Webinar on “Desalination & Renewable Energy”

7th June 2021

Desalination & Renewables perspectives in Morocco

Dr. Jauad El Kharraz
Senior Water-Energy-Climate Expert, Morocco

European Desalination Society Board Member
International Desalination Association (IDA) R&D Committee Member

Outline

- Water infrastructure in Morocco
- Desalination technologies adopted
- Desalination projects in Morocco
- Renewable desalination
- Solar desalination
- Conclusions

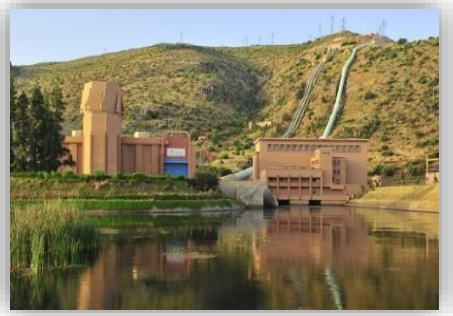
Main Water Infrastructure in Morocco

14
Desalination and demineralization plants
155 000 m^3/d capacity

30
Hydroelectric factories
1770 MW of installed capacity

144 *(With emissaries at sea)*
Domestic wastewater treatment plants (STEP)

43 **(completed or in progress)**
Reuse projects (REUE)

159 *(14: on-going)*
grands barrages
21.3 Billion m3 Capacity

125
Small dams
(Hill lakes not included)
100 Millions m3 of capacity

>300
Flood protection operations

Source: Dr. Siham Laraichi

12 123 km
linear drinking water supply

12 510 km
networks, canals and pipes

1 244 km
large adductors
346 m^3/s Capacity

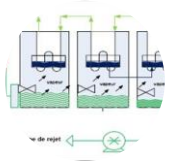


Desalination technology choice in Morocco

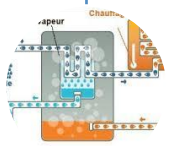
Desalination Technologies

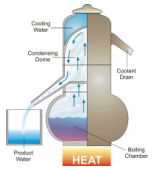
Thermal technologies

Membrane technologies



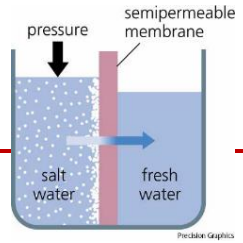
Freezing

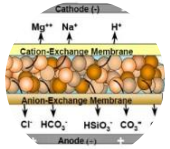




Distillation

Reverse Osmosis (RO)

