Water, Energy & Waste Management In Desalination

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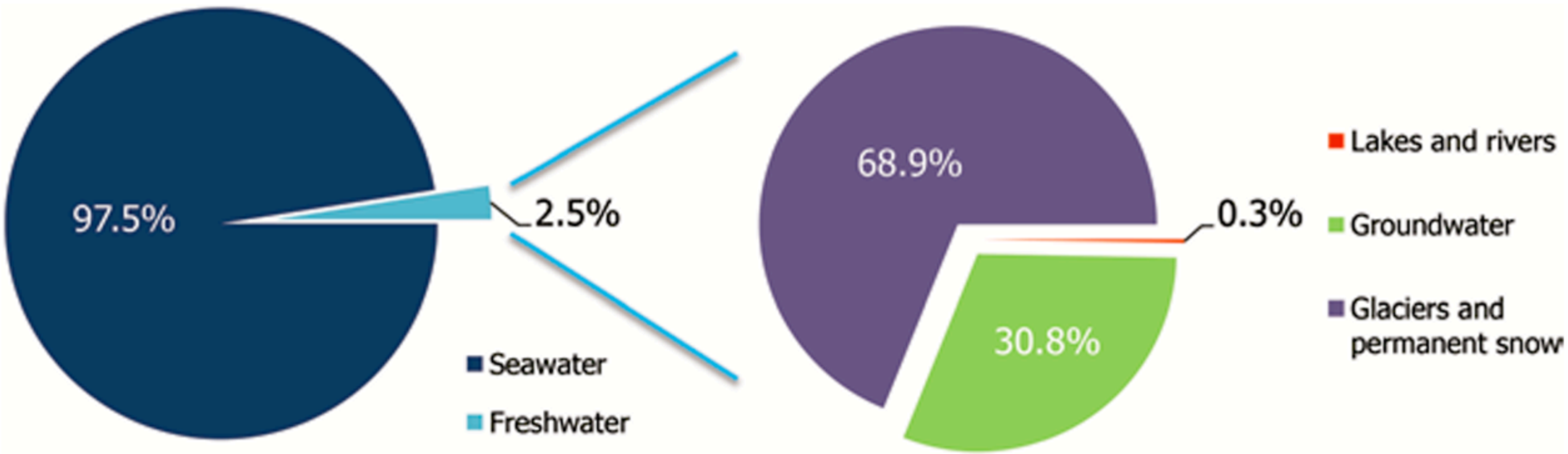
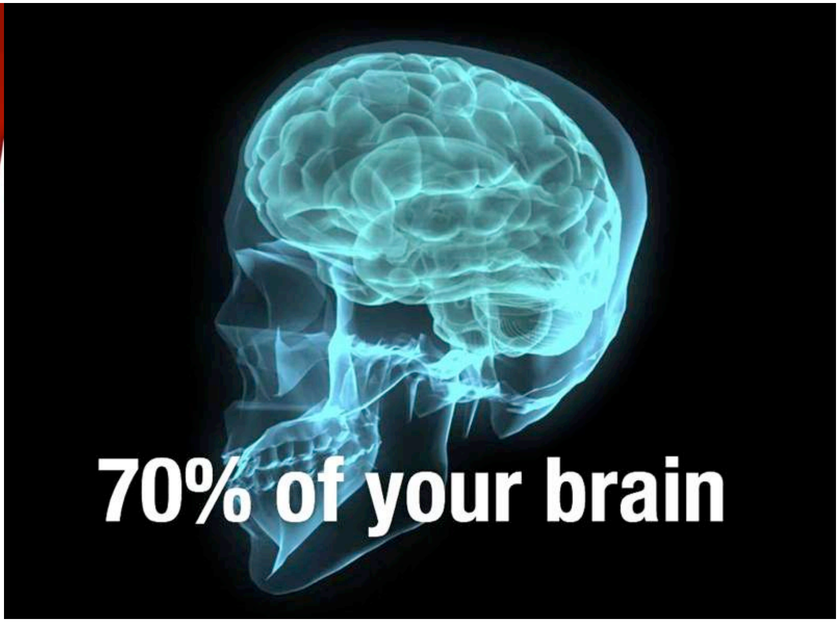
OSMOTEC

