Assessment of Desalination Technologies in Egypt

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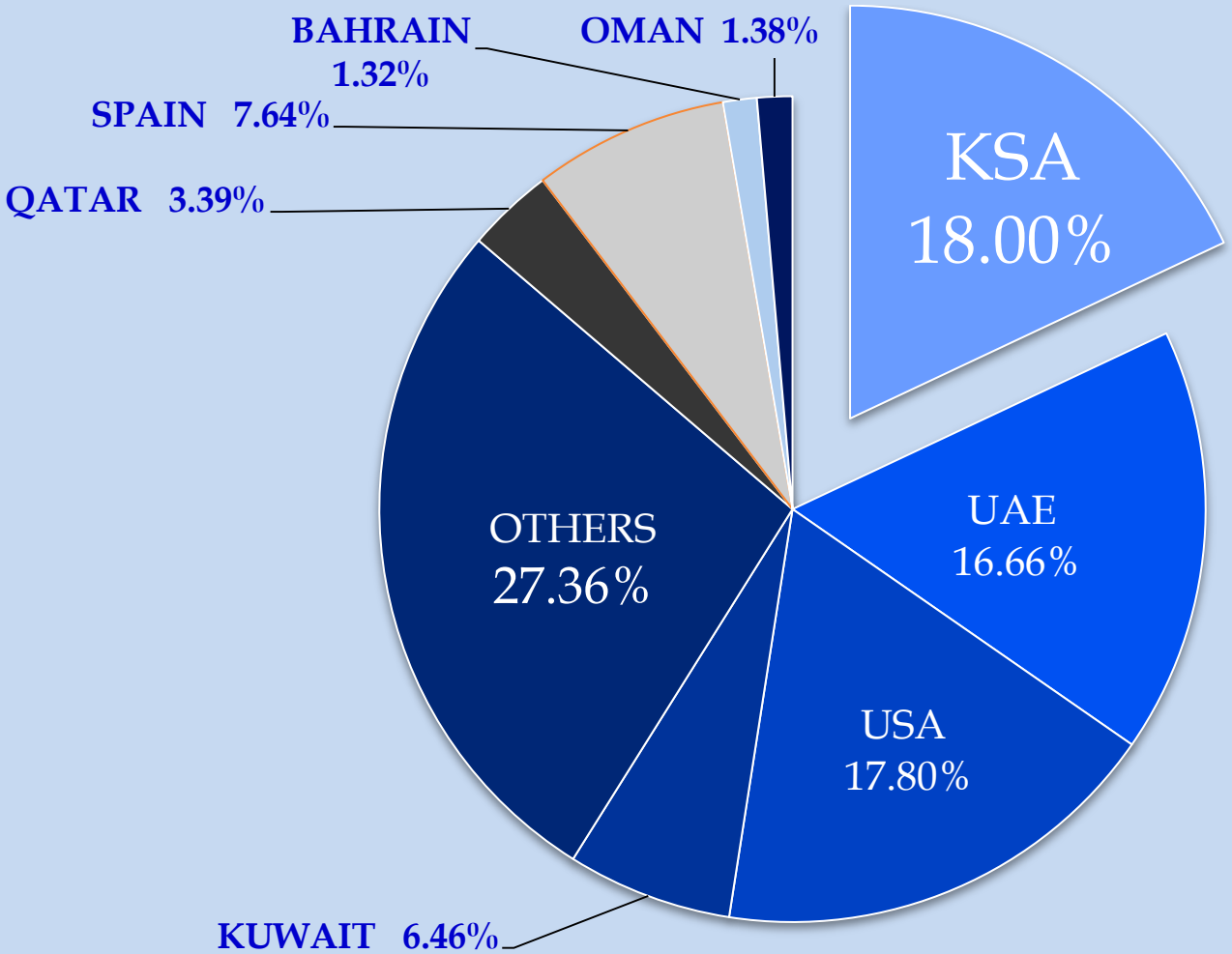
Content

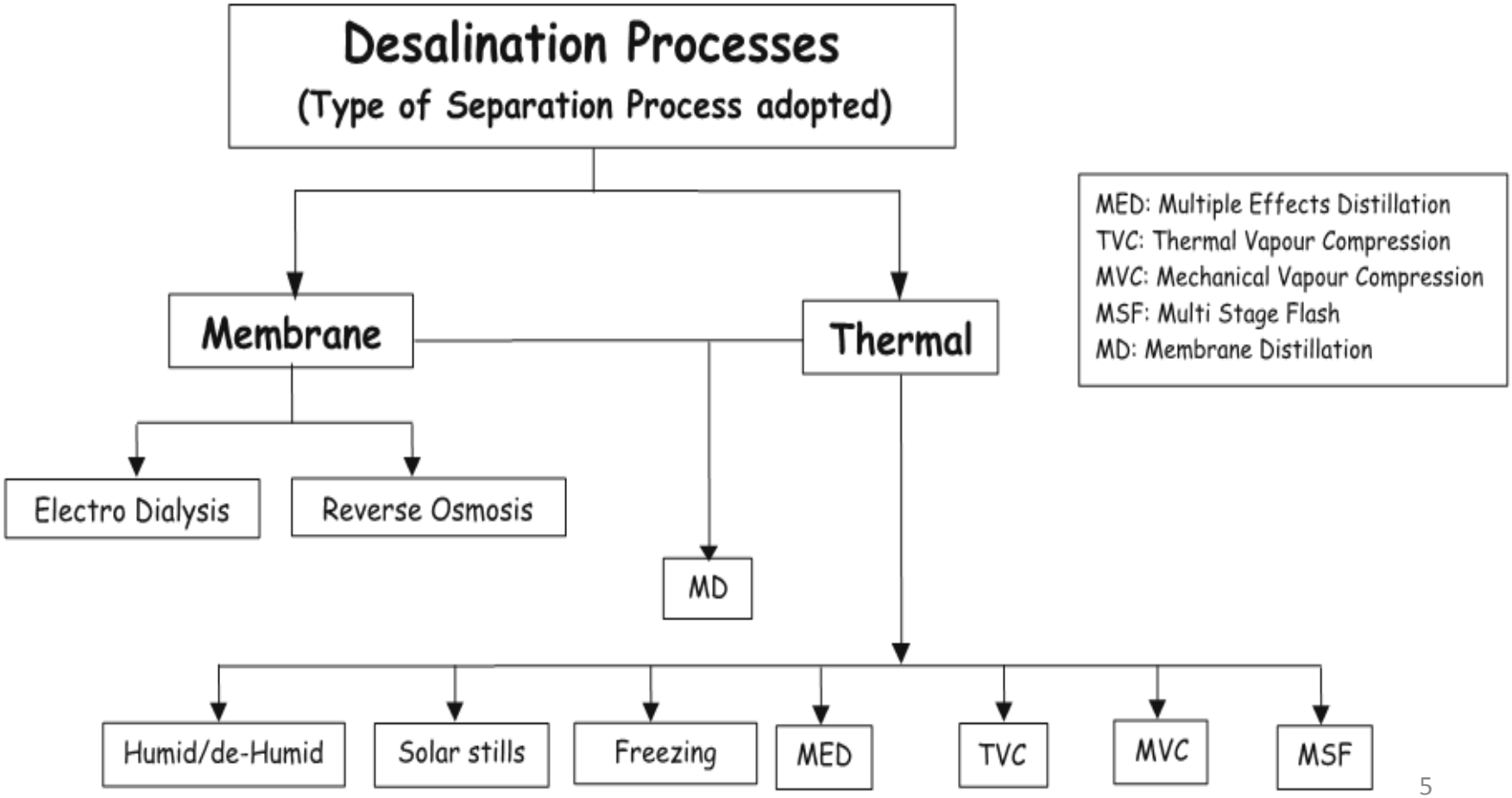
Introduction

- 75% of the Earth's surface is covered by water
- 97.5% of that water is oceans
- Only 1% is available for drinking
- 90 countries suffered from water scarcity by the mid-2015
- 1.5 billion people lack ready access to drinking water

