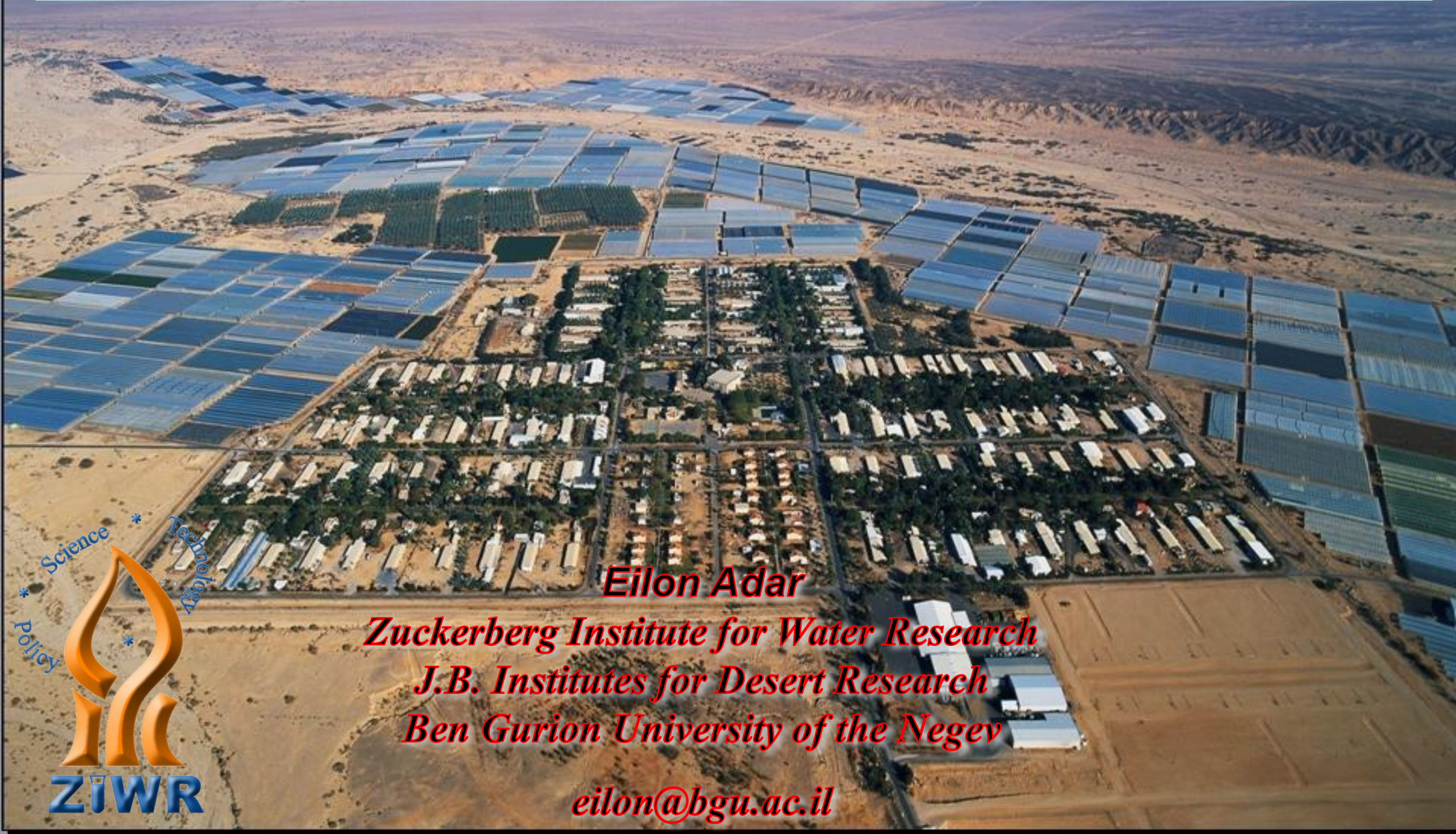
Overcoming Water Scarcity Sustainable Water Supply (Quality & Quantity) in Dry Regions – The Israeli Experience



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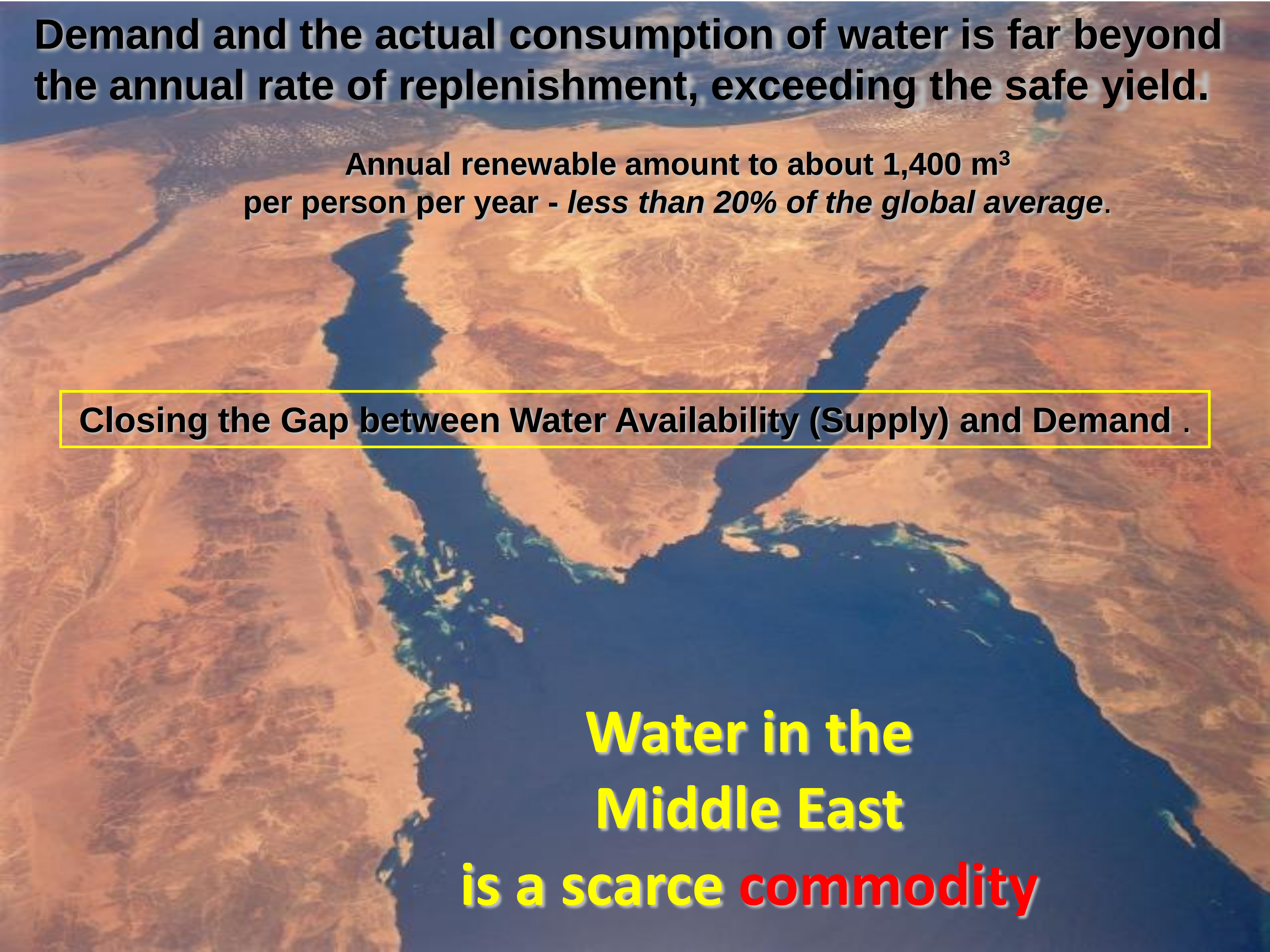
ZIWR

Science * Technology * Policy *



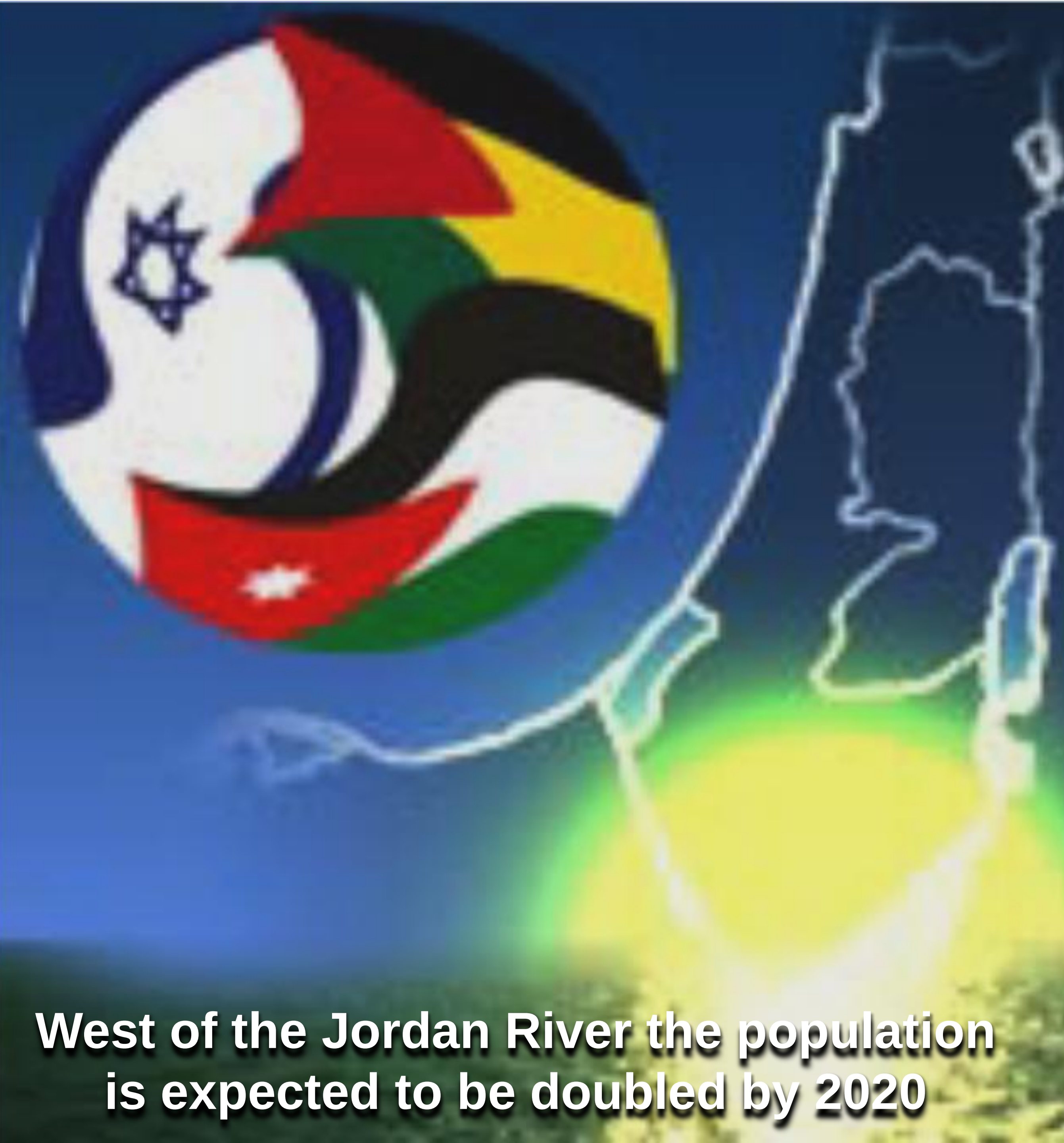
Demand and the actual consumption of water is far beyond the annual rate of replenishment, exceeding the safe yield.

