Water Desalination by Solar Energy - Potential & Options in Composting Process

Solar Solution Specialist – International Leader in Solar Heating/Cooling/Desalination/Power EPC, Project Dev, and R&D

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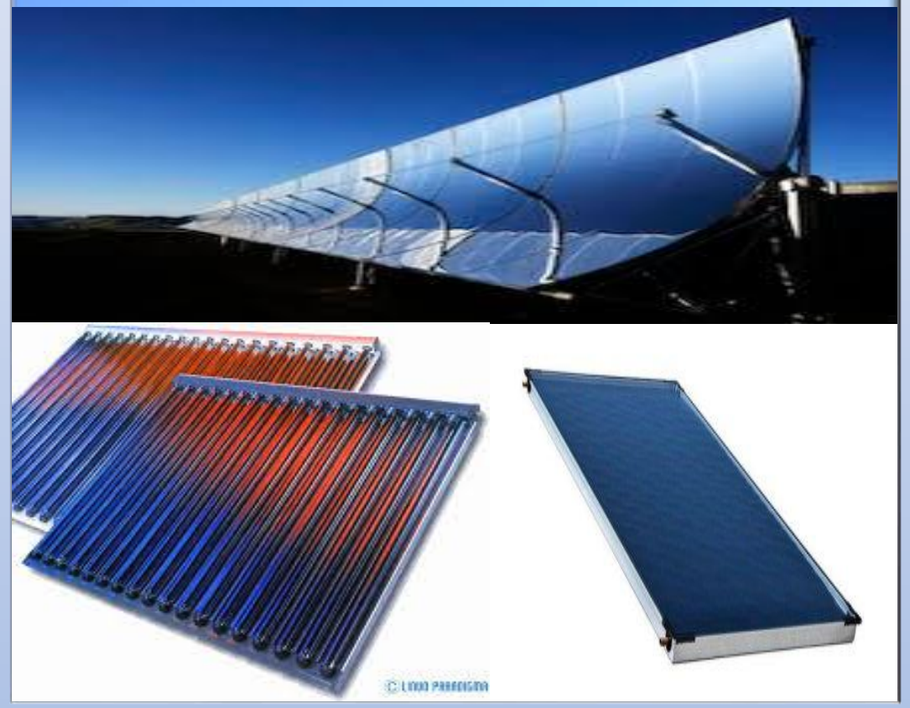
Millennium Energy Industries

Jordanian/International Company Established 2007

KSA | Palestine | UAE | Kuwait | *Qatar* | *Chile* | Jordan (HQ)

Solar Heating – Hot Water or Steam



Solar PV – Electricity

World's Largest Roof Installation at Princess Noura University – Riyadh, KSA (25 MW Capacity, 36,000m2 Collector Field + 1,000,000 Liters Storage)

3RD GLOBAL DISTRICT ENERGY CLIMATE AWARDS

SPECIAL AWARD: INTEGRATION OF RENEWABLE ENERGY

Awarded to **Princess Nora University for Women**

September 23, 2013 | New York City, NY

This is to certify that **Princess Nora University for Women** has been officially recognized by a team of international experts chaired by the International Energy Agency (IEA) Technology Network, for its outstanding achievement in demonstrating local District Energy leadership in providing clean, sustainable energy solutions to protect against the risk of climate change.

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Robert Thornton
President & CEO, IDEA

iea Energy Technology Network

Robin Wiltshire, Technical Director, BRE
Chair, IEA Implementing Agreement
on District Heating & Cooling

EUROHEAT & POWER

Frederic Hug
President, Euroheat & Power

MEI Solar Water Treatment/Desalination

- Accepted & Registered Patent Number EP1119017.
- Cost effective in comparison with current technologies.
- Production capacity scalable (from 1 -100,000 m3/day).
- Driven by waste heat , solar energy, fossil fuel heat.
- Operates at low pressure (0.8-1.1) Bar and temperature (90-125)° C within the system
- Significantly lower electrical consumption compared to other processes.
- High purity product water, high recovery ratio compared to Reverse Osmosis technology.