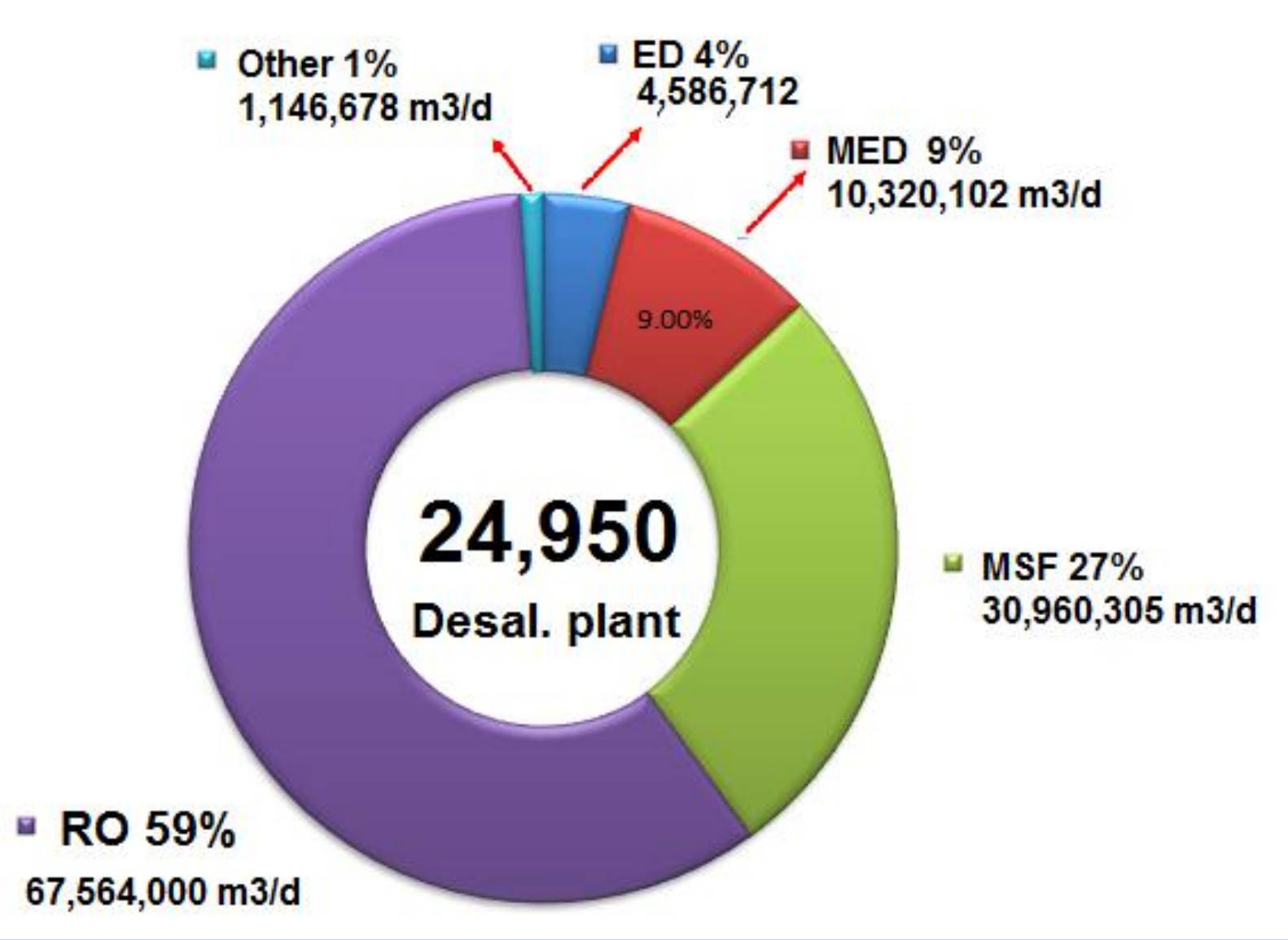
Global desalination Market share



Desalination technologies classification based on the separation process adopted

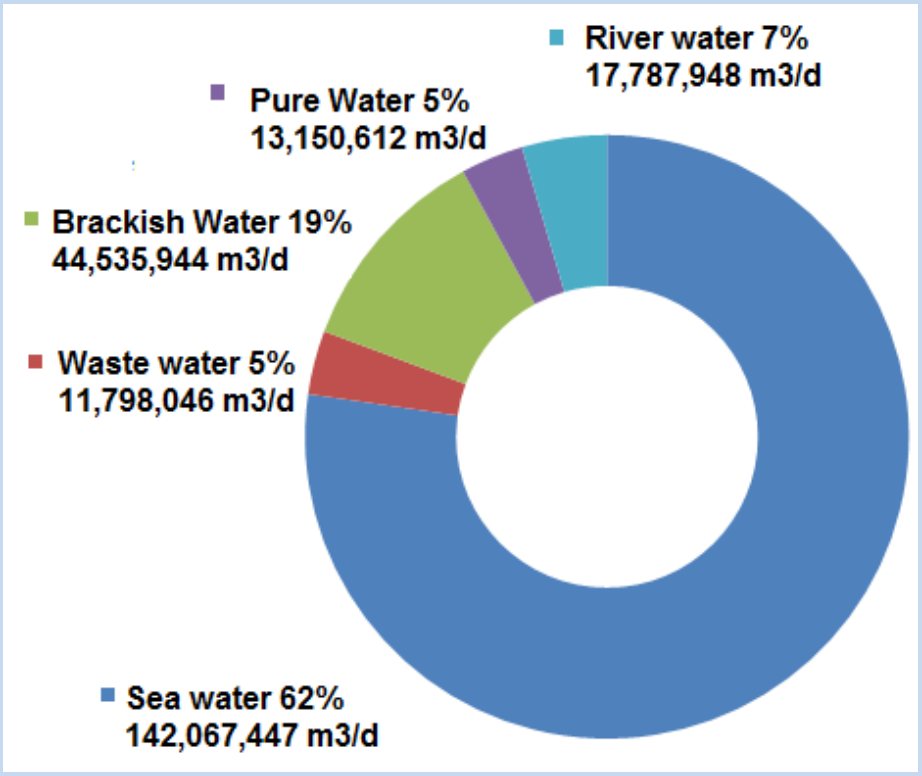


Desalination Technology

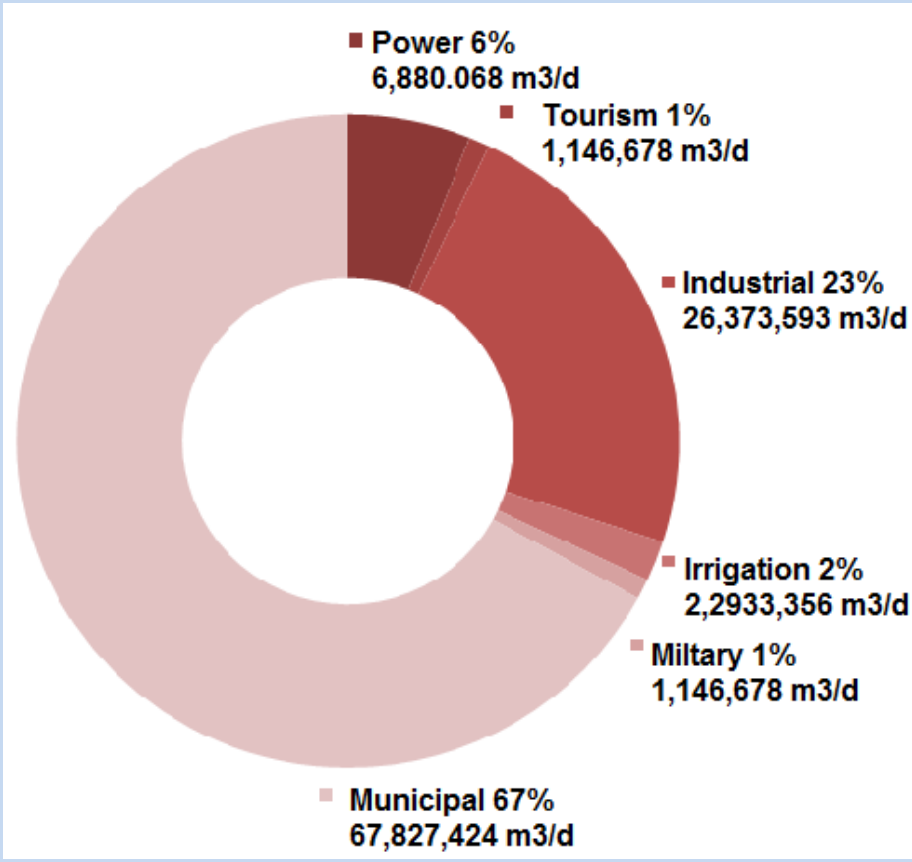


Desalted water Source and Uses

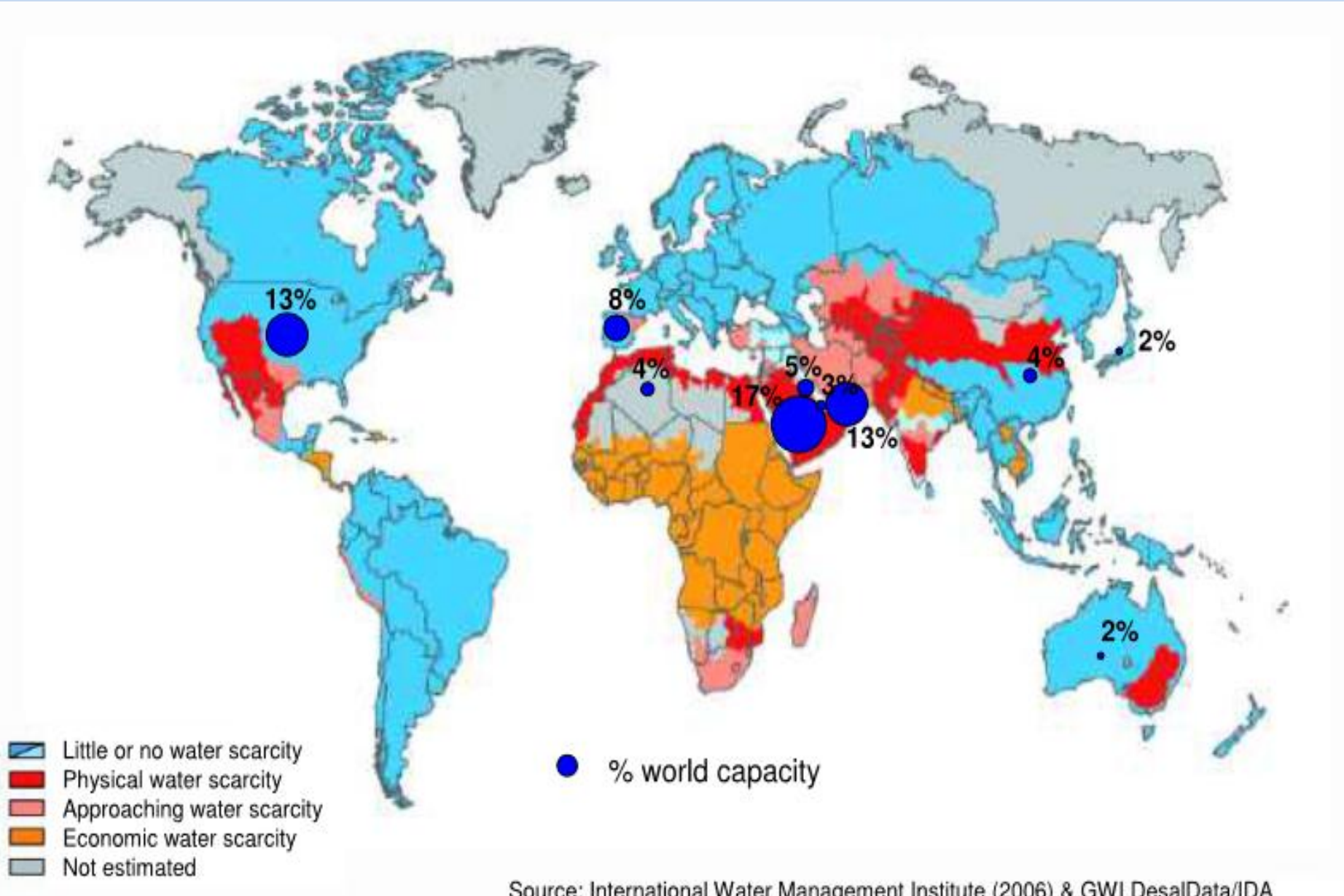
Water Quality



Water Uses



Major Desalination Plant In Countries



Egyptian Desalination Market Share

- **1- Surface water**
- **a) Nile River** (55.5 milliard cubic meter per year)
- **b) Rains water** (one milliard cubic meter per day)