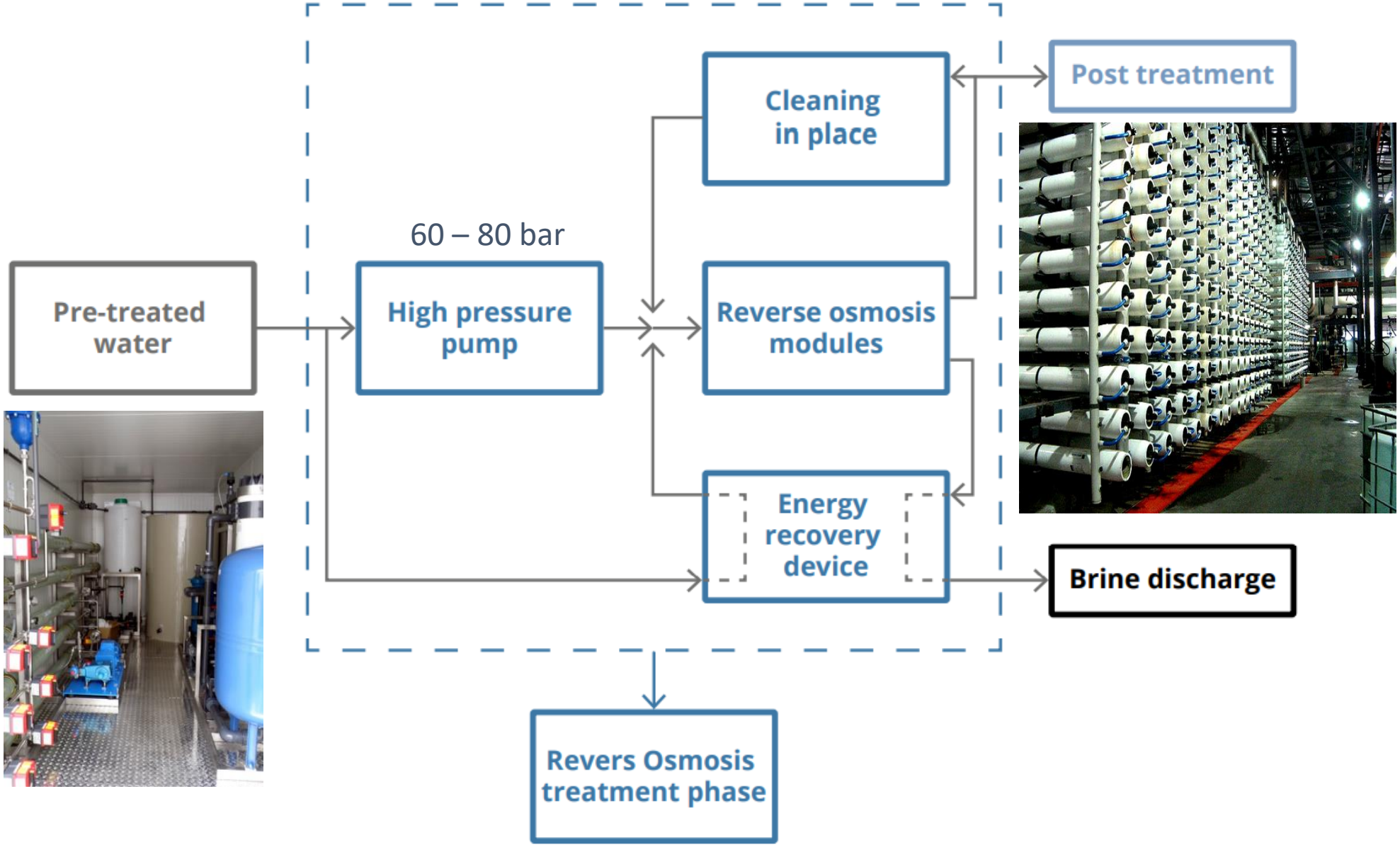




Electrodialysis

- Competitive implementation cost.
- Technology Adapted to the type of energy in Morocco
- Low specific energy consumption.
- Proven and most developed technology in recent years internationally.

RO Technology



Big PPP projects in Morocco

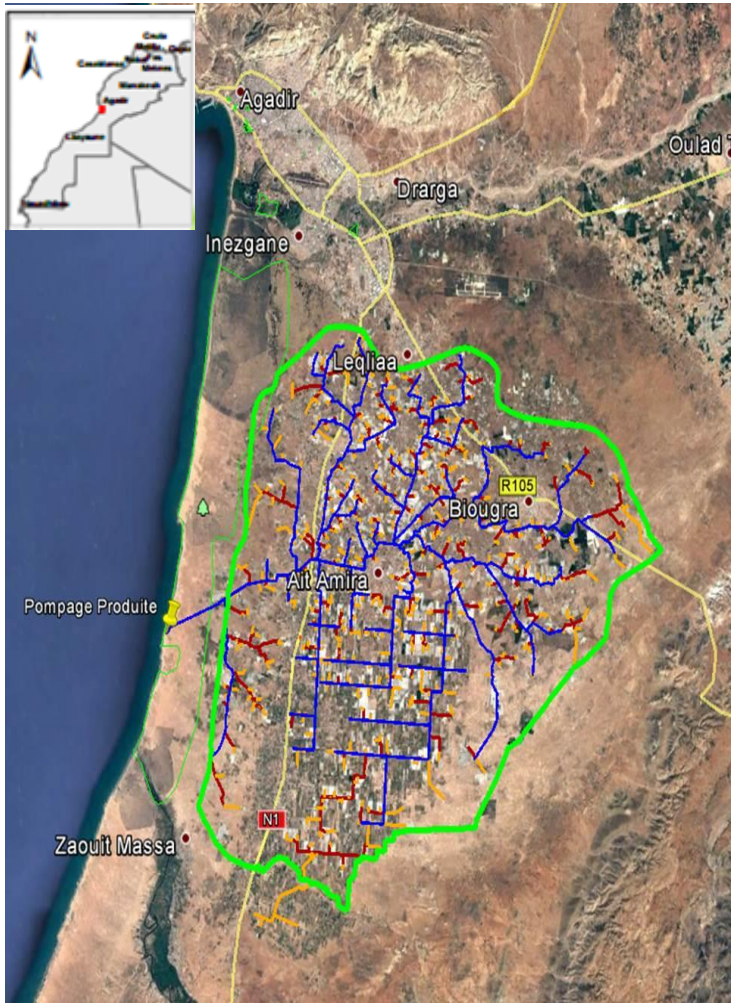
- Chtouka Desalination Plant: Drinking water supply and irrigation

Project Objectives:

- Secure the water supply to the Chtouka area by providing desalinated water as an alternative to withdrawals from the aquifer;
- Maintain agricultural activity in the area, including export crops with high added value;
- Requesting private sector expertise through the implementation of a Public-Private Partnership (PPP).

General data:

- Agriculture (1500 holdings: 15 000 hectares irrigated).
- Dinking water supply to Grand Agadir
- Initial capacity to be installed: 275,000 m3/d (including 125,000 m3/d of agricultural water & 150,000): Commercial operation later this year.
- Long-term capacity: 400,000 m3/d
- Treatment method:
  - Pre-treatment: Ultrafiltration.
  - Desalination: Reverse Osmosis.

