United Nations Framework Convention on Climate Change

Agenda item 4.1.(b)
Paragraph 18 of the annotated agenda, MP86 Annex 1

Technical Note – Desalination technologies

CDM EB 112

Glasgow, United Kingdom of Great Britain and Northern Ireland, 26 to 29 October 2021

UNFCCC Secretariat
Mitigation Division

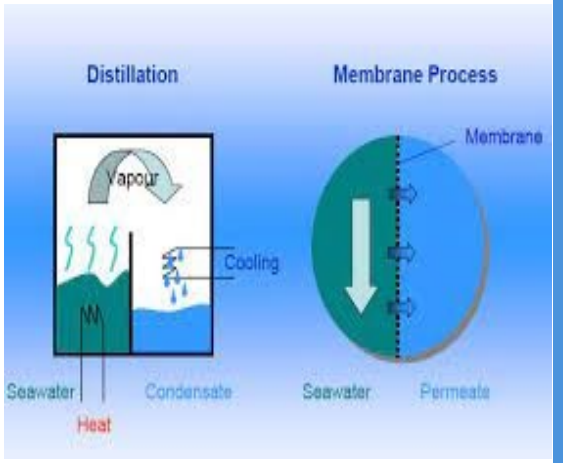
Procedural background

- MP 84 recommended to the Board to approve the methodology, *"Energy-saving through the use of the reverse osmosis technology in the water desalination process" (NM0377)*.
- EB 110 requested MP to further work on the methodology

  a) The Board noted that the underlying **assumption**, that project plant, especially **greenfield unit**, **will always displace existing desalination capacity of the water-grid**, needs further analysis in the context of the **growing demand** for potable water in many regions.

Procedural background

- NM0377: Energy saving through the use of the reverse osmosis technology in the water desalination process, was submitted by Acciona Agua, SA Qatar.
- Baseline scenario: water produced by a stand-alone thermal desalination plant based on common practice in the host country. In the case of submission, it is Multi-Stage Flash (MSF).
- Baseline emissions are due to thermal and grid electricity consumption, former based on steam:
    a) generated in in-house dedicated boilers using natural gas; or
    b) steam procured from a neighboring cogeneration plant; or
    c) Waste steam from in-house boiler or from a neighbouring facility.



Source – Fawazi Banat, Economic and technical assessment of desalination technologies, 2007

Background – Water grid emission factor approach proposed by MP

Following several rounds of consultation with PP, the MP modified the approach and recommended to EB 110:

- Baseline scenario: total water produced by networked desalination plants;
- Baseline emissions is the product of (a) water-grid emission factor (WGEF), i.e. emissions per unit quantity of water; and, (b) the desalinated water produced by project plant;
- WGEF is averaged based on:
  - Total desalinated water produced from all networked plants operating in the host country; and
  - Electricity and fossil fuels used (apportioning to exclude fuel used for electricity generation in the case of cogeneration);
- Project emissions are electricity and fossil fuel use of the project desalination plant.

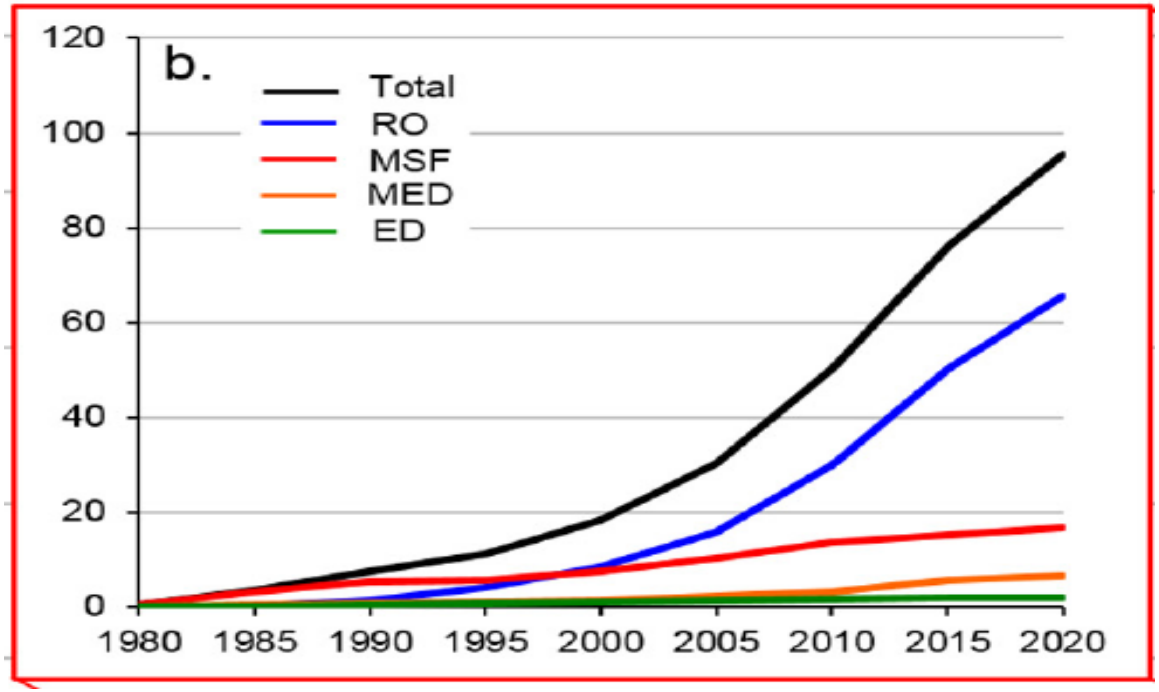
Purpose

- **Analyze characteristics and status of desalination technologies,** globally, specifically in the Middle-East and North Africa (MENA) region, which hosts the proposed project activity submitted along with NM0377.