Annual renewable amount to about 1,400 m^3
per person per year - *less than 20% of the global average*.

Closing the Gap between Water Availability (Supply) and Demand .

Water in the Middle East is a scarce commodity

All major water resources in the region are transboundary – Cross-Borders Water Resources



West of the Jordan River the population is expected to be doubled by 2020

The Goal: Bridging Over Water Shortage

Securing Sufficient & Adequate Water Supply by implementing novel water innovations and technologies

1. Improving Water utilization efficiency:
irrigation & water application; water reuse; water management: supply and quality

Simultaneously performed !

2. New Water: Reclaimed treated sewage
&
Seawater and groundwater desalination

National Water Distribution: Water transfer from wet to arid regions

Agriculture: past and present

1958

1963-1975

1985-2010

Protected cultivation
Net houses & Green Houses

- **Elevating Water Use Efficiency:**
- **Eliminate soil water evaporation.**

- **Drip & sub-surface drip irrigation; Pulse-response irrigation**
- **Sequential use of water.**

Technologies for water saving:
Drip Irrigation over sandy soil

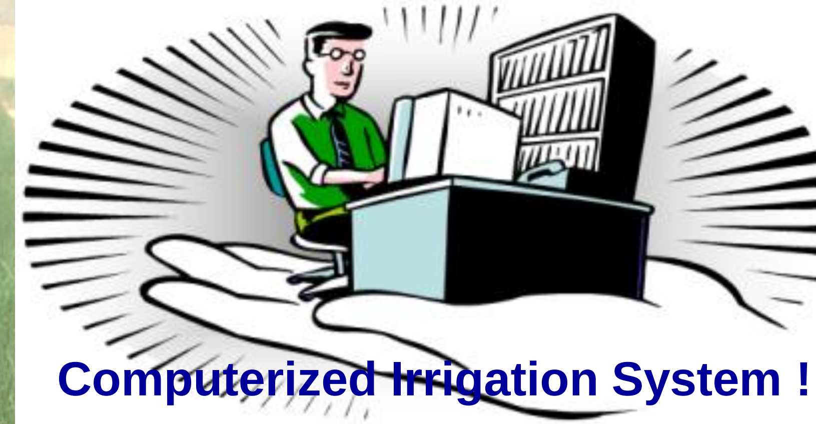
Avoid deep percolation from irrigation surplus

Avoiding soil water evaporation and top soil salinity

Water use efficiency on the farm scale

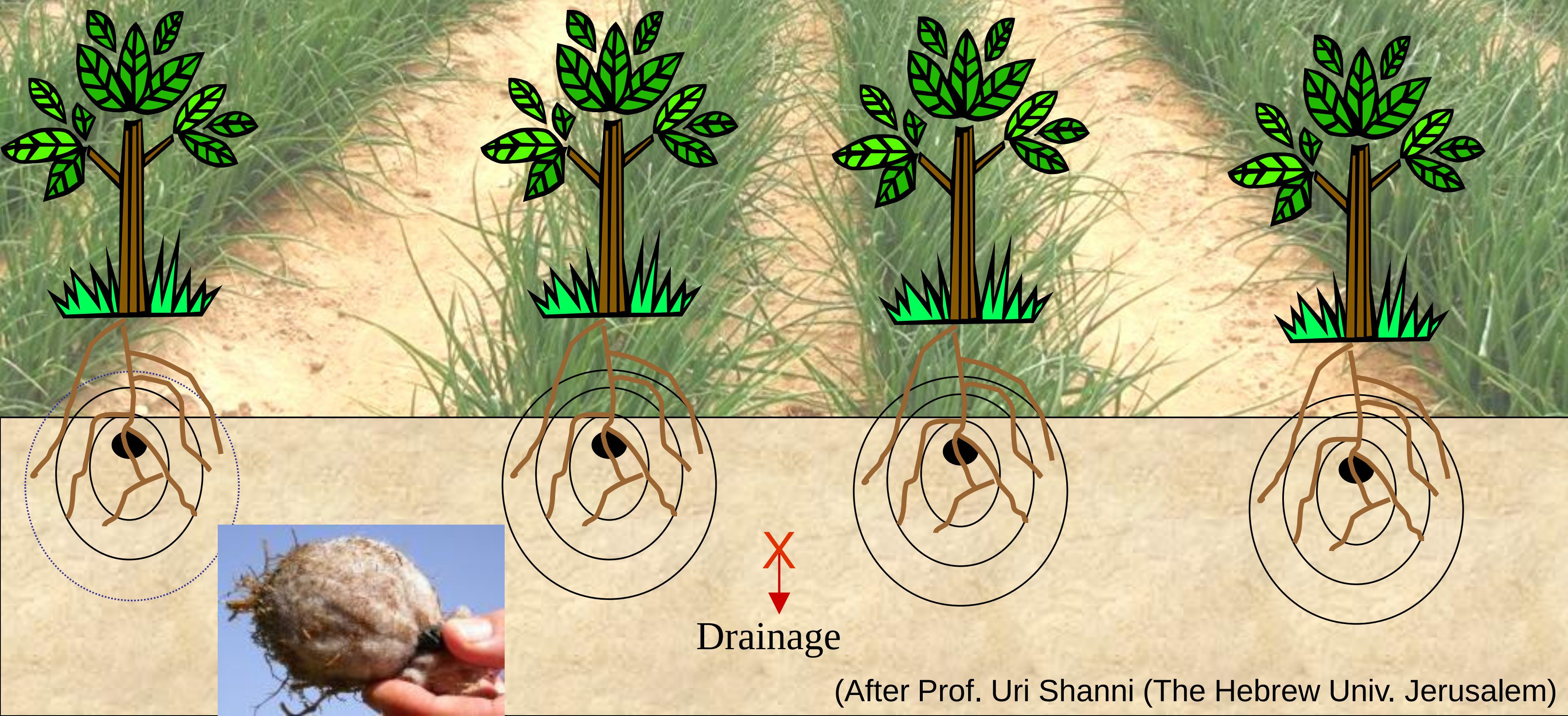
Responsive Irrigation

Soil Moisture detectors
Solar Radiation Sensors
Soil and Air Temperature
Rate of transpiration



Transpiration

88-90% irrigation efficiency in open fields!



Drainage

(After Prof. Uri Shanni (The Hebrew Univ. Jerusalem)