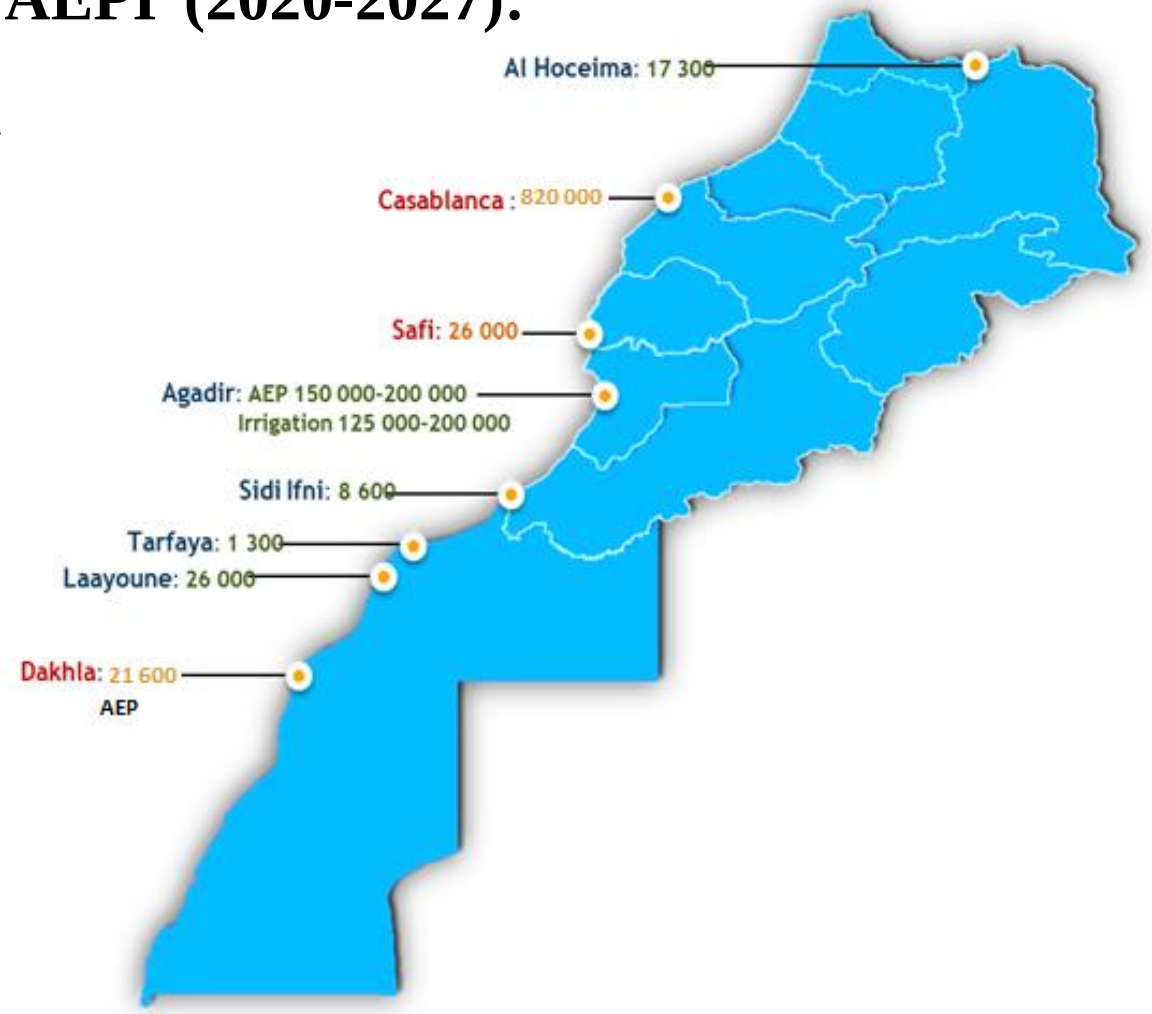


Source: Dr. Siham Laraichi

Seawater desalination: Opportunities of investment & partnership

5 Desalination plants are planned under the National Programme for Drinking Water Supply and Irrigation PNAEPI (2020-2027): Casablanca, Safi, Dakhla, Tarfaya, and Sidi Ifni

Cost: 13, 7 Billion DH ~ 1.6 Billion Euro



Source: Dr. Siham Laraichi

Seawater desalination: Opportunities of investment & partnership

Seawater desalination project for the Greater Casablanca (Drinking Water Supply)

Objective: Supplying drinking water to the Greater Casablanca
Capacity: 300 Million M3/year
Cost: 10 Billion DH (9.20 Billion Euro)

Study in progress:

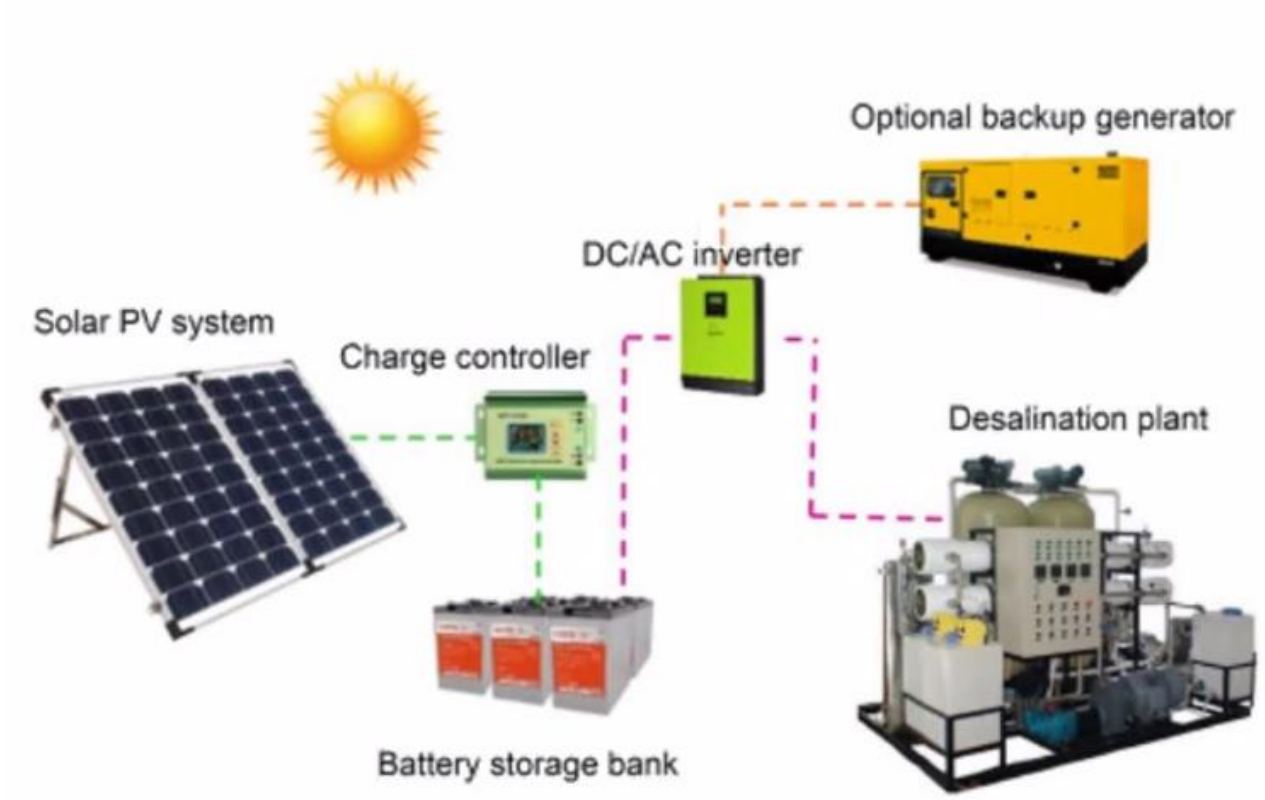
- Technical study
- Environmental Impact Assessment
- Preliminary assessment study for PPP implementation

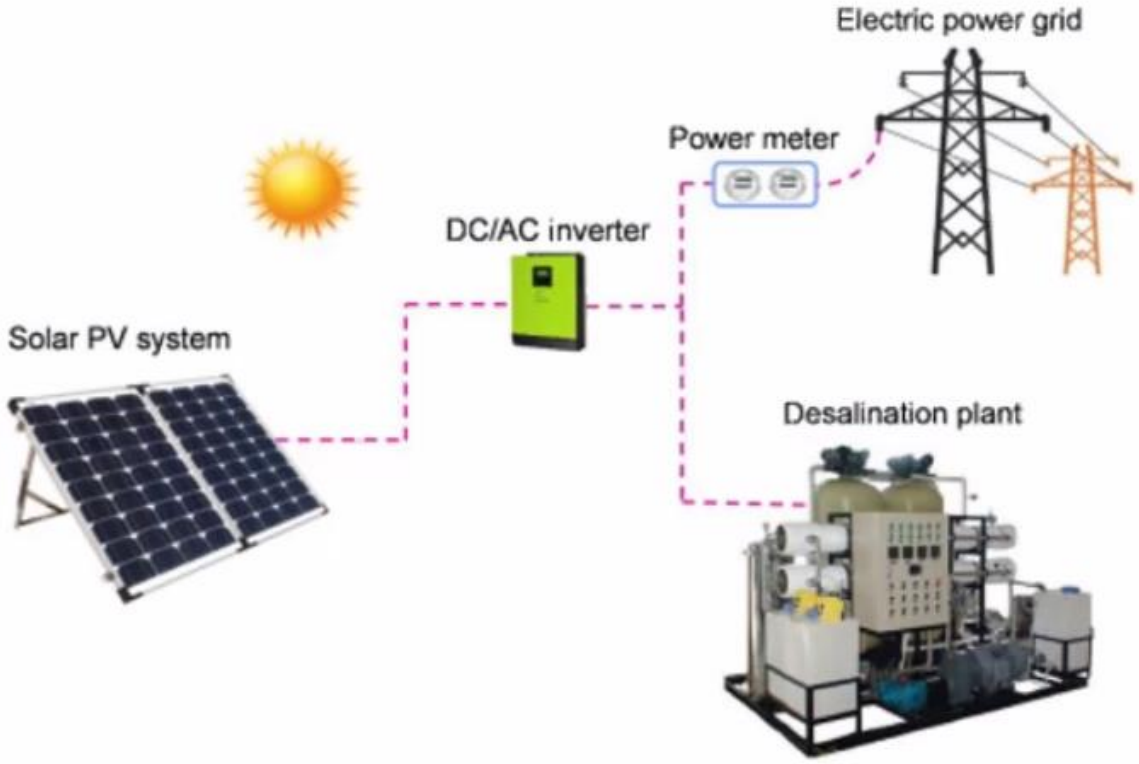
Source: Dr. Siham Laraichi

Renewable Desalination

The main challenge of Renewable Energy Desalination is that Desalination technologies generally work in **steady-state conditions** but Renewable Energy sources are usually **non-stationary**.

→ **Renewable energy generation needs adjustments for continuous supply (energy storage)**
→ **Desalination technologies can adapt to variable operation**





Photovoltaic Solar Energy Conversion. Technologies, Applications and Environmental Impacts. Chapter 8 - Applications of solar PV systems in desalination technologies, S. Gorjian et altres. 2020, Pages 237-274.