- Respond to the question from the Board, based on the analysis.

Key Issues – Overview of desalination technologies

Trends in global desalination capacity in million m3 per day (y-axis)



- Per most recent available data, membrane technologies, i.e. **Reverse Osmosis (RO) accounts for 70%** of capacity, **thermal technologies (MSF and MED) account for the rest** *(ref: Jones et.al 2019).*
- Historically thermal technologies dominated.

Key Issues – Overview of desalination technologies in MENA

- By 2019, of the global capacity of **95 million m3/day** MENA region accounted for nearly half, i.e. **45 million m3/day**.

- In 2015, in MENA **thermal was more prevalent than RO, i.e.** 53 per cent vs 47 per cent *(ref: WB 2019)* and accounted for > 90% global thermal capacity.

- **Regional differences for RO capacity** *(ref: Global Water Intelligence, 2018)*:
  - 50% in Saudi Arabia; < 30% in UAE, Qatar and Kuwait; > 90% in Egypt and Algeria.

Key Issues – Costs of desalination technologies

- Cost of water production depends on **technology choice, plant size, location, project delivery and environmental regulations** *(WB, 2019)*.

Summary of worldwide seawater desalination costs

Desalination method		Capital costs (million USD/MLD)		O&M costs (USD/m^3)		Cost of water production (USD/m^3)	
		Range	Average	Range	Average	Range	Average
MSF		1.7-3.1	2.1	0.22-0.30	0.26	1.02-1.74	1.44
MED-TVC		1.2-2.3	1.4	0.11-0.25	0.14	1.12-1.50	1.39
SWRO Mediterranean Sea		0.8-2.2	1.2	0.25-0.74	0.35	0.64-1.62	0.98
SWRO Arabian Gulf		1.2-1.8	1.5	0.36-1.01	0.64	0.96-1.92	1.35
SWRO Red Sea		1.2-2.3	1.5	0.41-0.96	0.51	1.14-1.70	1.38
SWRO Atlantic and Pacific Seas		1.3-1.76	4.1	0.17-0.41	0.21	0.88-2.86	1.82
Hybrid	**MSF/MED**	1.5-2.2	1.8	0.14-0.25	0.23	0.95-1.37	1.15
	SWRO	1.2-2.4	1.3	0.29-0.44	0.35	0.85-1.12	1.03

Note: Costs are at 2016-values. MED-TVC = multiple effect distillation with thermal vapor compression; MLD = million liters per day; MSF= multistage flash distillation; O&M = operation and maintenance; SWRO = seawater reverse osmosis

Key Issues – Costs of desalination technologies

- Cost is also influenced by Utilities' policies, for example:
  - **decision to dispatch power and or water** from different plants in the grid, based on diurnal or seasonal fluctuations;
  - **the availability of steam** from the combined cycle plant and cost assigned to it if any.

Key Issues – MENA specific factors for technology share

- As per IEA (2019), highly **subsidized cost of oil and gas and prevalence of cogeneration facilities** for power and water have led to higher share of thermal desalination technologies in the MENA region compared to rest of the world.
- Also, WB (2019) attributes the following factors for the use of thermal technologies;
  - **Physical operating conditions** - the regional seas are highly saline and warm and have high concentrations of organics, which are challenging conditions for RO; and
  - **Policy on subsidized cost of energy.**

Key Issues – Outlook for desalination in MENA

- IEA (2019) based on present policies of countries in MENA projects a marked **downward shift in fossil fuel use in desalination**, i.e. from about **50% in 2016 to about 20% in 2040** due to:
  - **declining cost** of membrane-based technologies;
  - **anticipated reforms** to energy-pricing;
  - **high solar irradiation, and rapidly declining costs for solar projects in the region**, could alter the energy mix (from the present 1 GW solar and 90 GW FF generation to increasing share of RE).
- National policy documents of MENA region countries in relation to desalination refer to **RO-based desalination and augmenting renewable energy supply** in the energy mix.

Key issues – Response to issues raised by EB110

- EB 110 request recap: *"The underlying assumption of the methodology that the project plant, especially the greenfield unit, will **always displace the existing desalination capacity of the water-grid** needs further analysis in the context of the growing demand for potable water in many regions."*
- MP noted in Qatar (NM 0377 host), there was an **average 5.2% annual growth** between 2015 and 2019 and there is significant storage capacity as compared to daily water production.
  - Hourly/daily demand/supply of water will not demand a similar response in the water supply system, as would the case with an electricity grid. Modelling these impacts of annual growth and storage in water grid emission factor approach may need different algorithms than those of the electricity grid.

Key issues – Response to issues raised by EB110

- Noting ongoing decarbonization of the desalination sector, the MP is of the opinion that the **other approaches in paragraph 48 of CDM M&P may need to be explored** to determine the baseline emissions, besides the water grid emission factor approach that was previously proposed.
- However, it is possible that under such alternative approaches, the **proposed project under NM 0377 may not be able to claim emission reductions**.
- MP seeks guidance from the Board as **to whether to continue to work on the methodology**, e.g. on a top-down basis even if it may not be applicable to the proponent of NM 0377.

Recommendations to the Board

- MP recommends the Board to take note of this information note and **provide guidance regarding the work** related to further consideration of NM0377.
- If a workable solution, in conjunction with PP, can not be found, the Board may request the MP to further consider the methodology to:

  - **Option 1:** reject the proposed new methodology;

  - **Option 2:** reject the proposed new methodology but develop a new methodology for desalination sector on top-down basis.