Cost Estimates to Produce 1 m³ of Freshwater with Low Salinity

Desalination Technology By Energy Source		Large Capacities					
		10,000 m^3/day			100,000 m^3/day		
		Capital Cost Million $ (*1,000,000)	Running Cost w/o Depreciation ($/ m^3)	Production Cost ($/$m^3$)	Capital Cost Million $ (*1,000,000)	Running Cost w/o Depreciation ($/ m^3)	Production Cost ($/$m^3$)
	RO/Conventional energy (Electricity)	7.60	1.22	1.28	85.00	0.66	0.72
Solar Energy	MED/Solar Energy	28.94	0.30	0.51	398.90	0.20	0.49
Solar Energy	MSF/ Solar Energy	41.24	0.61	0.91	478.50	0.46	0.81
Solar Energy	RO/ Solar Energy	N/A	N/A	N/A	N/A	N/A	N/A
Solar Energy	**MEI/ Solar Energy**	**40.00**	**0.15**	**0.44**	**390.00**	**0.12**	**0.41**
Waste Energy	MED/Waste Energy	9.51	0.30	0.37	98.00	0.20	0.27
Waste Energy	MSF/ Waste Energy	8.86	0.61	0.68	90.00	0.46	0.53
Waste Energy	RO/ Waste Energy	N/A	N/A	N/A	N/A	N/A	N/A
Waste Energy	**MEI/ Waste Energy**	**5.00**	**0.15**	**0.19**	**50.00**	**0.12**	**0.16**

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Composting Facilities in Jordan, Water Requirement

Irbid Composting Facility

Located at the administrative border between Ramtha and Irbid, the facility can process up to 15 metric tons of purely botanical waste daily, including fruits, vegetable waste, and tree trimmings. It receives around 5 metric tons of feedstock per day.

Karak Composting Facility

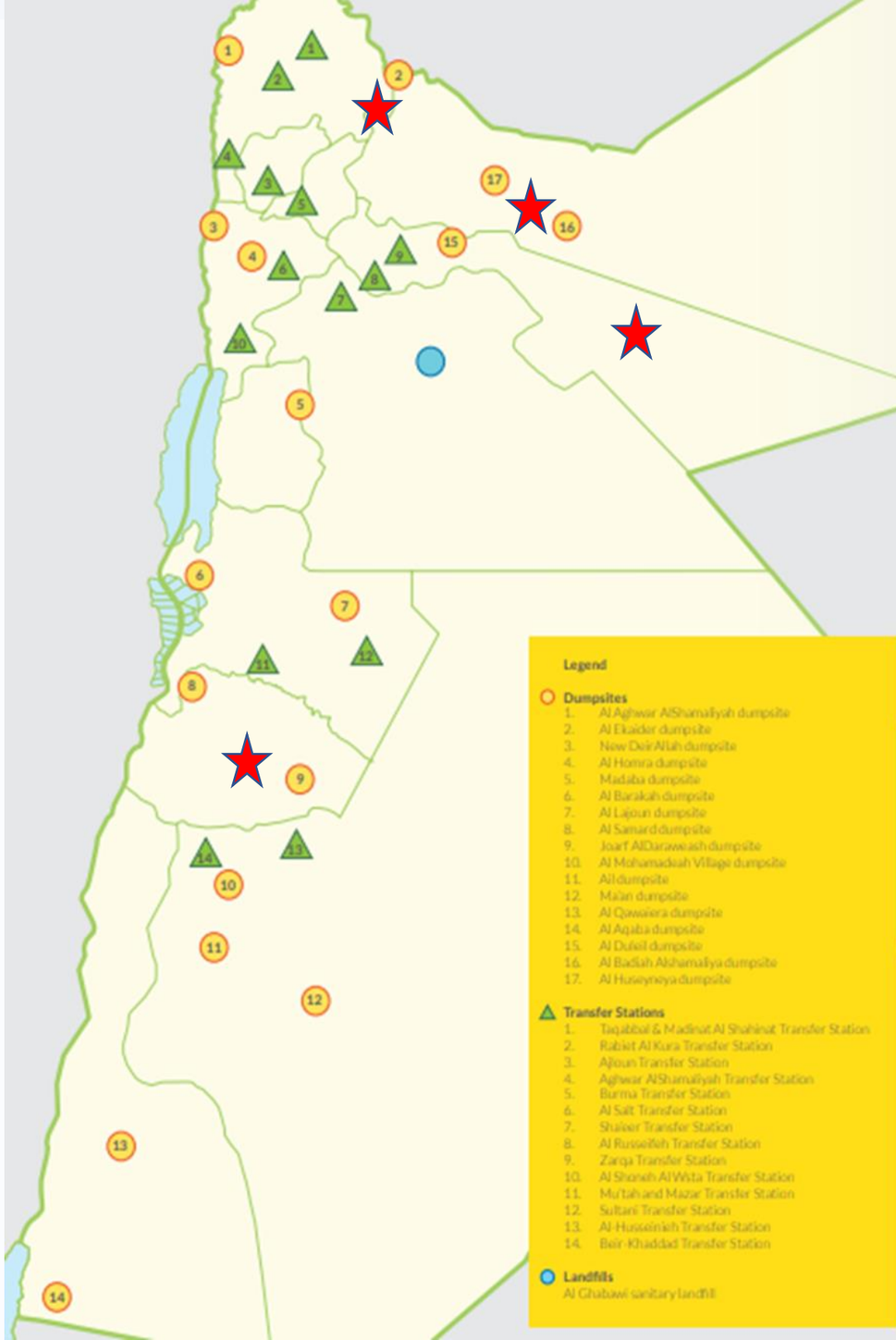
Close to the industrial city in al-Lajjoun, the facility processes up to 5 metric tons daily, mainly animal manure with some botanical waste. Daily intake is approximately 1.7 metric tons.