Irrigation control

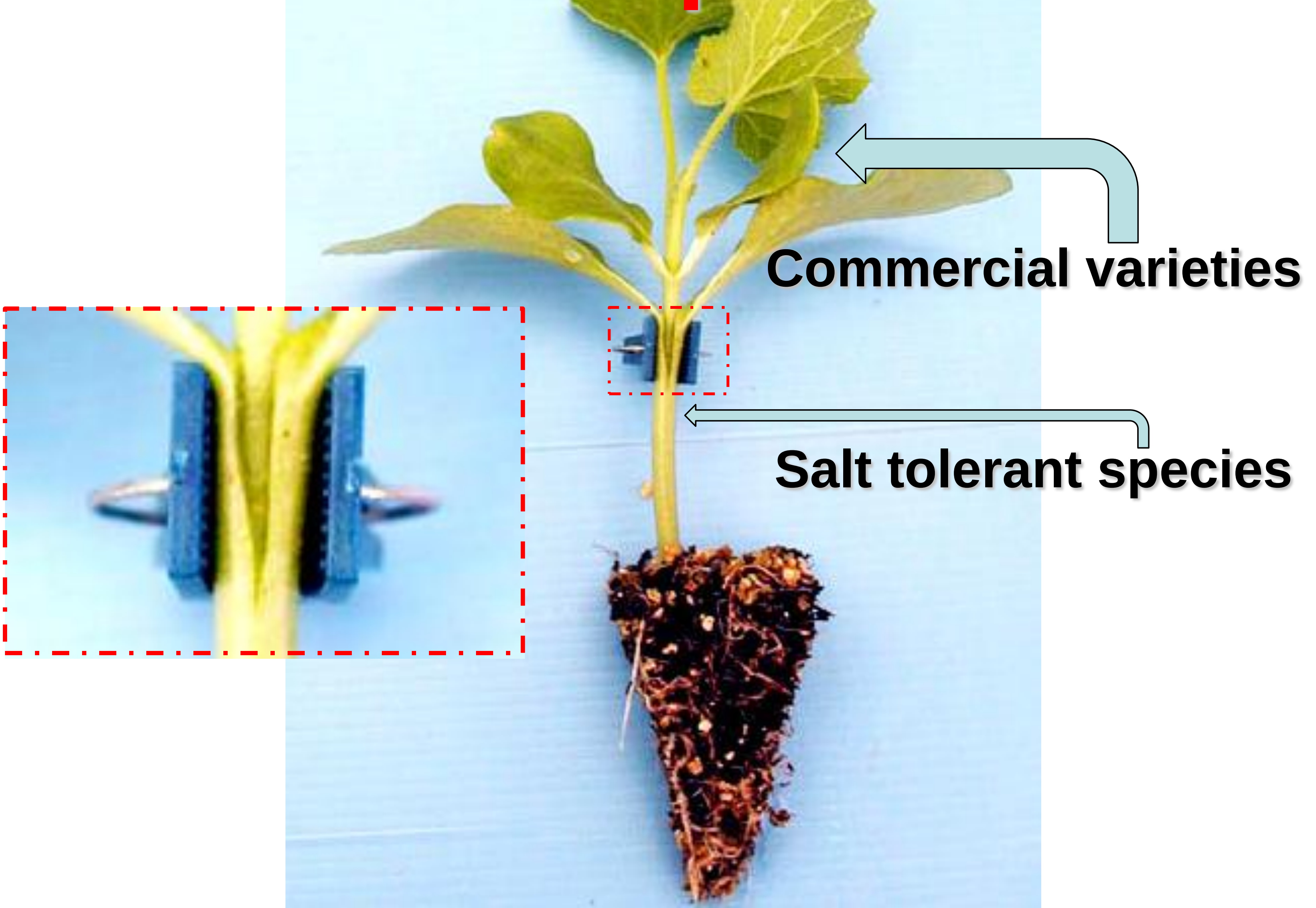
Developing plant species that can tolerate relatively wide range of water & soil quality under variable micro-climate conditions


Salt resisting shoots grafted with Merlot

New Mango plantation on sandy salty soil in the Arava Valley.

Olive plantation in the Southern Arava Valley

Grafted plants



Grafted red pepper

Tomato variety diversity

BGU Grafted Melons

Tolerate Salty Water

Mini Watermelon

Tolerate Salty Water

Oceanic Fish Species in Desert Fish Farms

Aqua-Culture Farms:
Warm-hot saline groundwater for aqua culture

The Effluent is not a Waste !

Multiple End Users: Using effluents from the fish ponds for irrigation of olive & Jojoba plantations

Olive Plantation - End User 2


Negev Olive Oil

Ornamental Fish Farms

End User 1

End User 2

Lilies flowers over the ammonia treatment lagoons

Dates Plantation

End User 3

New End Users with High Cash Crops

Algae Farm utilizing salty groundwater with grace of desert sun

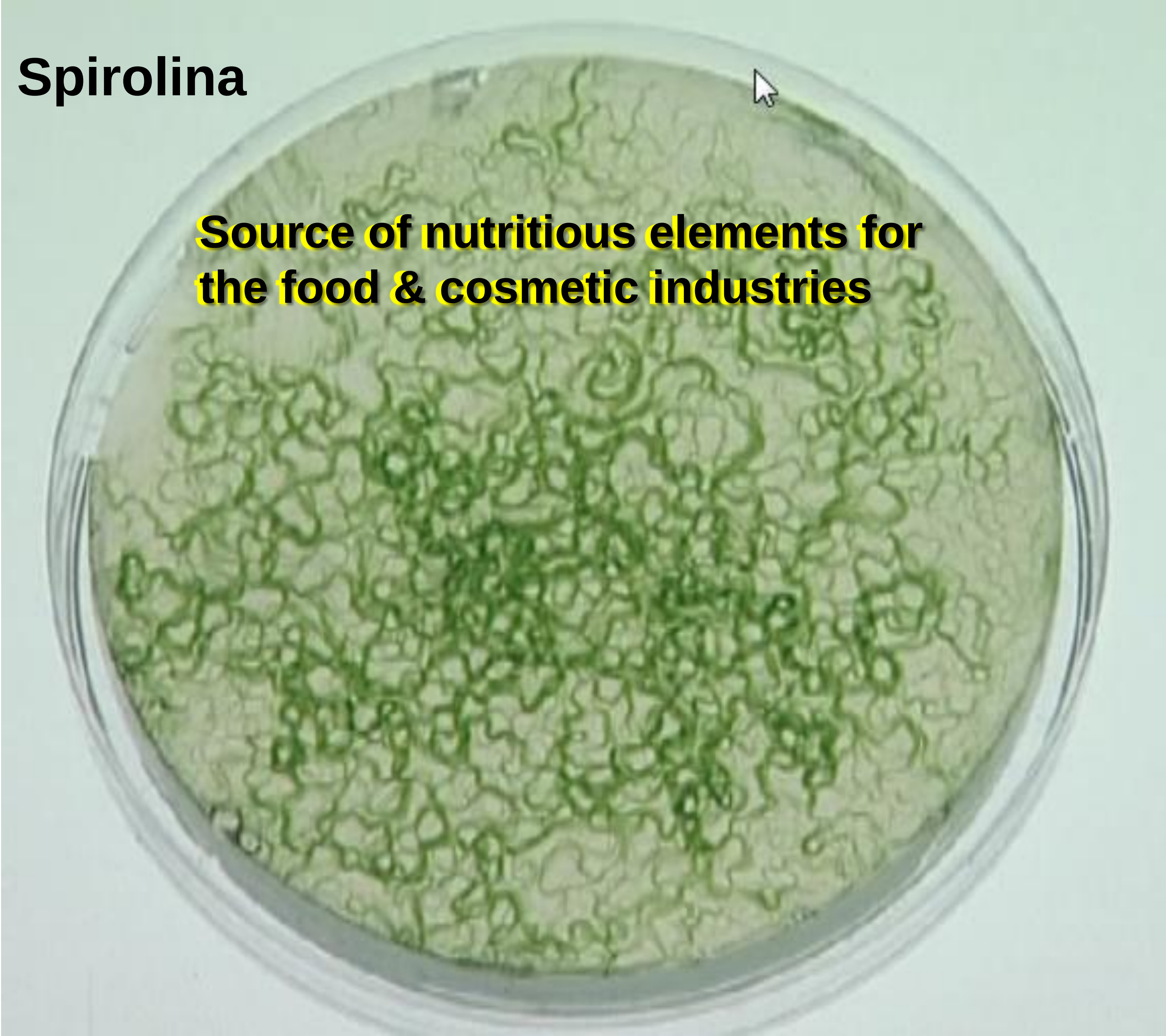
Green Algae – Pink Salmon

Hematococus Fluvialis: Stage A-Green Algae

Hematococus Fluvialis: Stage B-Red Algae

Spirolina

Source of nutritious elements for the food & cosmetic industries



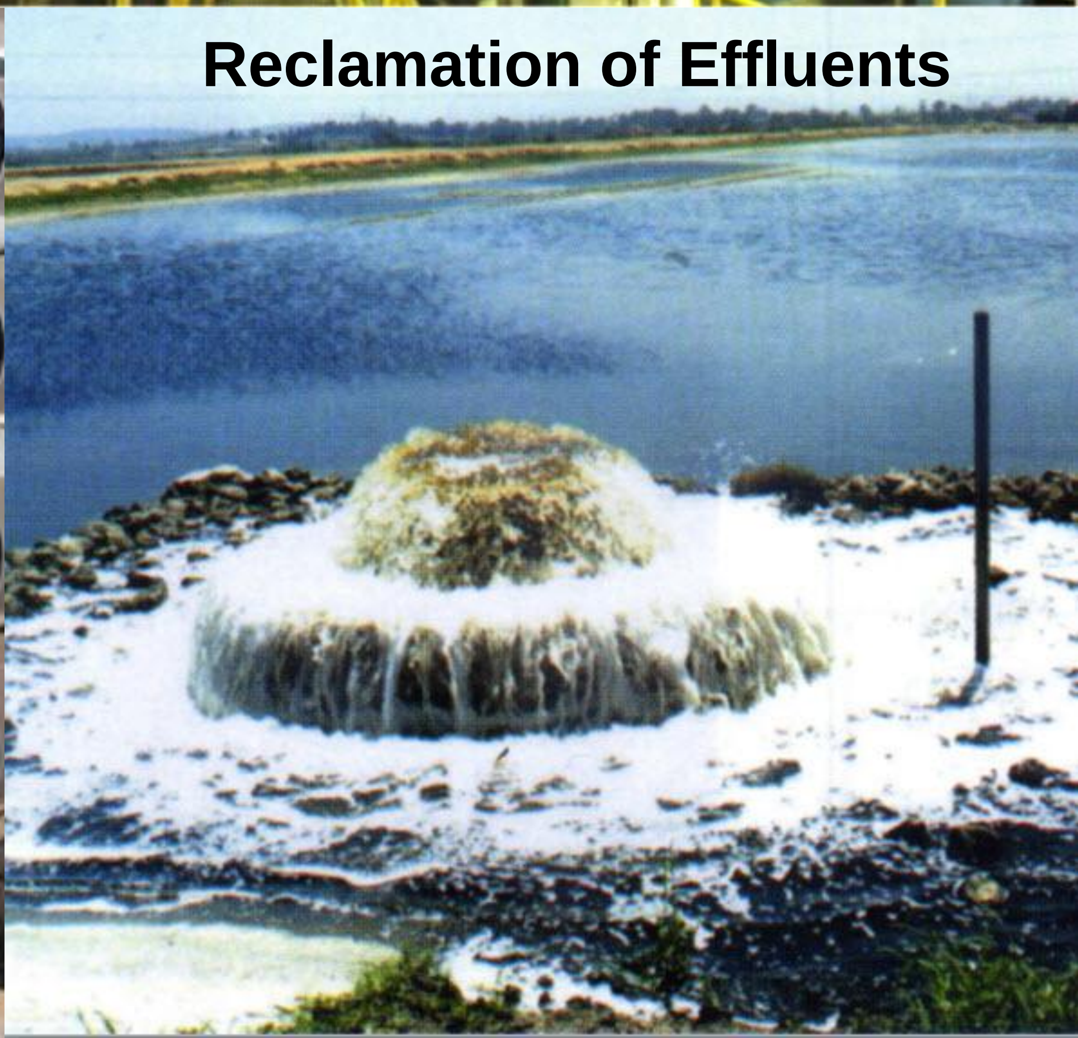
Dunaliella Biotechnology

Intensive Plant, NBT Ltd., Eilat, Israel, 100,000 m^2


Will the conventional policy of *Water Saving & Increasing Water-Use Efficiency* enable humanity to avoid water shortages and provide water security?
At most, only temporarily mitigate water scarcity!
We shall not be able to meet the increasing demand for water (and food) by simply improving water-use efficiency.