- **2- under ground water** (4.8 milliard cubic meter per year)

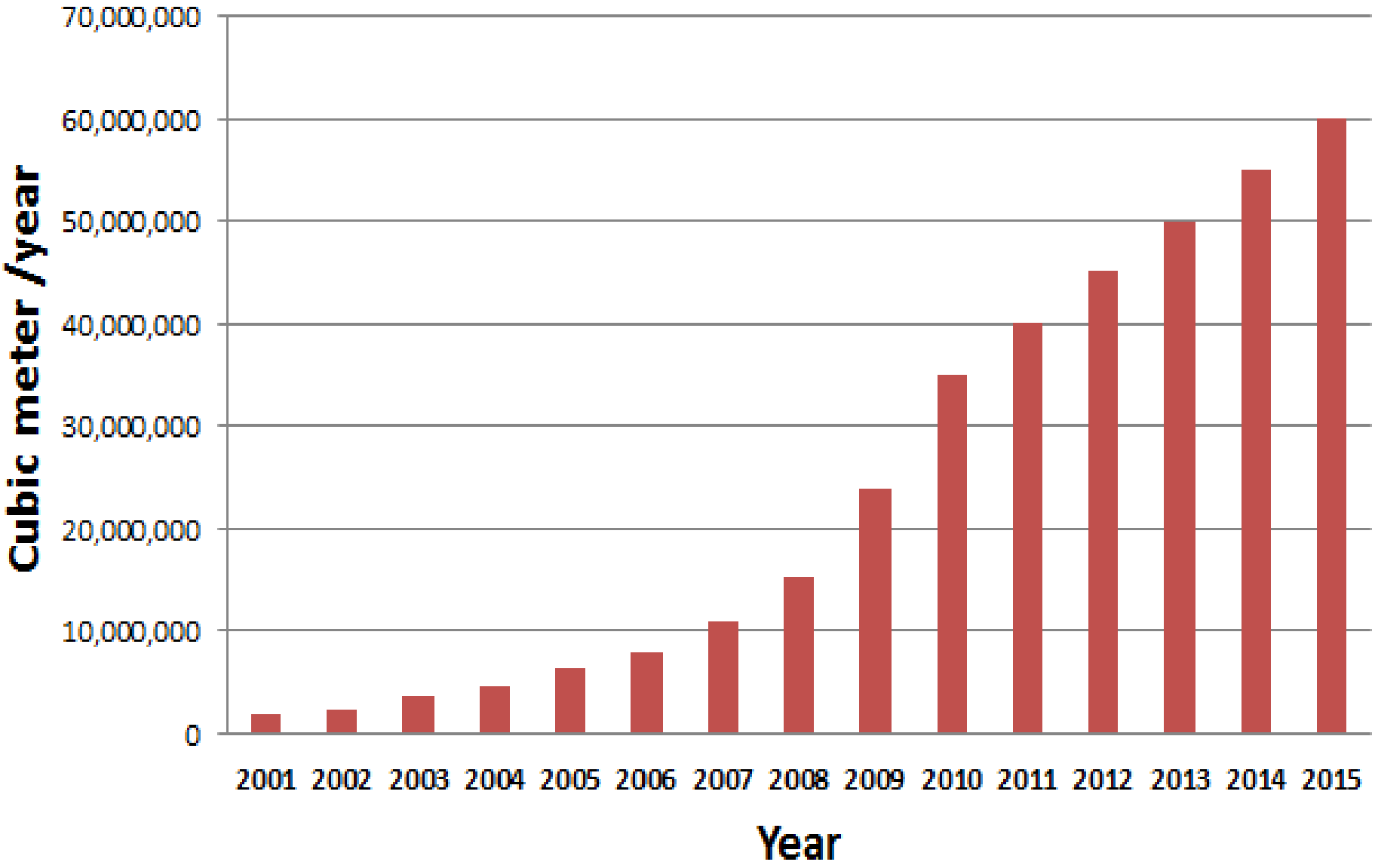
- **3- Recycled water**
- a) Agriculture drain water (4.5 milliard cubic meter per year)
- b) Industrial Drain water (6.5 milliard cubic meter per year)
- c) Sanitary water (0.7 milliard cubic meter per year)

- **4- Desalination**
- Desalination technologies (0. 6 milliard m3/ year)

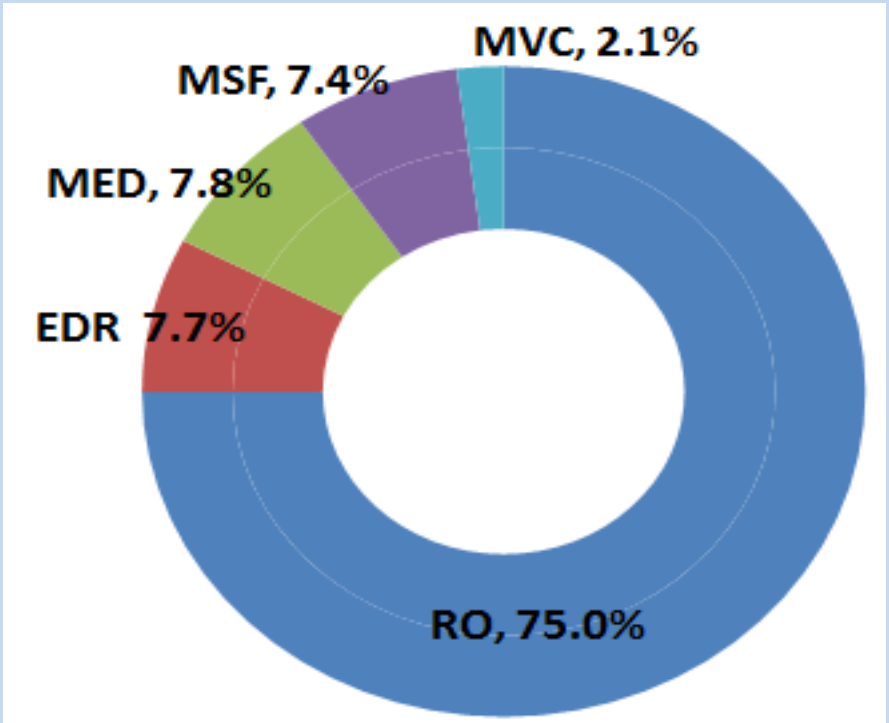
- ***Total amount of water in Egypt = 73.6 milliard cubic meter /year***
- ***Personal share = 816 meter per year***