Al-Husaynniate Composting Facility

Situated at the Mafraq landfill, the facility processes exclusively animal manure with an operational capacity of at least 8,000 metric tons annually.

Azraq Composting Facility

Situated near Azraq city's current waste dumpsite, the facility processes mainly manure and green waste. With an annual capacity of approximately 2,000 tons of raw material, it produces 1000-1100 tons of compost.



Approximate Water Consumption for Each of the Composting Facilities in Jordan

According to various sources including a research study conducted in 2019 by Dr. SAFWAT HEMIDAT in his theses for the Doctorate Degree at Rostock University (https://rosdok.uni-rostock.de/file/rosdok_disshab_0000002181/rosdok_derivate_0000078747/Hemidat_Dissertation_2019.pdf) following may be considered:

- Each kg of feedstock (Fruits, Vegetable Waste, & Trees Trimmings) needs around 2 Lit of water

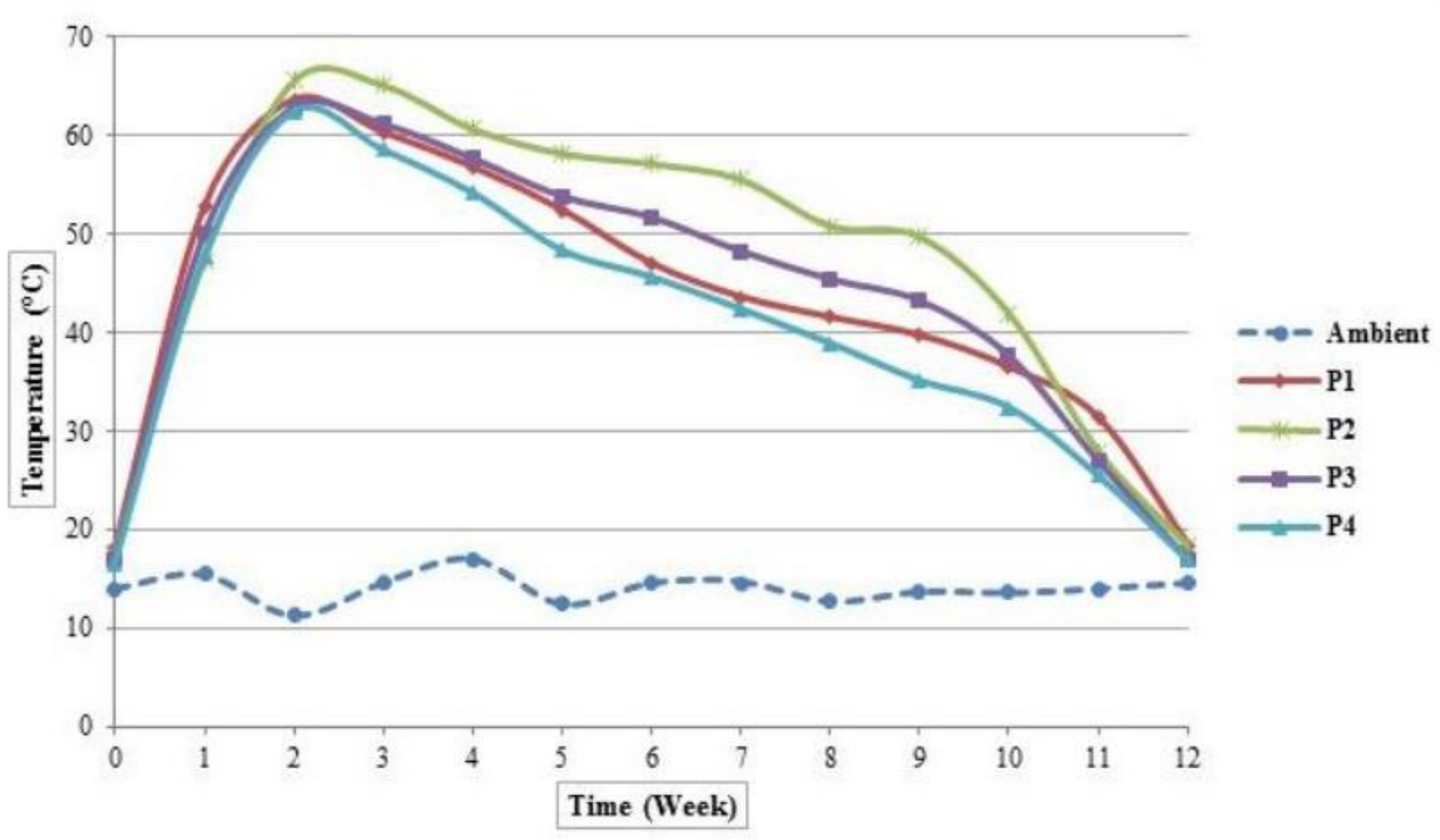
- Each kg of feedstock (animal manure) needs around 6 Lit of water.