One cannot sustain the water and food supply with a diminishing amount of water and a continuously growing population.

Production of Alternative New Water



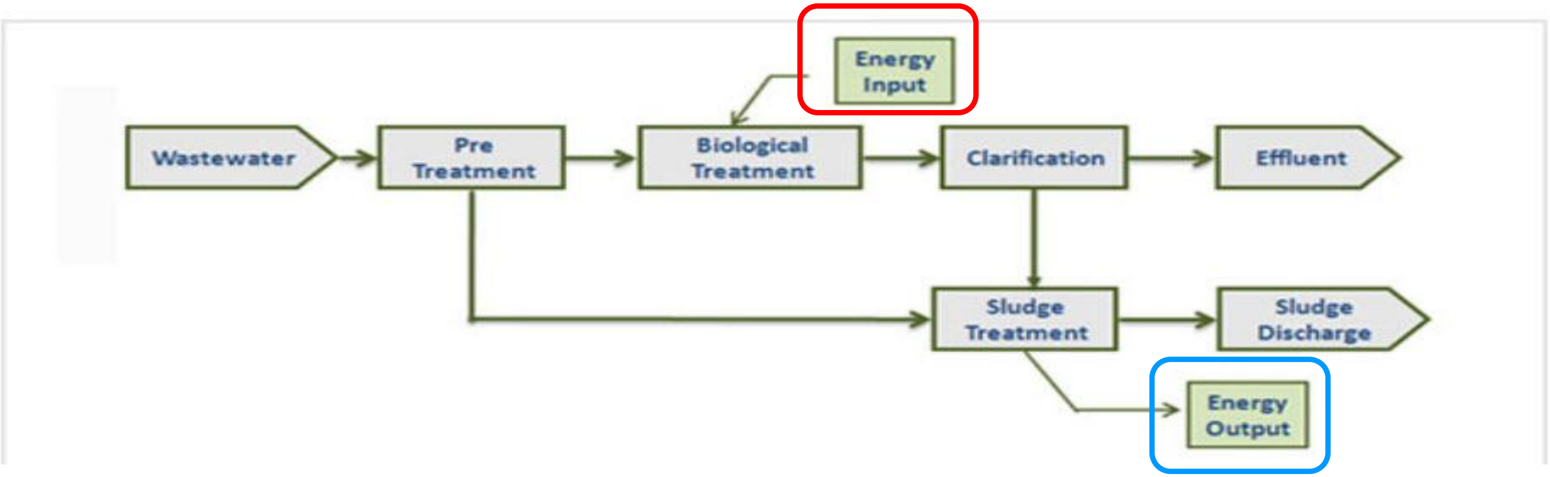
Water Treatment for Tel Aviv Metropolita

Israel:
82% Reclaimed Effluents = 68% of the water used by the agriculture Sector