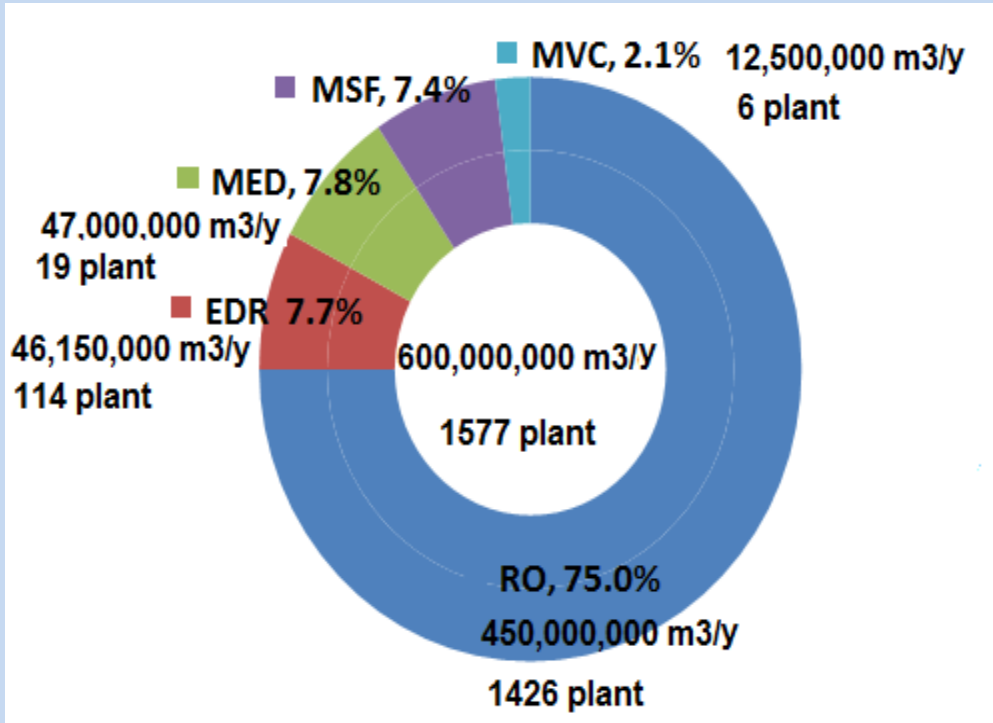
Desalination plant Location in Egypt

Egyptian Desalination Market



Desalination Technologies





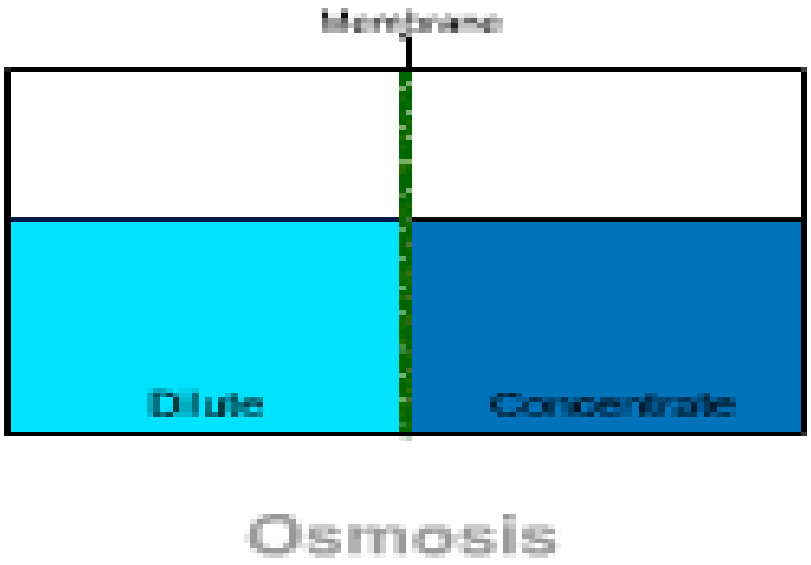
Sector	Techology	M3/d	%
Tourism	RO	360,000,000	59.9%
Industry	RO + EDR	81,575,000	13.6%
Public water	RO	13,500,000	2.2%
Petroluim	RO+EDR	41,075,000	6.8%
Power	RO +MCV+MED+MVC	104,850,000	17.4%

Type of Desalination

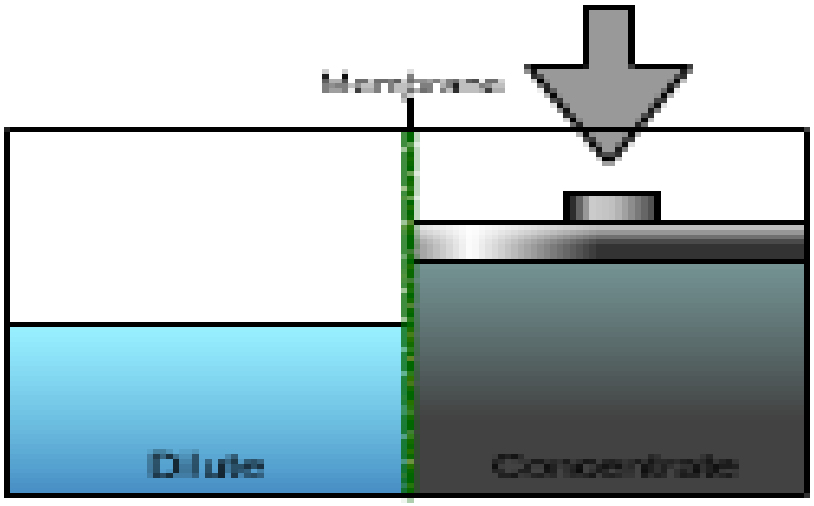
- Electro-dialysis Reverse (EDR)
- Multistage Flash (MSF)
- Multi Effect Evaporation (MED)
- Mechanical Vapor compression (MVC)
- Thermal Vapor compression (TVC)
- Freezing
- Zero Liquid Discharge (ZLD)
- Reverse Osmoses (RO).