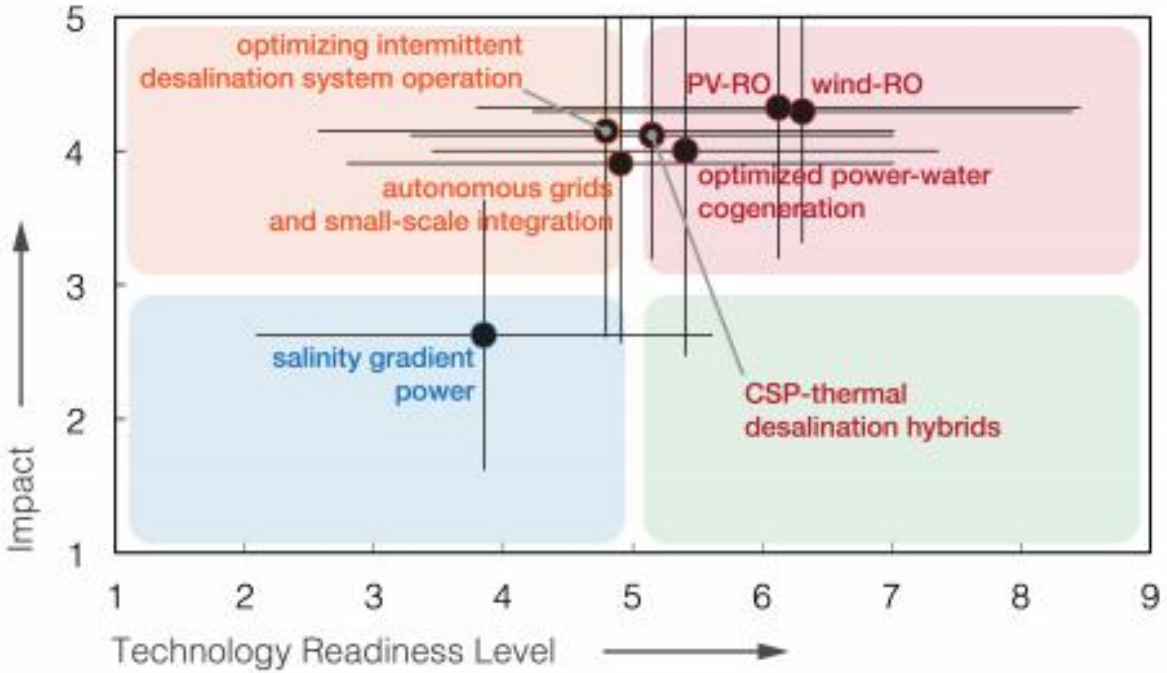
Renewable Desalination

GHG Impact vs TRL for Several Low Carbon Desalination Systems

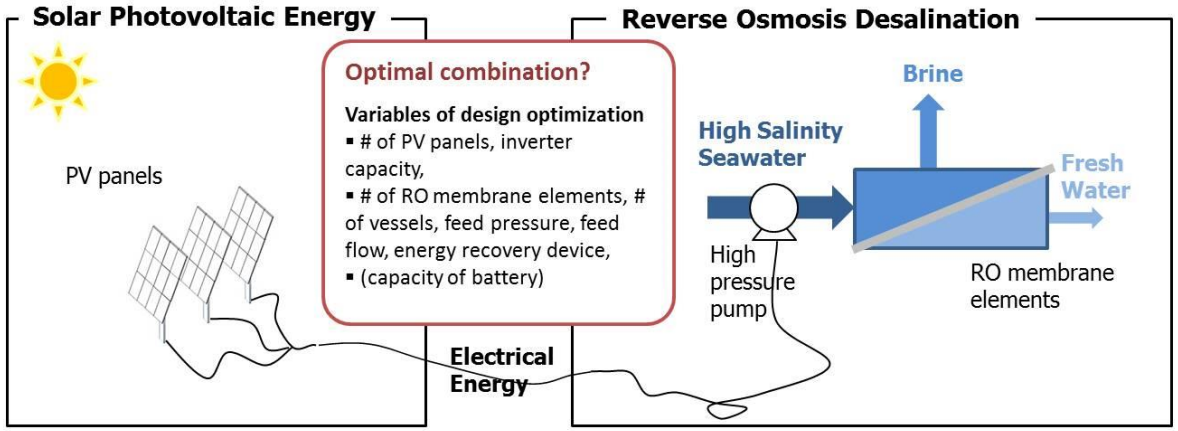
4 areas were ranked high Technology Readiness Level (TRL), high impact:

1. PV-RO,
2. Wind-RO,
3. CSP-thermal desalination hybrids, and
4. Optimized power-water cogeneration.

Indirectly coupled arrangements or PV- and wind- RO were viewed as higher TRL than directly coupled arrangements.

