant(s)/unit(s) is located in year y
Source of data:	Project activity site
Measurement procedures (if any):	This parameter should be monitored using volume flow meters
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meter should be calibrated periodically based on internal procedure of the project participant and relevant industry standards or national standards
Any comment:	-

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Document information

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