Osmosis theory

Click on image to begin animation

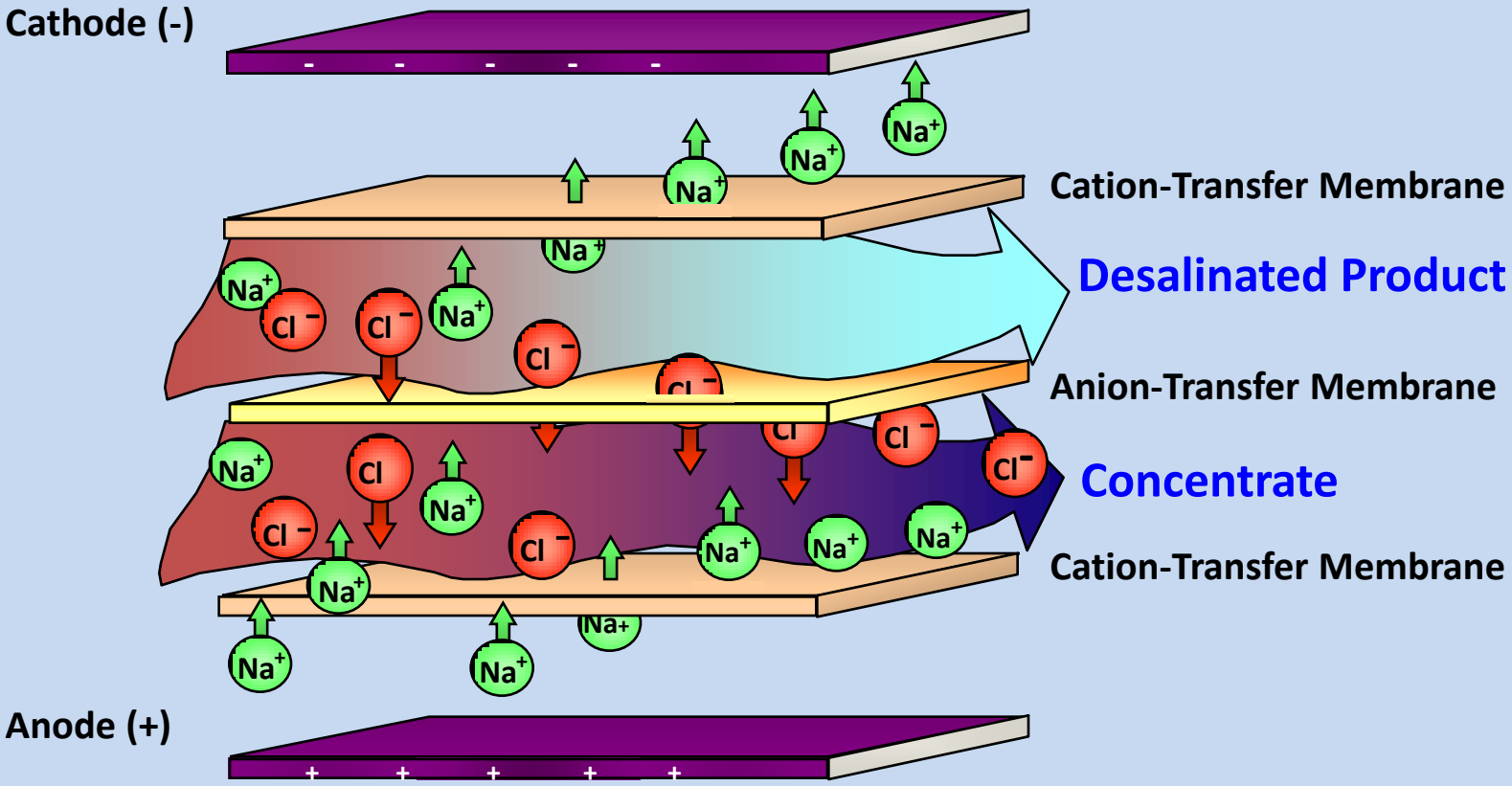


Reverse osmosis theory



Reverse Osmosis

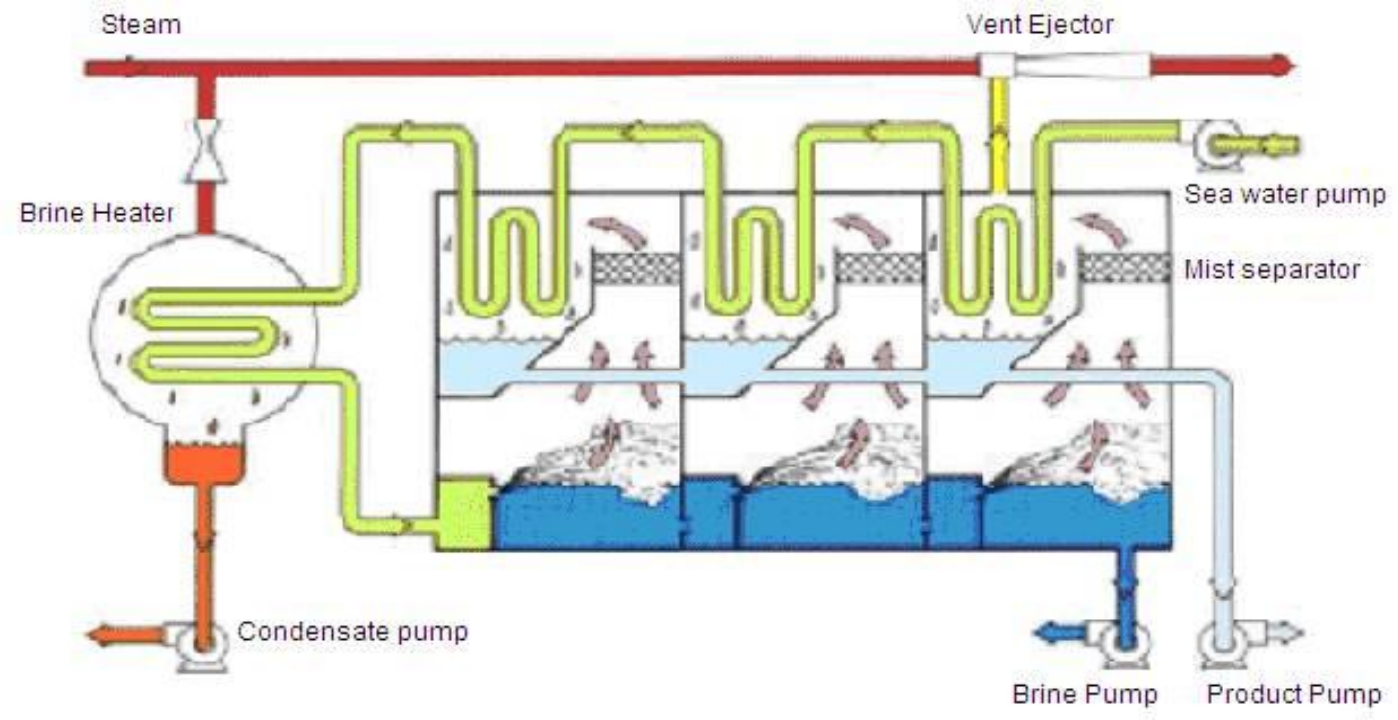
Electro- dialysis



- The use of membranes composed of ion exchange material saving power from 2.3 kwh/m3 to 1.8KWh/m3
- Use Graphite Electrode . Solve many problem

Multi Stage flash (MSF)

- Added No of stage
- Recycle pump increase the recovery of the system
- Heat exchanger
- Martial
- multiple times in different stages at lower pressures, requiring no extra heat But, multi stage flashing reduces thermal efficiency
- 85% of world's desalinated water is generated through MSF



Solar Powered Desalination

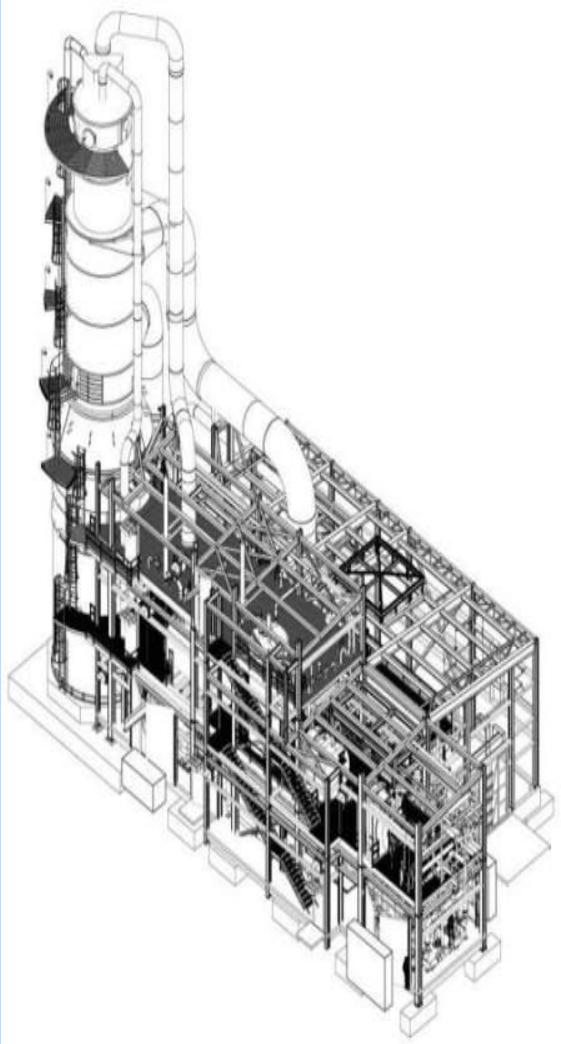
- Desalination powered by renewable energy using photovoltaic cells, possibly in conjunction with a fuel cell.
- It is applicable with other desalination as RO, EDR ,……

Photovoltaic cells

http://www.greenfield-hydroponics.com/

Zero Discharge Technologies Solidification/Stabilization

- Process to solidify and stabilize crystallizer water
  - Using Heat for evaporation
  - Produces a stable solid Slat
  - Lower capital costs (<50%) compared to dryer technology
  - Comparable operating costs, or slightly lower, than dryer
  - Higher reliability, minimal materials handling



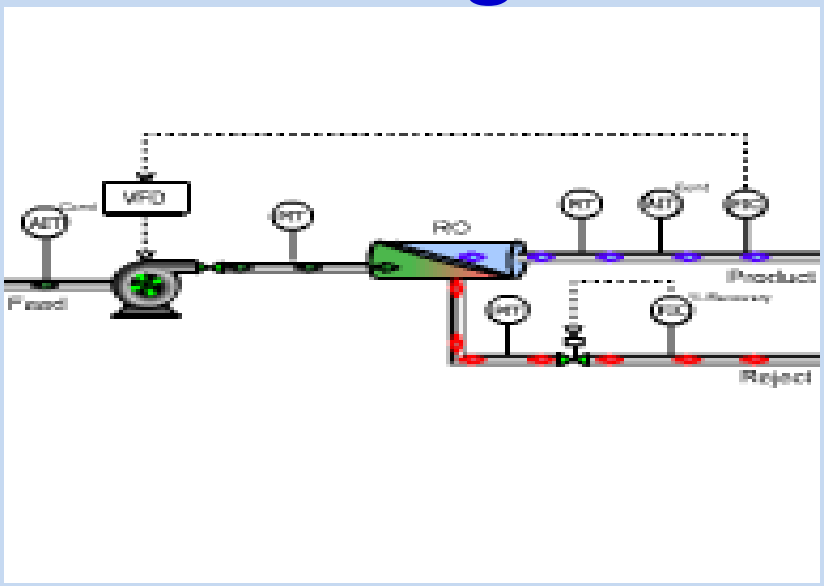
Nuclear Desalination

- There have been over 15 years of experience with nuclear desalination, mainly in India, Japan, and Kazakhstan
- In Japan, 8 nuclear reactors are linked to 10 desalination plants
- India: hybrid Nuclear Desalination Demonstration Project (NDDP)
- Information: World Nuclear Association