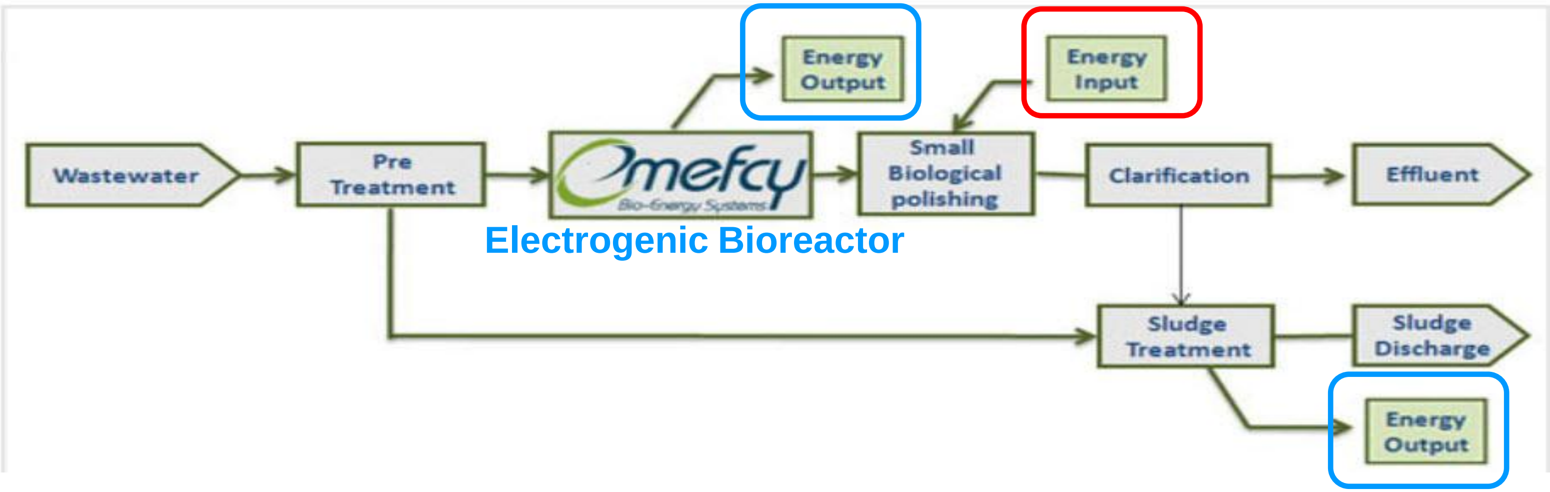
Cotton plantations

Drip Irrigation with treated effluents

Novel technologies for treating effluents: Higher Quality under Lower Cost

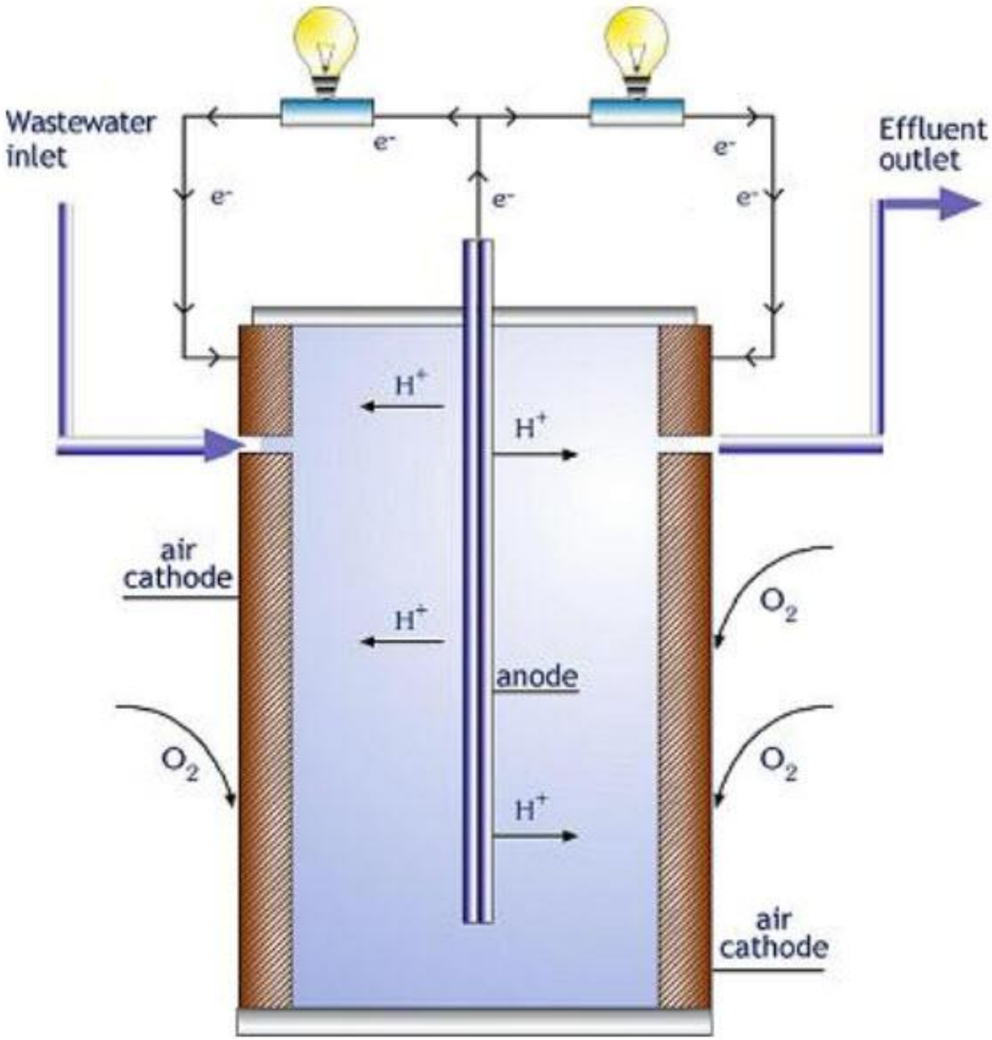


Block Diagram of a Waste Water Treatment Plant



Block Diagram of a Waste Water Treatment Plant with Electrogenic Bioreactor

The Microbial Fuel Cell Technology - Electrogenic Bioreactor



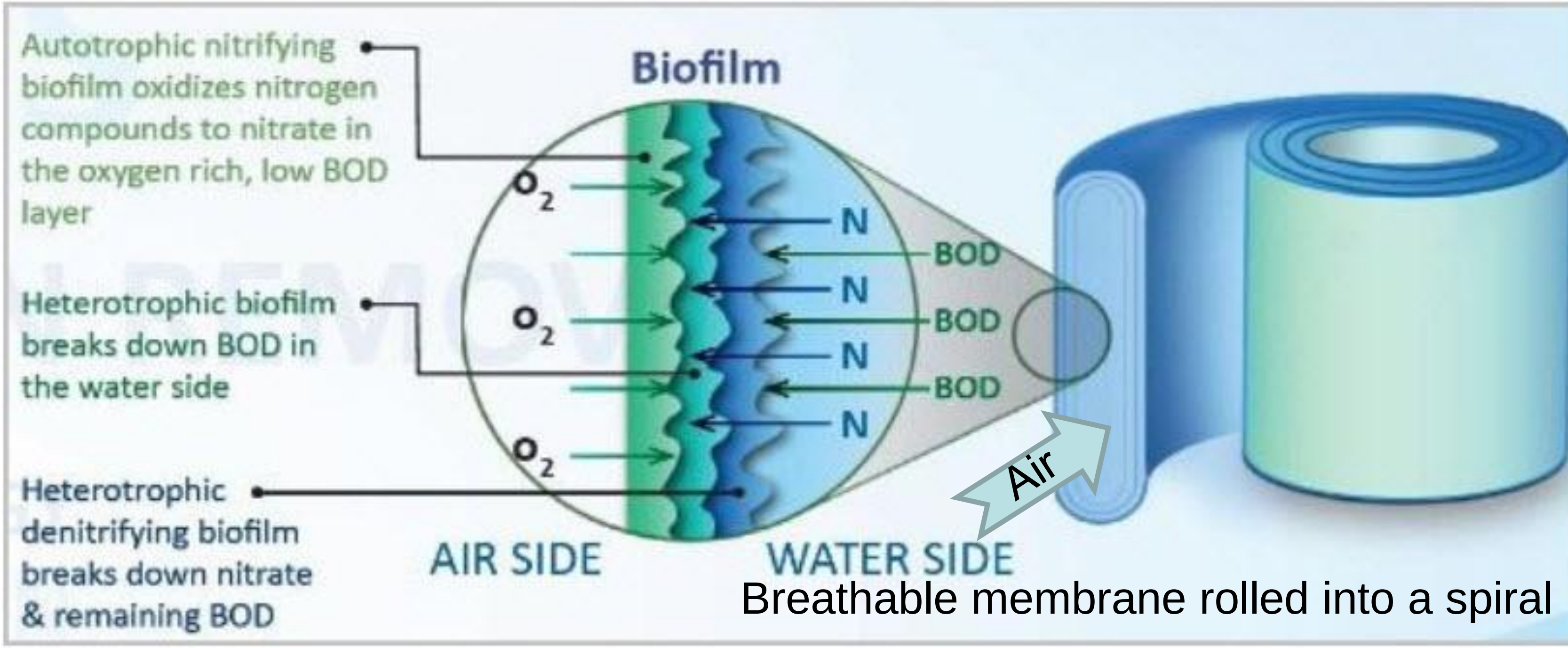
In Microbial Fuel Cell, electricity is produced directly from degradation of organic matter.

The anaerobic anode chamber is connected internally to the cathode chamber by an ion exchange membrane

The circuit is completed by an external wire.

Electrogenic Bioreactors may use wastewater as a fuel!

Spiral Aerobic Biofilm-Reactor



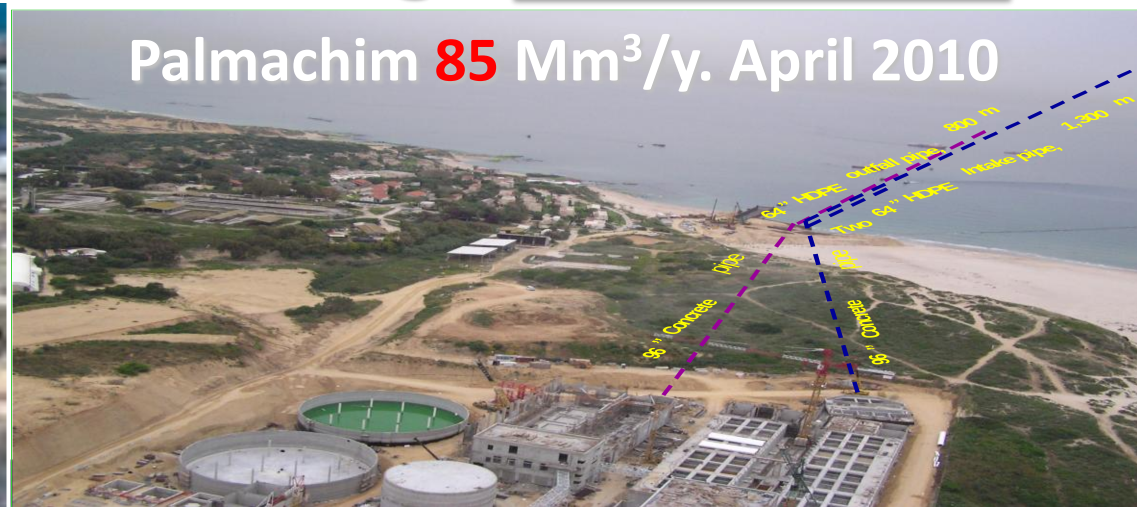
Back Aeration Biofilm Development

1. SABRE significantly reduces energy consumption and the amount of excess sludge.

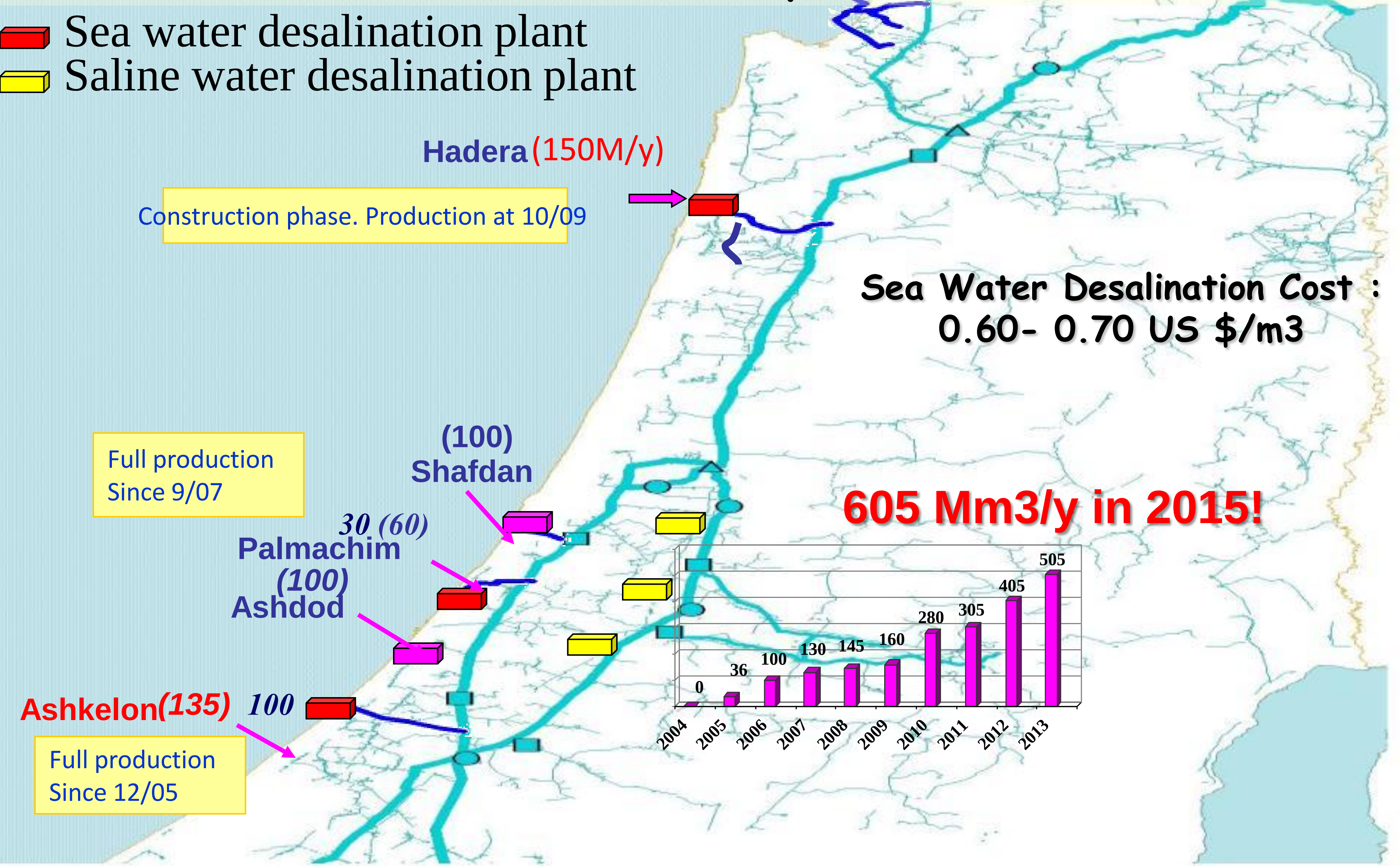
Features and Benefits:

- 95% less aeration energy, 85% less energy (including feed pump)
- 30%-50% reducing in the amount of excess sludge compared to conventional processes
- Simultaneous nitrification and de-nitrification
- Integrated clarifier: reduces footprint
- Modular design - enables gradual implementation and expansion
- Encapsulated system, odorless, dry installation