Accordingly Each of Jordan's Composting Sites Water Requirements Would be as Follows:

Composting Facility	Processing Capacity	Approximate Water Needs M^3/ Day
Irbid Composting Facility	**15 ton/day**	**30**
Karak Composting Facility	**5 ton/day**	**10**
Al-Husaynniate Composting Facility	**8,000 ton/year**	**130**
Azraq Composting Facility	**2,000 ton/year**	**32**

Temperature Variations in Typical Piles of Feedstock During Composting Process

Typical composting temperature trend, achieving thermophilic temperatures of more than 55°C, reaching approx. 68°C within 2 weeks and remaining above 50°C from week 4 to week 6, before dropping further.



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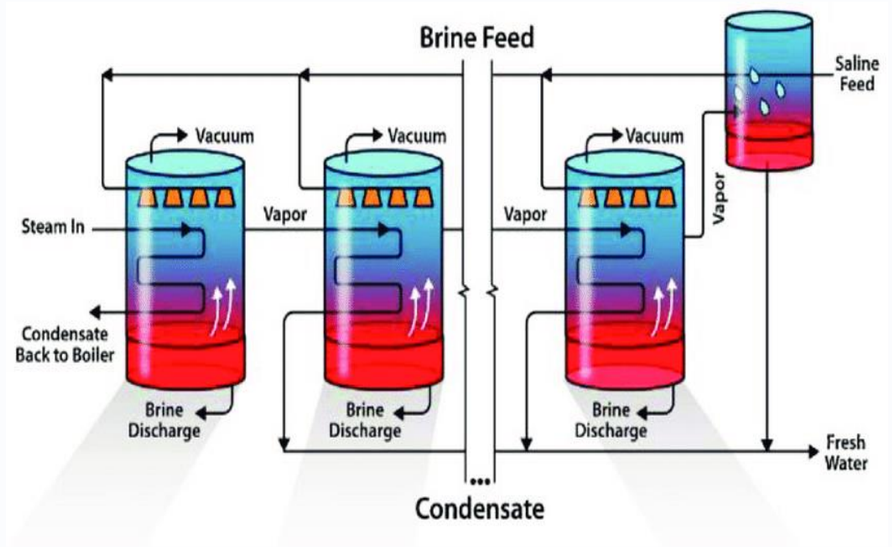
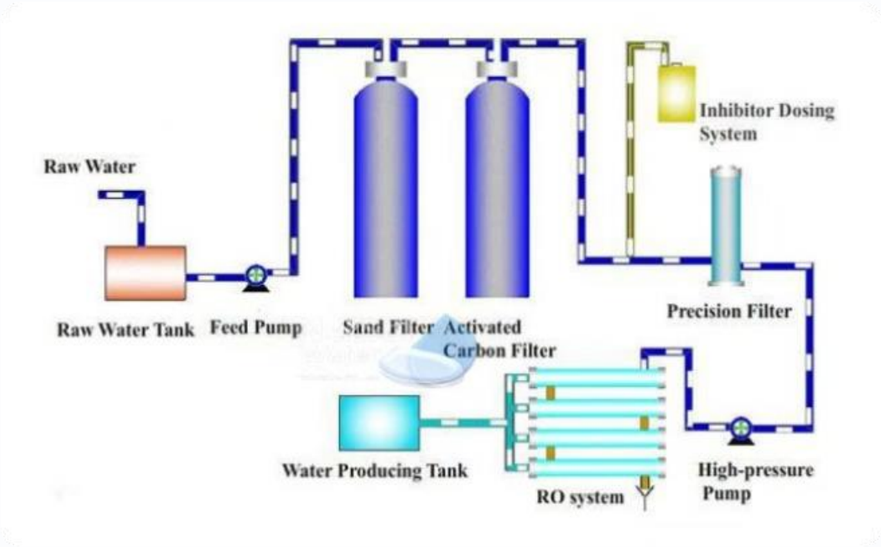
Overview of Main Methods Used in Desalination Technologies