Available Freshwater



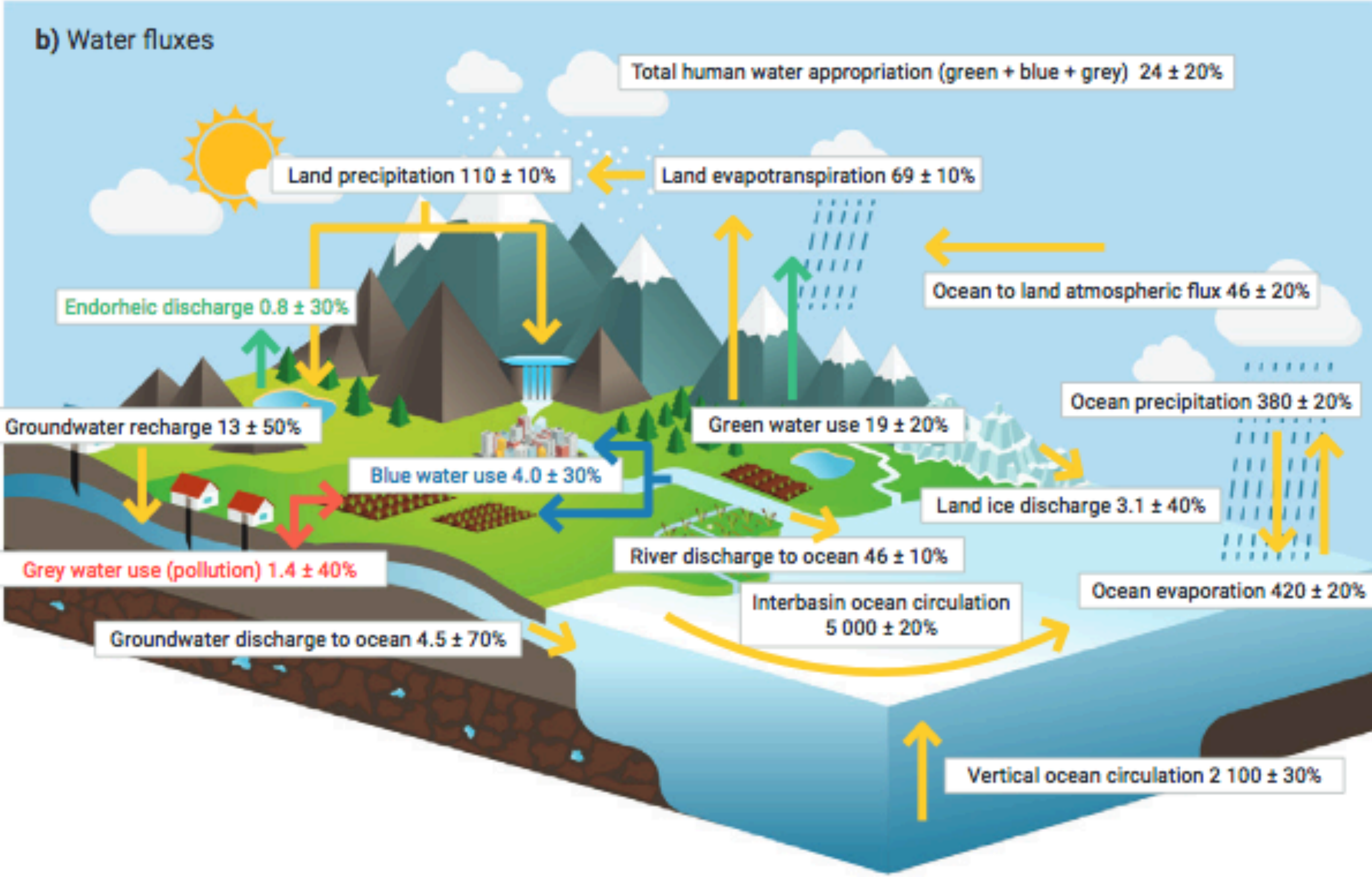
<0.007% is available to drink

"Fierce competition for fresh water may well become a source of **conflict & wars** in the future."
Kofi Annan, March 2001