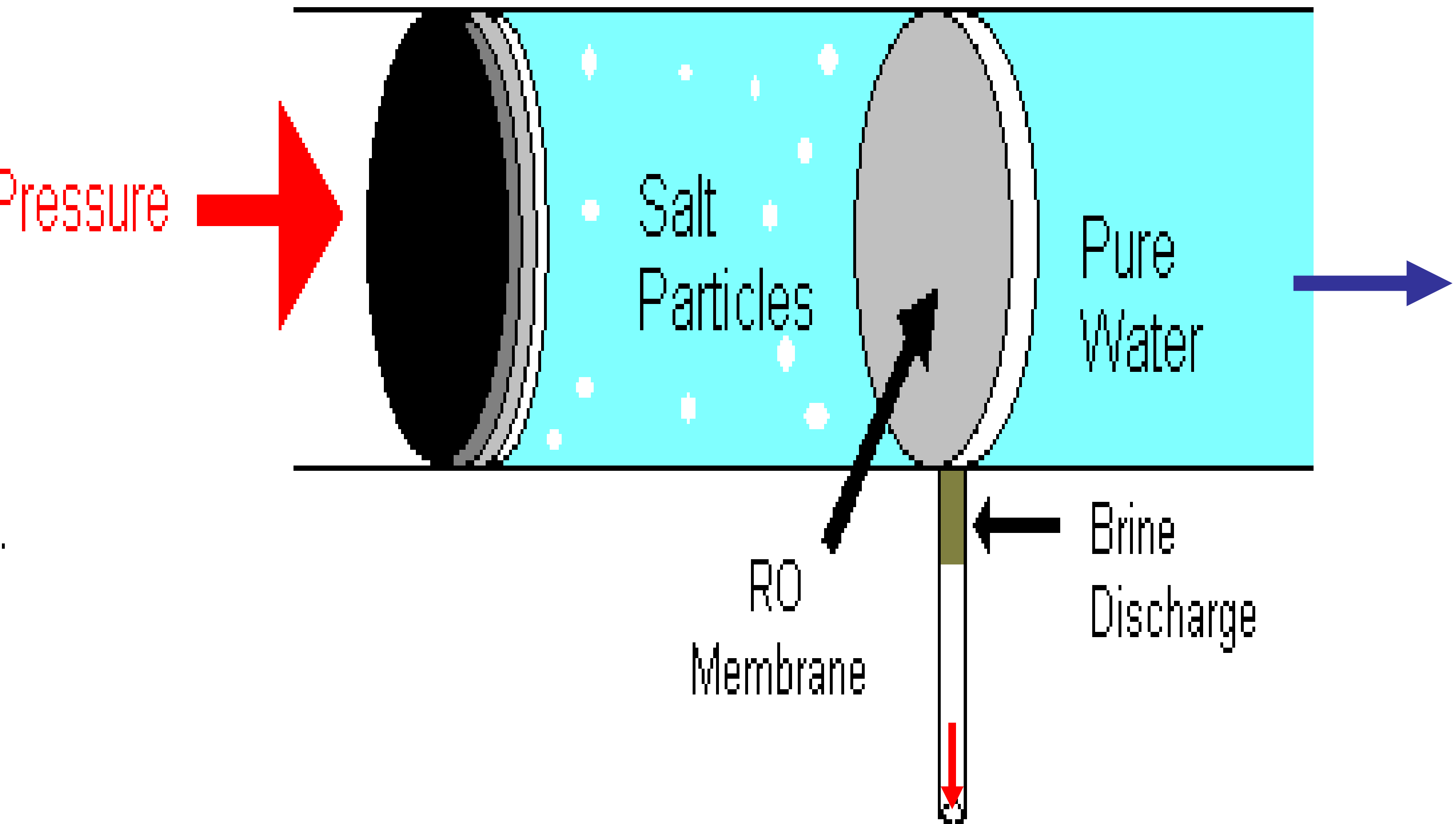
Creating New Water: seawater, groundwater & treated sewage desalination