Multiple Effect Desalination (Thermally Driven)

efficiently desalinates Sea/Brackish/Well water, through successive stages of evaporation and condensation, recycling heat for energy efficiency.



Reverse Osmosis (Electrically Driven)

Reverse osmosis desalination purifies Sea/brackish water by pushing it through a membrane under high pressure, separating salt and impurities to provide clean water for various purposes.

Reverse Osmosis Desalination Option Energy Consumption & Production Capacities

DATA SHEET — BRACKISH WATER REVERSE OSMOSIS SYSTEM

Technical Specifications

Product water flow rate*	21 m³/h (5550 gal/h)
Product water quality*	TDS < 50 mg/L, pH 7
Raw water feed flow rate	36,2 m³/h (9560 gal/h)
Recovery rate*	58%
Minimum salt rejection	99,5%
Brine flow rate*	15,2 m³/h (4010 gal/h)
Brine quality*	TDS 4860 mg/L
System pressure	9 bar
High-pressure pump (HPP)	AISI 316L centrifugal multi-stage or equivalent
HPP motor	15 kW, Bevi
Raw water feed pump**	7,5 kW, AISI 316L
Pressure vessels	6 x 80120, Composite
RO Membranes	18 x 8040 BW30HRLE-440
Cartridge pre-filtration**	High-flow cartridge 25, 3 micron
Variable frequency drive (VFD) [HPP]	Vacon 100X, 15kW, Danfoss
Specific energy***	0,55 kWh/m³
Recommended minimum of PV panels***	50 x 360 Wp
DC power supply requirement (solar PV)	600 - 800 VDC
AC power supply requirement (grid)	380 - 480 VAC / 50 - 60 Hz

** Test Conditions: Brackish water TDS 2000 mg/l, pH 7-8, T 25°C, system pressure 9 bar*
*** Raw water pump model and characteristics subject to change depending on site-specific requirements*
**** Raw water feed pump not included*
Specifications and system design are subject to change without prior notice.