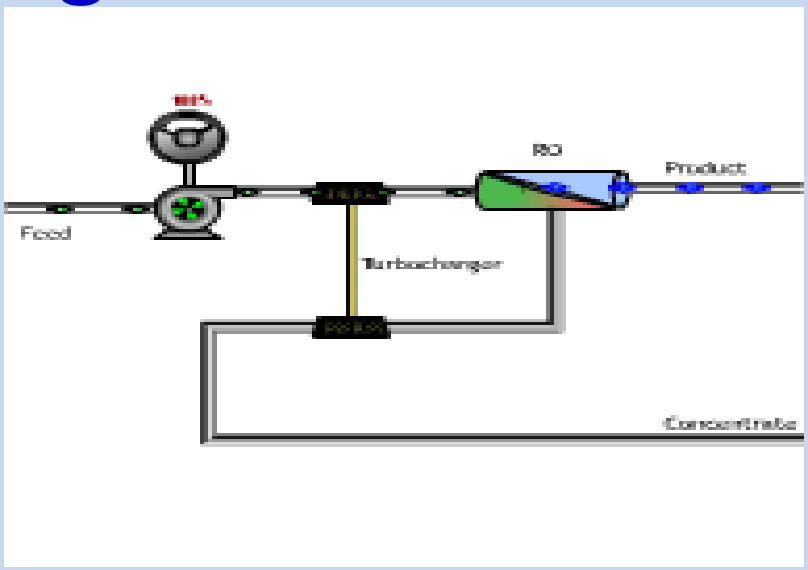
RO Development

- Power
- Membrane
  - Membrane material
  - Low Energy (LE)
  - Low Fouling membrane (LF)
  - Increase membrane Area (370 ---- 400)
  - Increase No. stages
  - increase No. membrane per vessels
- Pretreatment