Development of sea water desalination plants in Israel along the national system

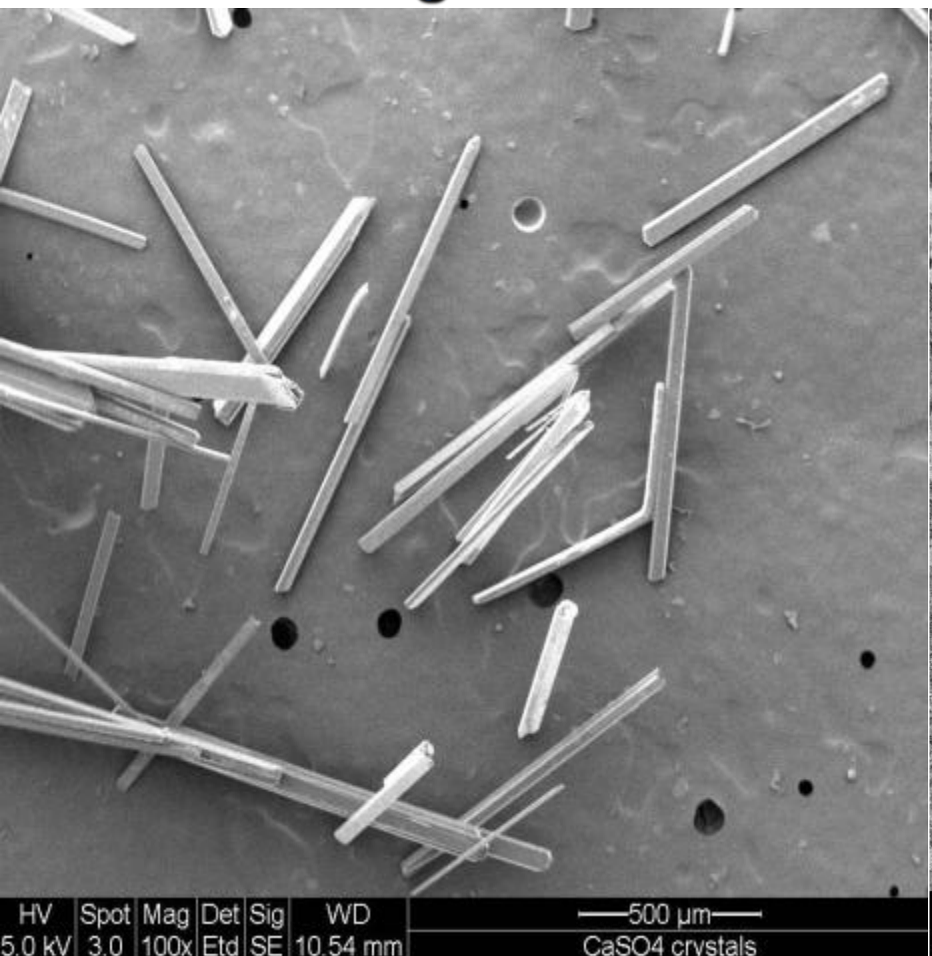


Function of RO Membrane

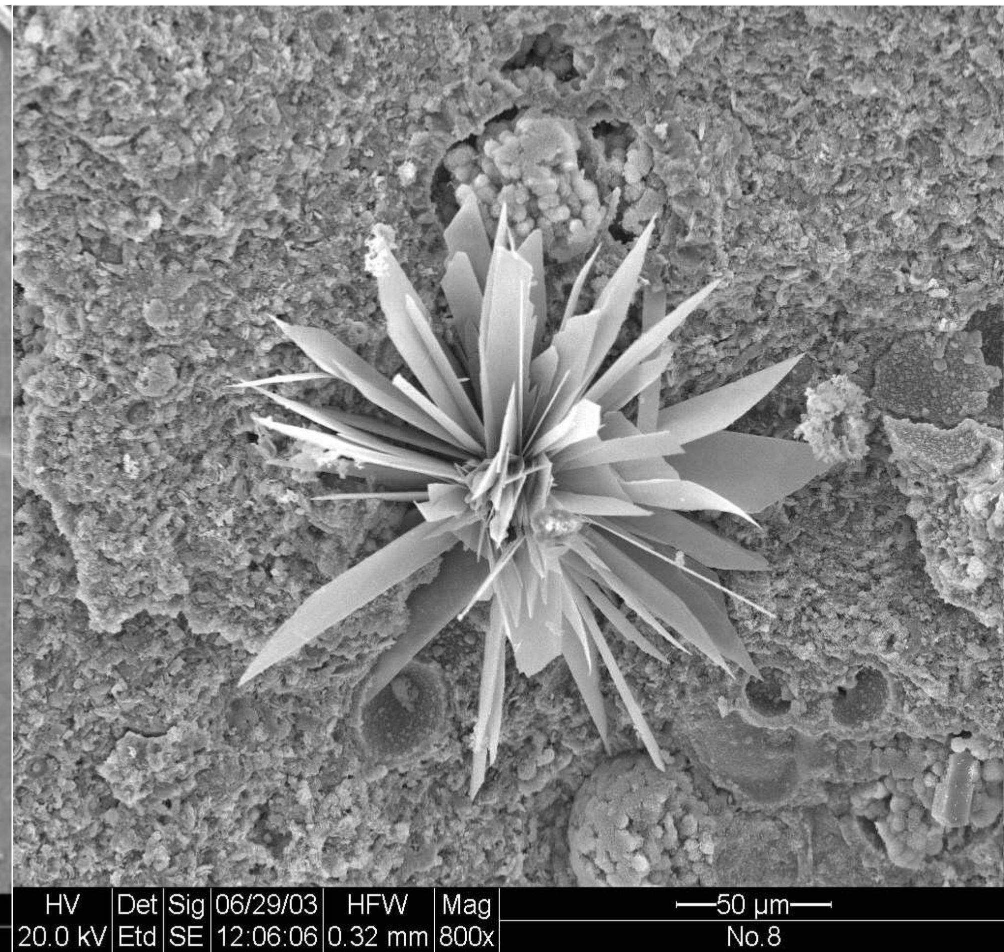


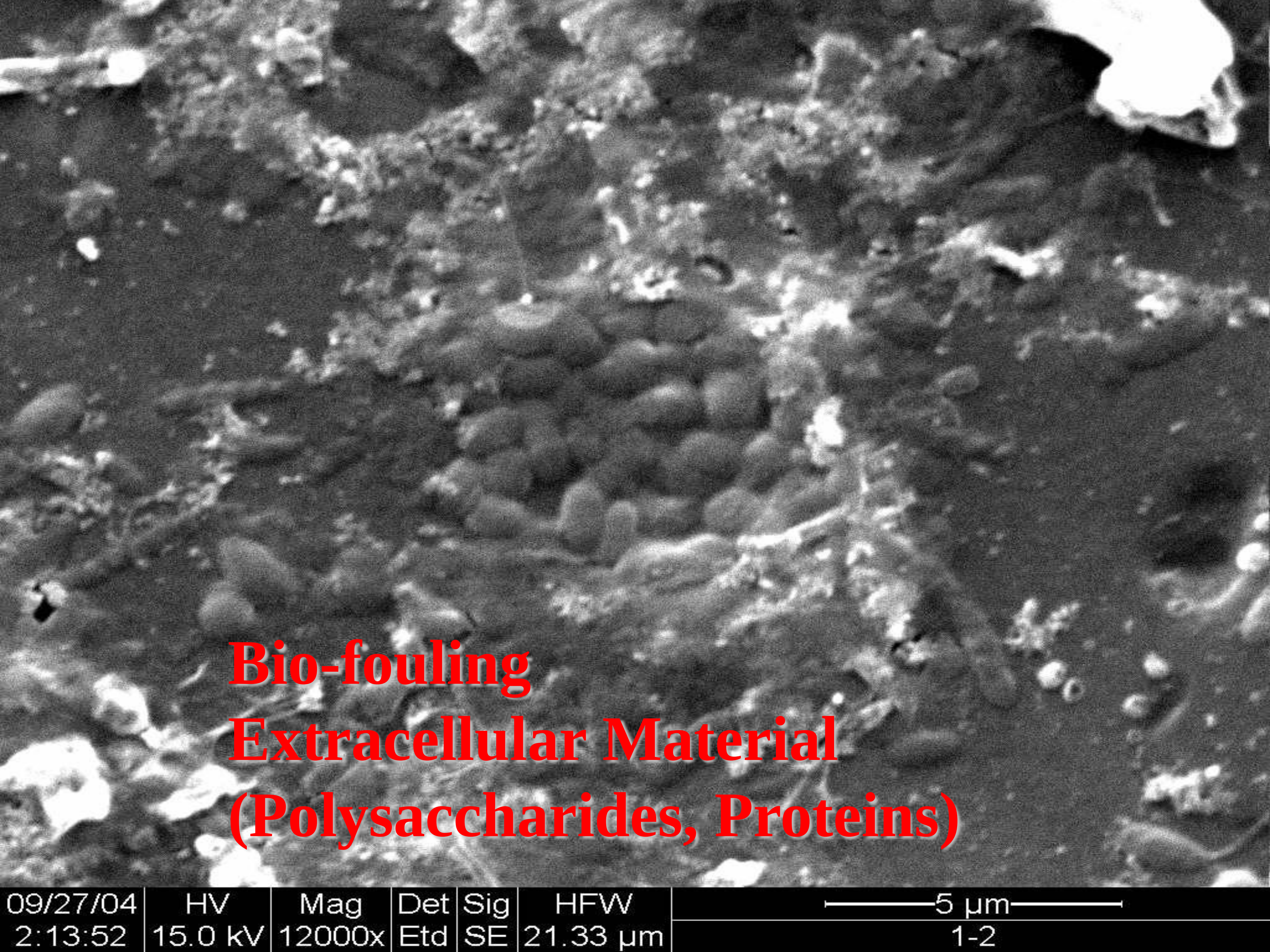
Avoid sealing & damaging of membranes by minerals deposition

Gypsum crystals
Mag x100



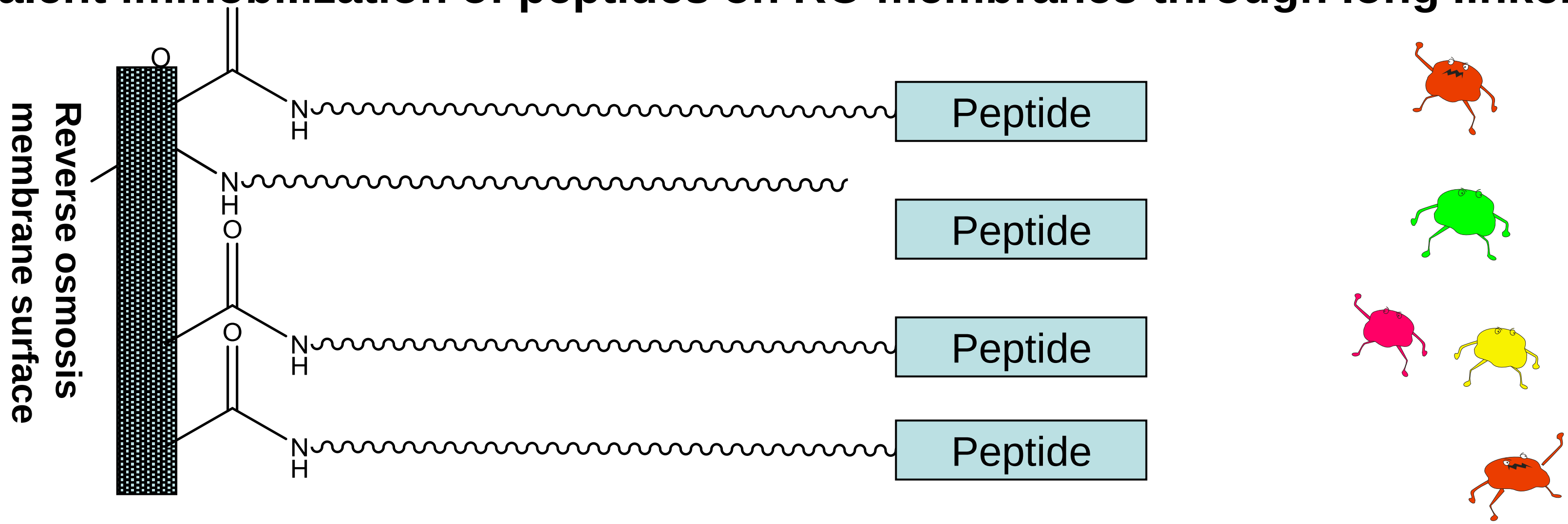
Calcium crystals
Mag x800




Bio-fouling
Extracellular Material
(Polysaccharides, Proteins)
09/27/04
2:13:52
HV
15.0 kV
Mag
12000x
Det
Etd
Sig
SE
HFW
21.33 µm
5 µm
1-2

Antimicrobial peptides kill bacteria by permeabilization of bacterial cell membrane

Covalent immobilization of peptides on RO membranes through long linkers



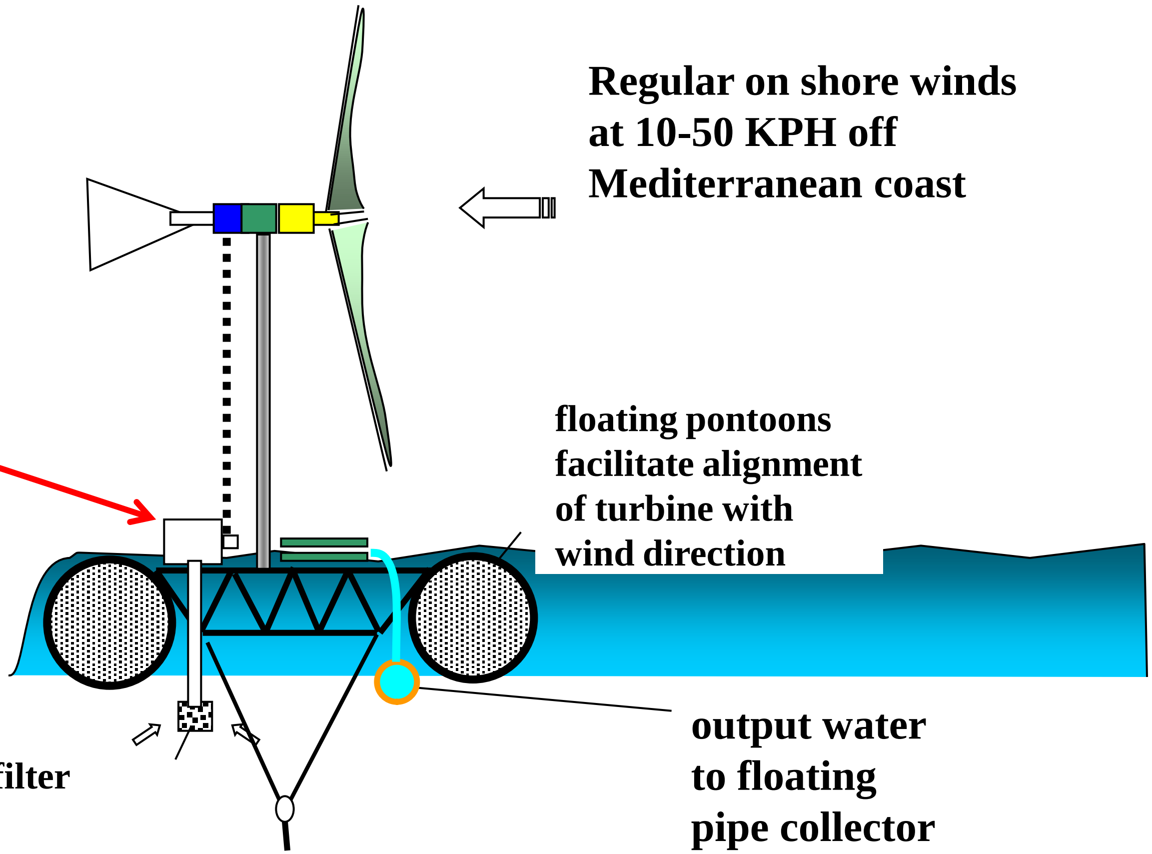
Benefits of antimicrobial peptides:

- **Active against wide range of microorganisms**
- **Bacteria do not acquire resistance to it;**
- **Non toxic to humans**

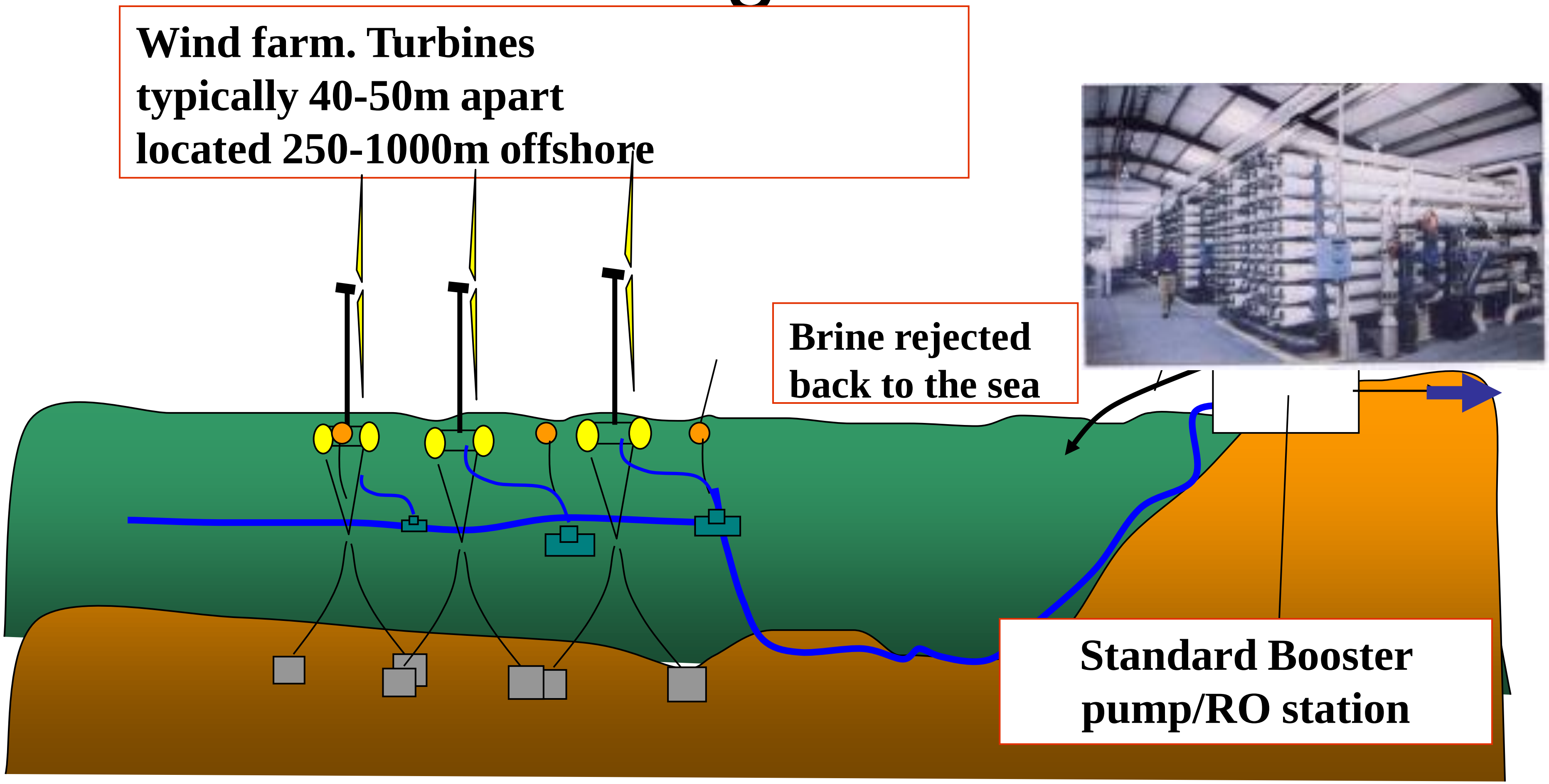
Solar Desalination System

Wind –RO with low-speed turbines

Dr. J. Gilron

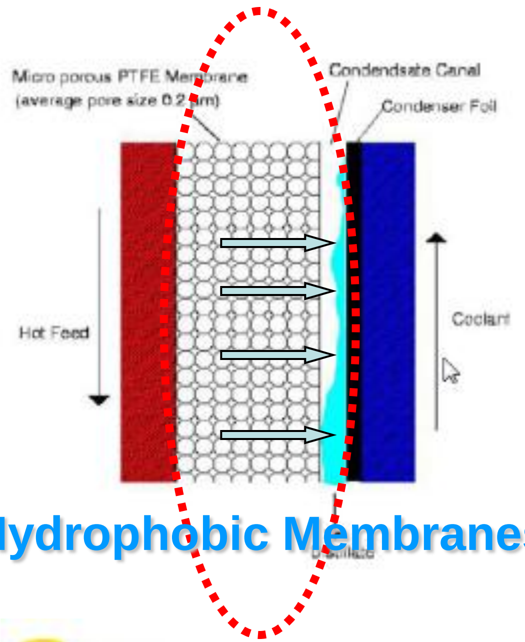


Off-shore floating wind turbine



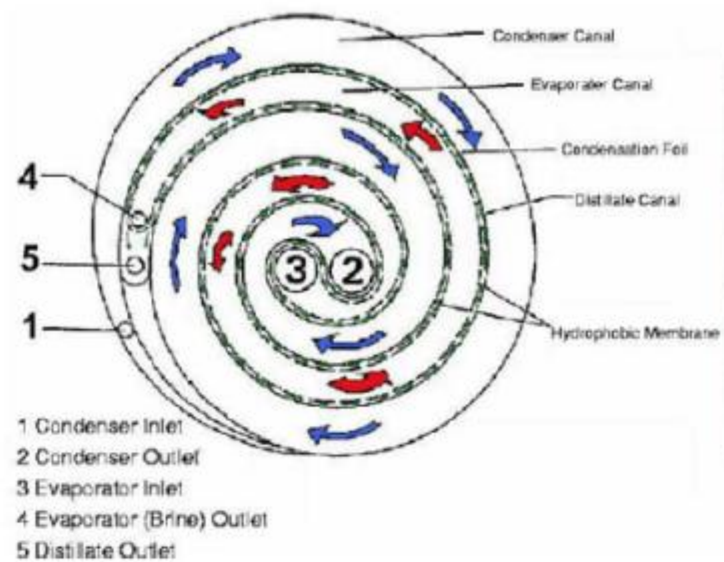
Goals for the Next Generation of Desalination: Decreasing the cost!

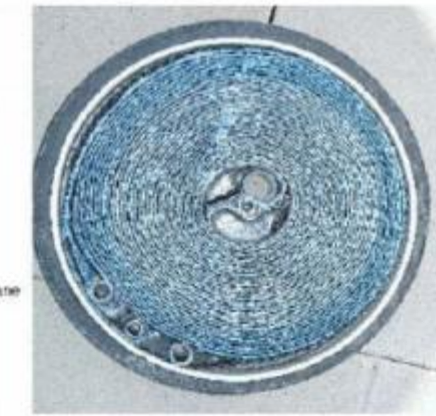
Vacuum Thermal Membrane Desalination (?)

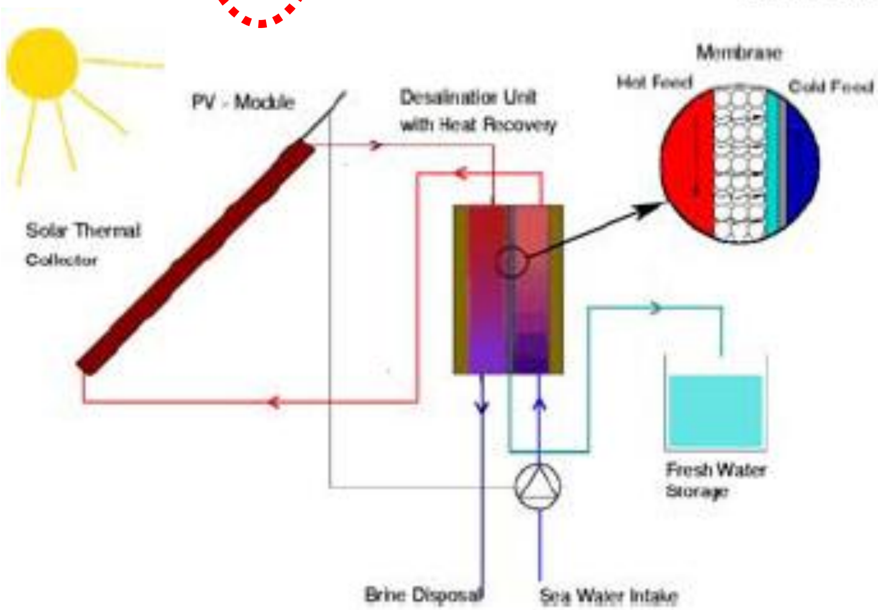


Hydrophobic Membranes

J. Koschikowski et al. / Desalination 156 (2003) 295–304







Solar Vacuum Thermal Vapors Hydrophobic Membranes Desalination (?)

Innovation In Water:
The Origins are Already In the Bible!

Water Innovations Driven by Needs!

Thank you

Water needs care & attention

The impact on the production of the agriculture-industry

Water Consumption by the Israeli Agriculture Sector/Industry: Impact on productivity!

Year	Annual Water Consumption (Bm3/y)	Fresh Water (%)	Reclaimed Water (%)	Population (M)	Agriculture Production (X)	GDP (X)
1965	1.074	100 %	0	3.2	Reference	Reference
2006	1.108	48 + 5	47			
2007	1.020	35 + 7	58	7.3	9.9	8.5
2010	0.998	24 + 8	68	7.5	10.05	9.02

- Cross calculations reveals that the AGRICULTURE PRODUCTION per UNIT OF WATER was DOUBLED in 15 years!

- **Farmers in Israel have perfected the art of *producing more with less*!!!**