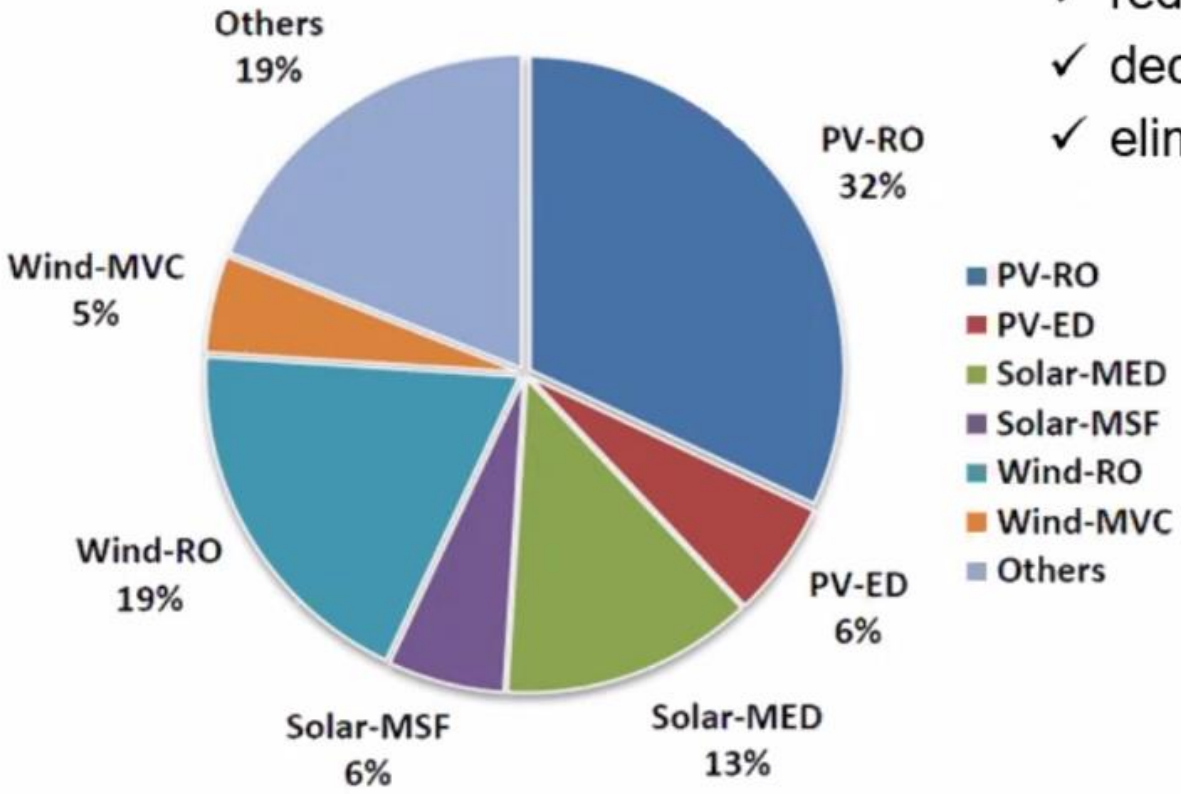


Source: Abdul Latif Jameel World Water and Food Security Lab, MIT



Solar Desalination

- The use of RO desalination has grown in response to water scarcity. Despite steady improvements in energy efficiency, RO desalination remains an energy-intensive process.
- Renewable energy is an attractive solution to:
  - ✓ reduce RO plants' carbon footprint,
  - ✓ decrease their running costs,
  - ✓ eliminate the link between water prices and fuel costs.



- ❖ Numerous studies focused on using solar PV energy to drive RO plants on a small scale.
- ❖ About 32% of autonomous desalination systems are based on PV powered RO units. Both PV solar energy and RO are mature technologies with wide commercial network of manufacturers and suppliers.

Renewable and Sustainable Energy Reviews. Volume 112, September 2019.

Solar Desalination in Morocco

Autonomous Desalination System Concepts for Sea Water and Brackish Water in Rural Areas with Renewable Energies – ADIRA

Raw water is brackish water from inland wells (salinity 2.5 – 8.7 g/l).

5 m³ freshwater per day: Sufficient
for 100 people→ Covering food & sanitation
Site parameters:
-Water production capacity of 1 m³/h
-Energy consumption: 4 kWh / m³
-PV capacity: 8 kWp
→Capital cost: 70.000 Euro
→Cost of water: 3 – 6 Euro / m³

RO unit (1 m³/h).

PV field (4 kWp).

Solar Desalination in Morocco

DESSOL® systems in Morocco

Characteristics of the Moroccan villages

Drinking water supply was by tankers and rain water accumulation in underground tanks. Economical activities agriculture and cattle farming.

Village	Azla	Tazekra	Amellou	Tangarfa
Situation	Essaouira		Tiznit	
Population supplied	200	200	200	100
Electric grid	Weak	Weak	No	Weak