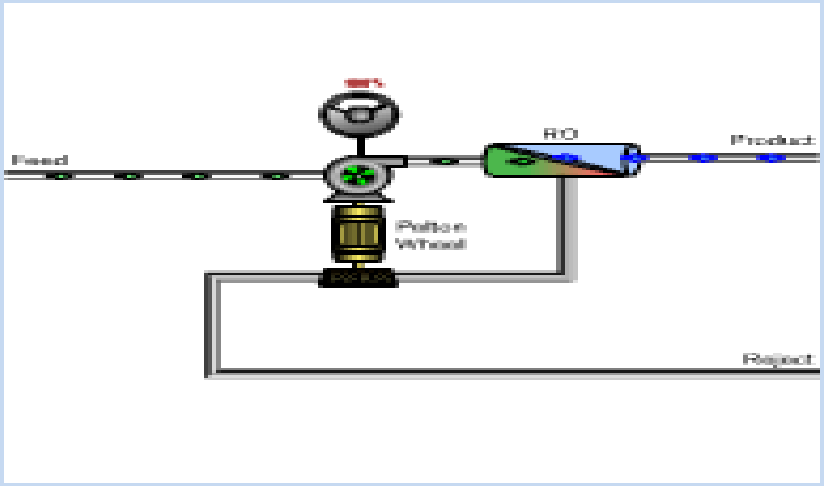
Saving Power : Using control Valve



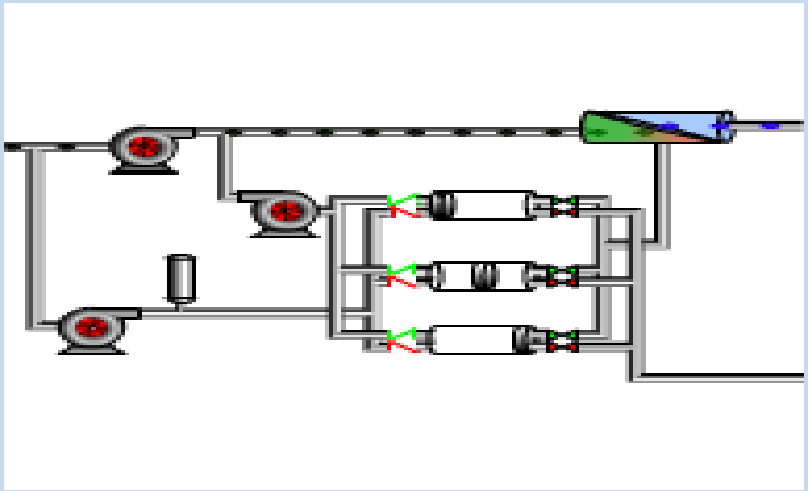
Power Cons. 11.8 Kwh/m3



Power Cons. 8 Kwh/m3

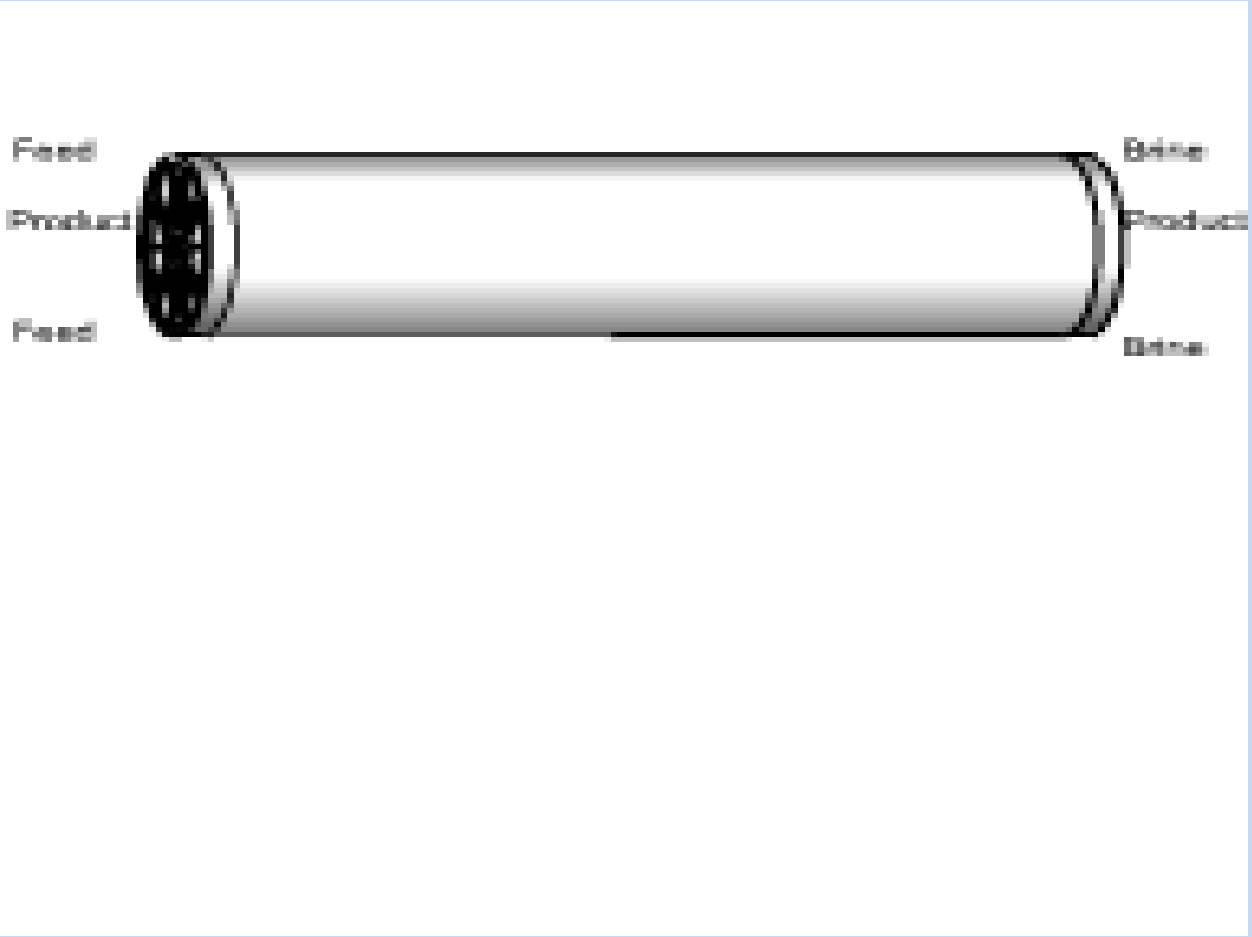


Power Cons. 5 Kwh/m3



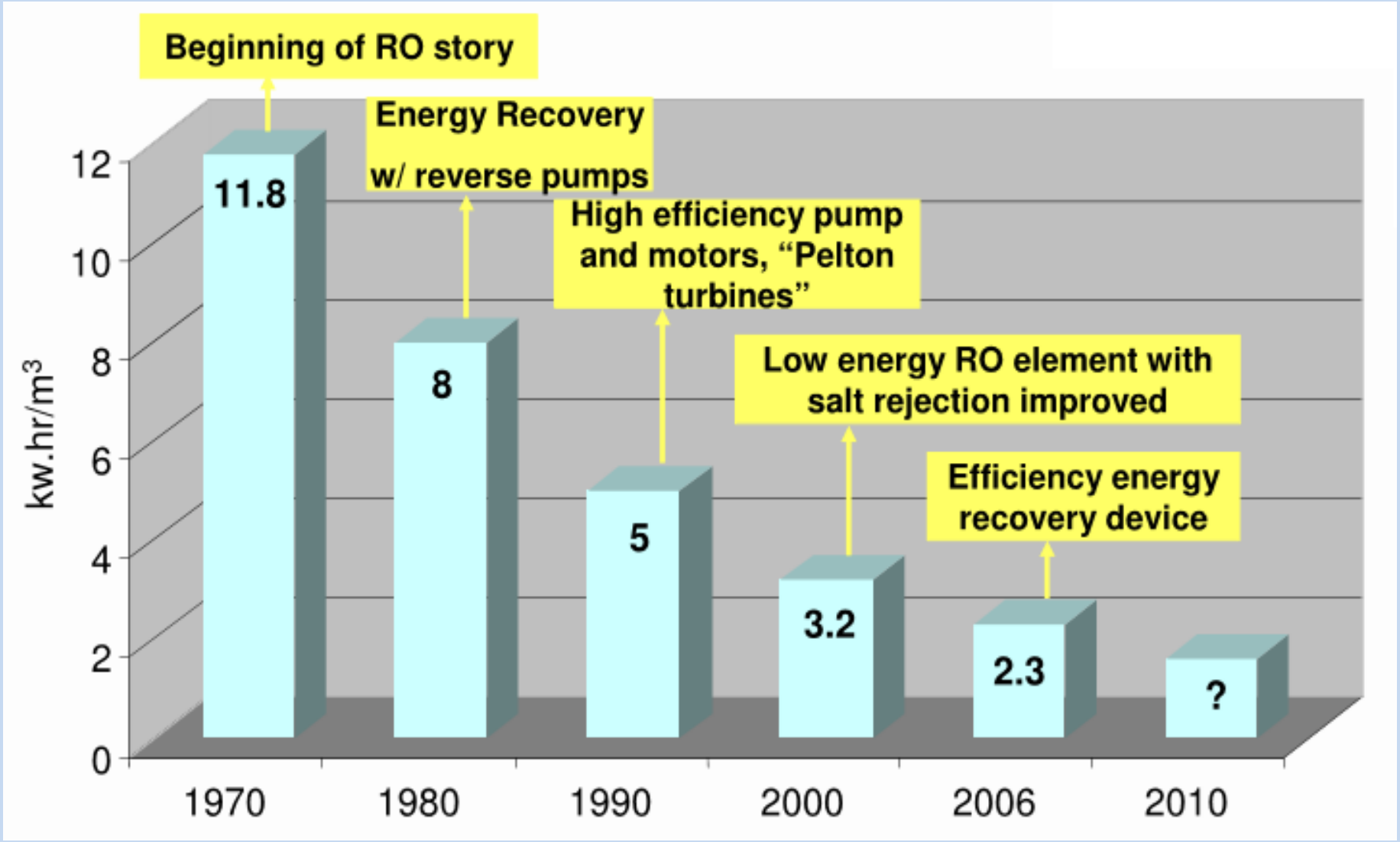
Power Cons. 2.3 Kwh/m3

Low Energy Membrane

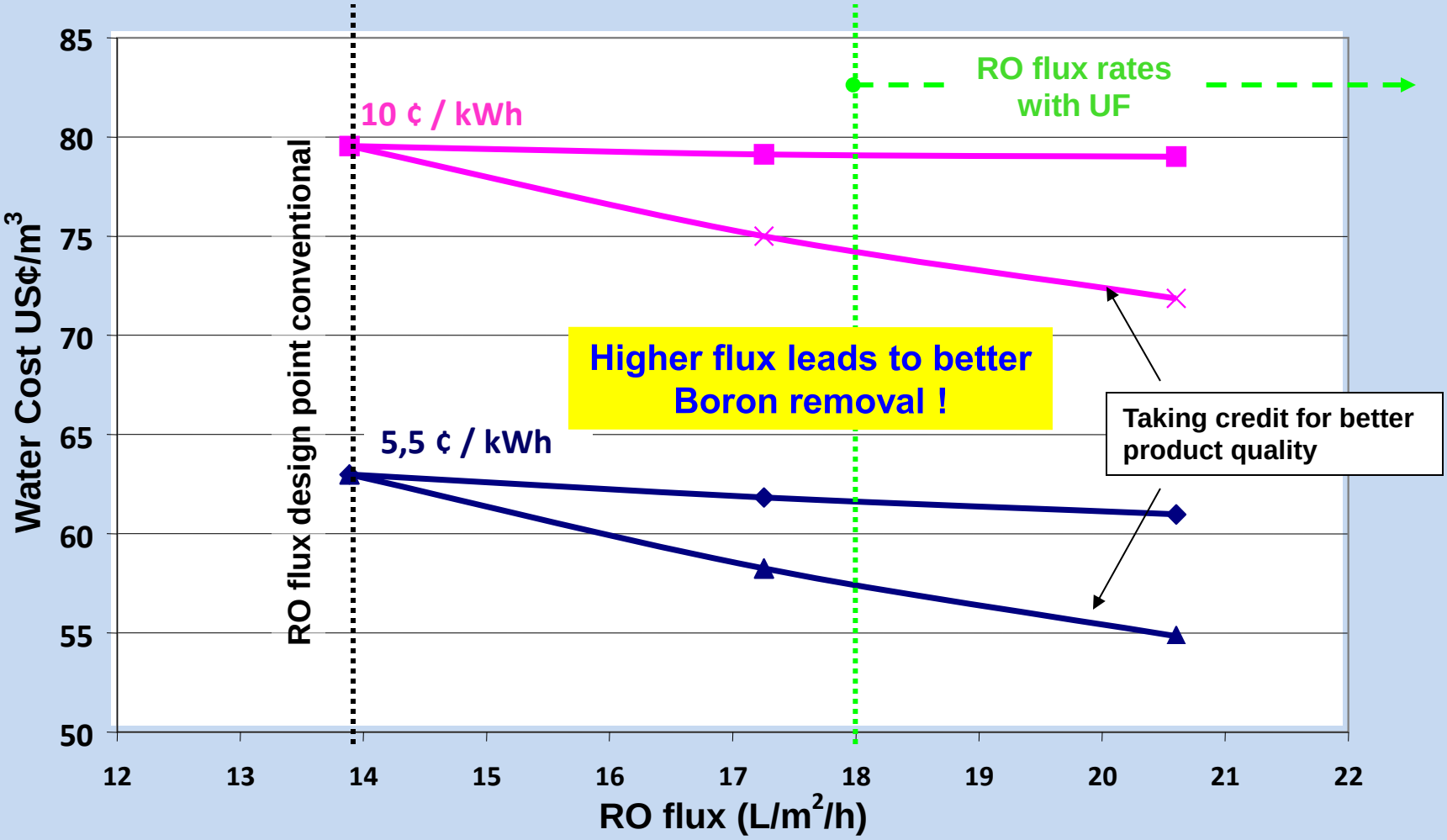


Power Consumption 3.2 Kwh/m3

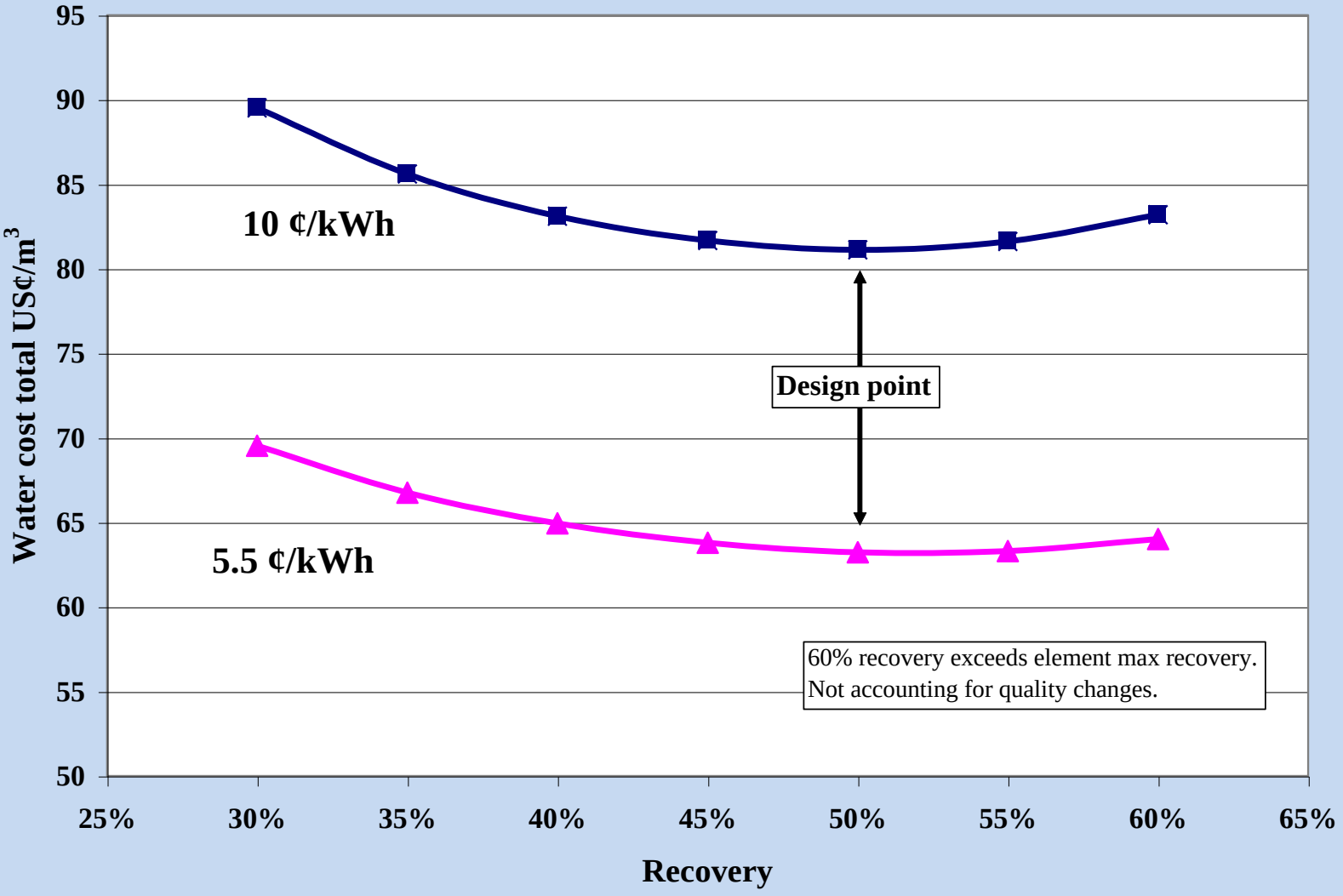
Evolution of Electrical Consumption For RO System