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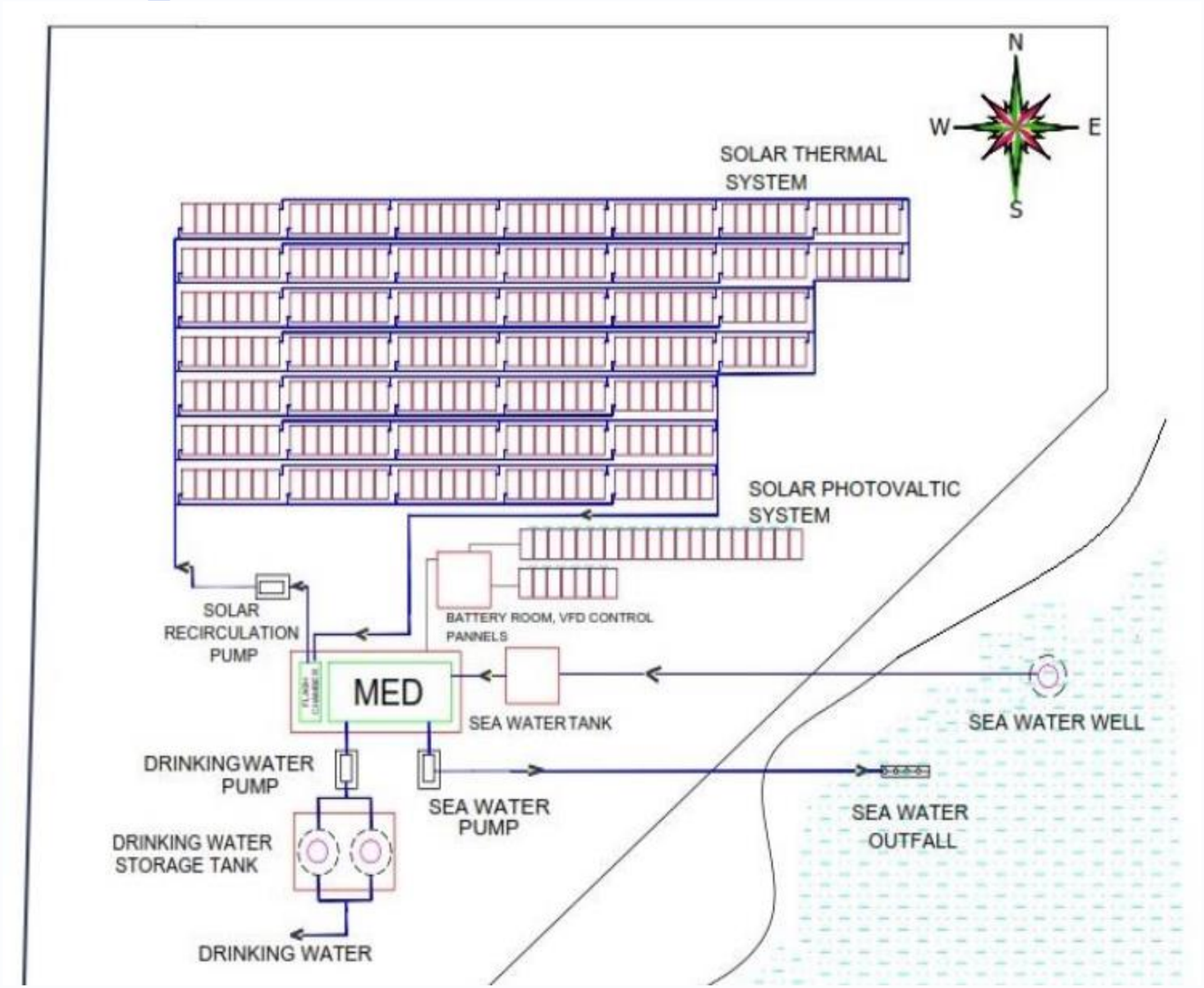
Multiple Effect Desalination Plant Layout



RO & MED cost of production water (US$/m³)

#	Aspect	RO	MED	Municipal
	Water quantity = 10m³/ day			
1	Initial cost (US$)	119,000	202,000	-
2	Energy use desalination (kWh/m³)	2.7	4	-
3	Solar energy (kW)	11 (PV panels)	240 (ST collectors)	-
4	Required Area (m²)	50	600	-
5	Water production (m³/ day)	10	10	10
6	Feed water TDS (ppm)	3,000-40,000	35,000-45,000	-
7	System life expediency (year)	15	25	-
8	Cost of water ($/m3)	2.17	2.21	0.71
	Water quantity = 50m³ /day			
1	Initial cost ($)	386,000	750,000	-
2	Energy use desalination (kWh/m³)	2.7	4	-
3	Solar energy (kW)	46.3 (PV panels)	1,320 (ST collectors)	-
4	Required Area (m²)	250	3,300	-
5	Water production (m³/ day)	50	50	50
6	Feed water TDS (ppm)	3,000-40,000	35,000-45,000	-
7	System life expediency (year)	15	25	-
8	Cost of water ($/m3)	1.41	1.64	3.1

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Thank You

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