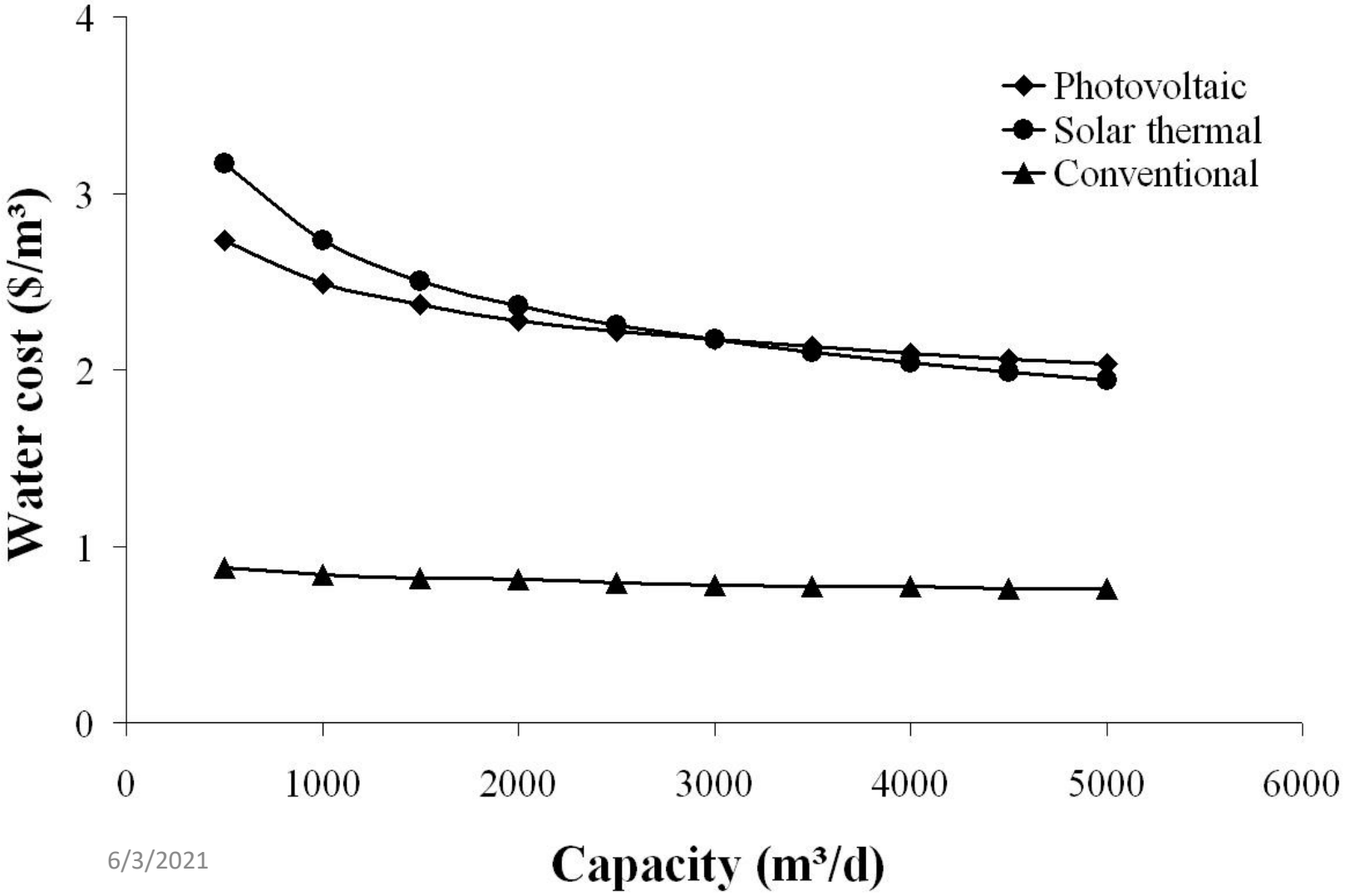
In all four cases fresh water is stored in an elevated tank and distributed by gravity to a near fountain, and brine flow is disposed in evaporation ponds (area 100 m^2).

Feed water salinity [g/L]	2.4	8.2	2.9	2.9
Fresh water flow [m^3/h]	1	1	1	0.5
PV installed power [kWp]	4	4	4	2.5
Number of PV modules	32	32	32	20
PV surface [m^2]	33	33	33	19

Source: JA. De La Fuente, ITC

Solar vs Conventional Desalination Costs

For each analyzed option the trend of the production cost, when the capacity varies between 500 & 5.000 m³/d:



Conclusions (1/2)

- **Desalination** on a larger scale has environmental and energy implications (**brine, GHG emissions, energy security**)…**should be sustainable**.
- **Renewable energy (e.g., PV, CSP) is possible**, making it a feasible energy
- Arab countries are on the cutting edge of innovation in **combined use of desal & RE**
- Advantages of PV become decisive for **stand-alone configurations and smaller sized systems (approx. 1000 m3/day).** In addition, ground requirements are less than half with better expectations of cost reduction.
- PV is often combined with RO. As electricity storage is still a challenge, combining power generation & water desal can also be **a cost effective option for electricity storage** when generation exceeds demand.

Conclusions (2/2)