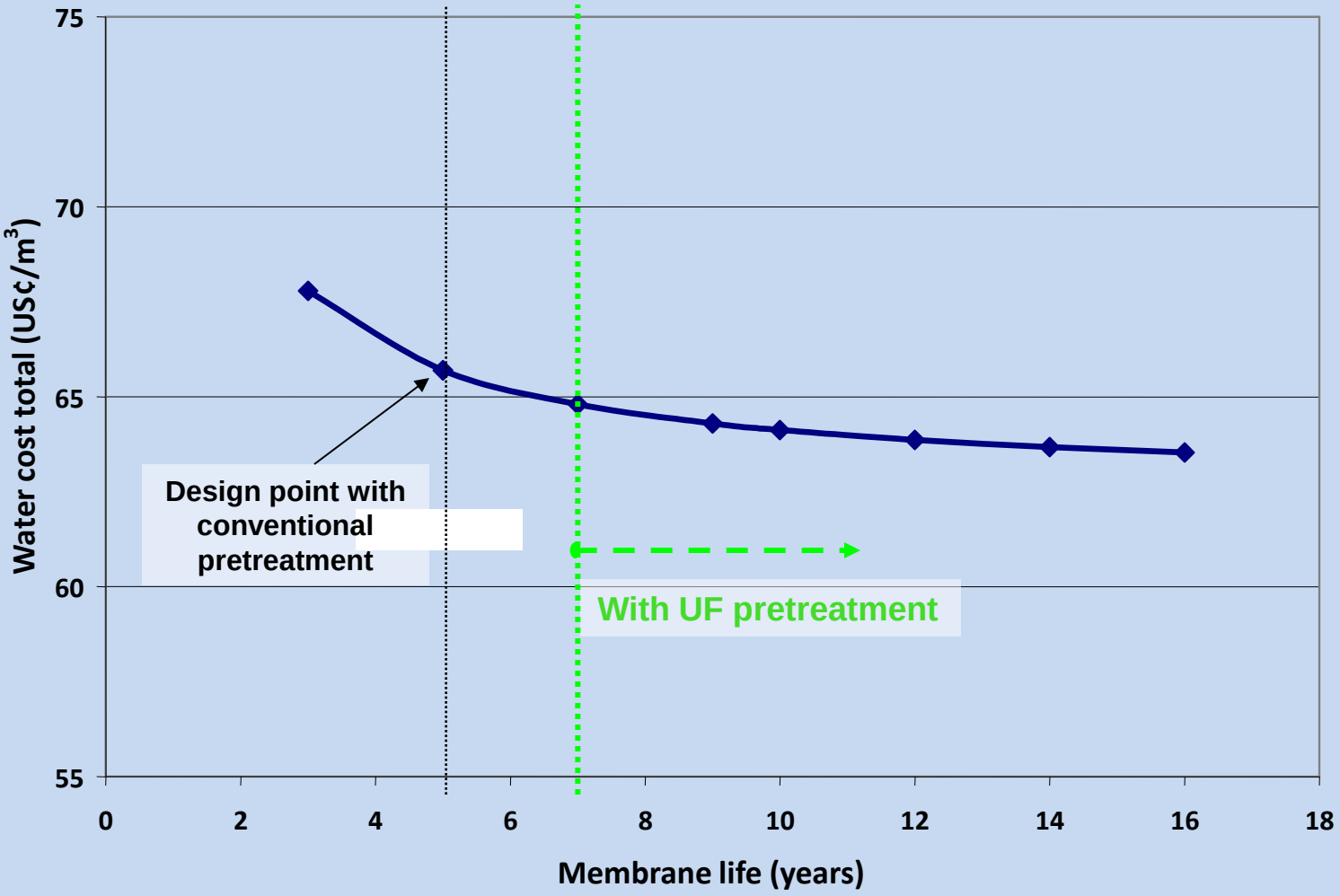
Using UF as pretreatment



UF- Impact of 1st Pass RO Recovery



Impact of RO Membrane Life on Water Cost

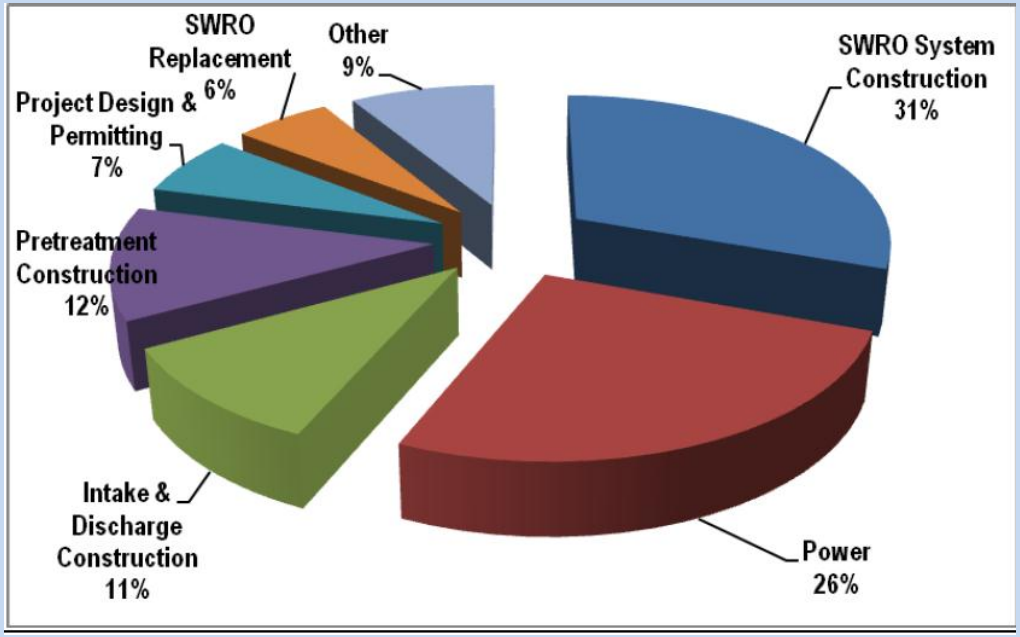


Power consumption per each Technologies

Process	Thermal Consumption Mj/m3	Equivalent Power consumption KWh/m3	power consumption KWH/m3	Total power consumption KWH/m3	Production cost $/m3
MSF	190 -282	15.83 23.5	2.5 - 5	19.58 - 27.25	0.56 - 1.75
MED	145 -230	12.2 -19.1	2.5 - 5	14.45 -21.35	0.52 -1.5
MVC	none	none	7 -12	7 -12	2 -2.6
TVC	227	14.5	1.6- 1.8	16.26	0.87 -0.9
SWRO	none	none	4-6	4-6	0.45 - 1.72
BWRO	none	none	1.5 - 2.5	1.5 - 2.5	0.26 - 1.33
ED	none	none	1.5 - 4	1.5 - 4	0.6 1.05
Solar	145 -230	12.2 19.1	2.5 - 5	14.45 - 21.35	2.4 - 2.8
Solar PV/RO	none	none	1.5 - 2.5	1.5 - 2.5	6.5 - 9.1
Solar PV/ED	none	none	1.5 - 4	1.5 - 4	10.4 -11.7
Wind /RO	none	none	1.5 - 2.5	1.5 - 2.5	1.9 - 9.0
Wind /MVC	none	none	7 -12	7-12	5.2 - 7.8

Breakdown construction Cost

	Sea water RO	Brackish water	MED	EDR	MCV	MSV
Capital cost $Im3/d	1600 -2500	600 -1800	2500 -4000	570 - 3250	2500 -3900	2100 -3400
Operation cost $/m3/d	1.8 -2.2	0.65 - 1.5	1.8 - 2.8	1.8 - 2.8	1.5 - 2.6	1.4 - 2.2
	0.65 - 0.8	0.25 - 0.6	1.2 - 1.6	1.2 - 1.6	1 - 1.3	0.9 - 1.4



Desalination Issues

1- Brine Water discharge to Sea effect on
- Coral reefs
- Oxygen
- High salt

2- Brine Water discharge to deep well effect on
- Mixing with groundwater
- Soil salts

Project


ZLD
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