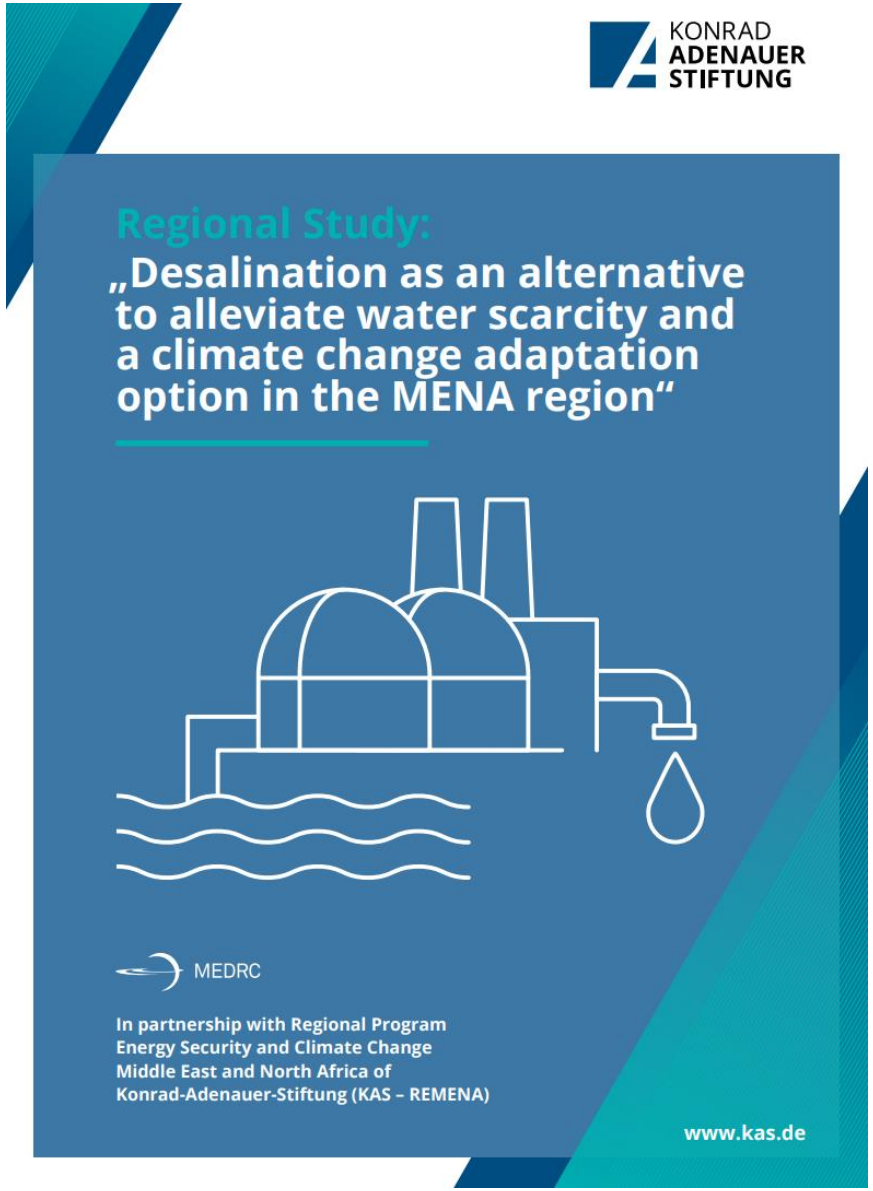
Solar desalination is a good example of **the water-energy-food nexus implementation** if combined with food production through greenhouses practices and other similar projects. Solar desalination is called to contribute significantly to SDG2 (food security), SDG6 (water), SDG7 (energy) & SDG13 (climate action).

Morocco has finalized the implementation of the roadmap (2021-2030) related to hydrogen, biomass & natural gas, and it is looking at marine energy and geothermal energy as well. Those renewable sources could also be considered for eventual renewable desalination projects in Morocco in the future (incl. **Offshore desalination solutions using wave energy**, etc.)

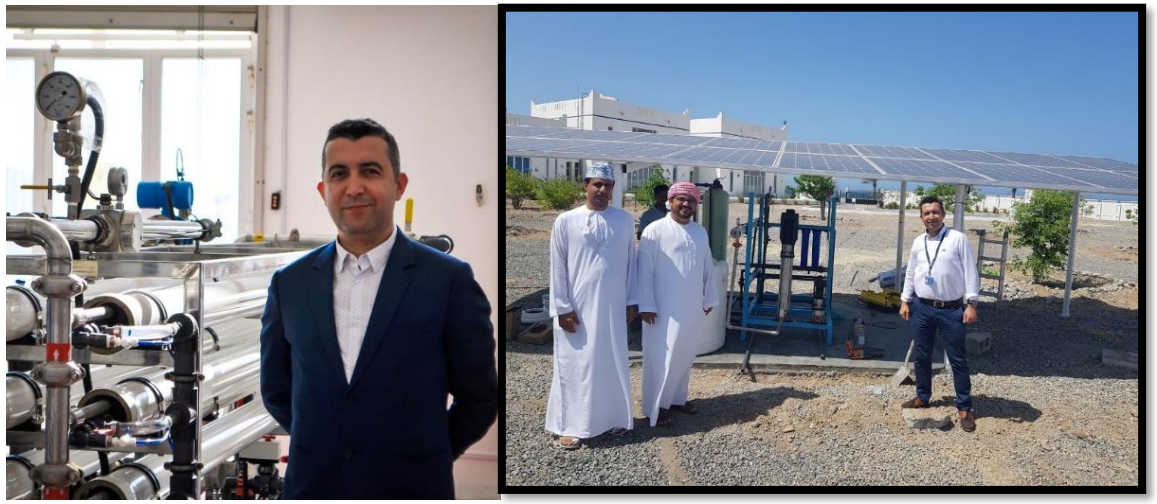
PPP (e.g. BOT) and other innovative financial mechanisms to support the sustainability of desalination schemes, will likely be required. Innovation should be encouraged in desal projects in the region (e.g. Agadir Desal Plant, Morocco)

Countries relying on desalination need **to localise knowledge and technology**.

Available online at: https://www.kas.de/documents/264147/264196/kas_remena_studie_meerwasserentsalzung_web.pdf



Thank You



Author: Dr. Jauad El Kharraz
jauad.elkharraz@gmail.com