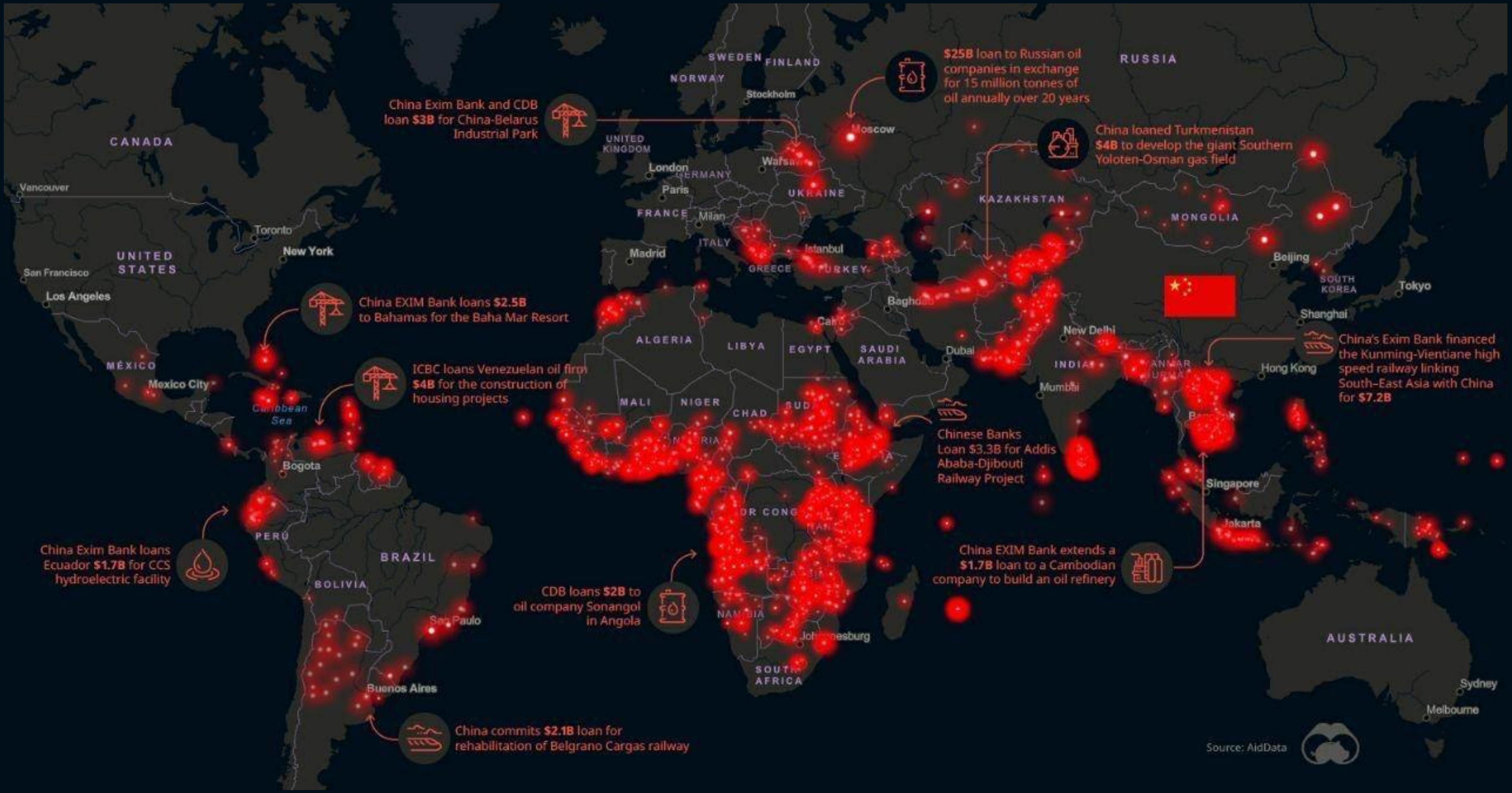


your body
can't survive
one week
without water.

While you can go almost
a month without food…


b) Water fluxes
Total human water appropriation (green + blue + grey) 24 ± 20%
Land precipitation 110 ± 10%
Land evapotranspiration 69 ± 10%
Ocean to land atmospheric flux 46 ± 20%
Endorheic discharge 0.8 ± 30%
Groundwater recharge 13 ± 50%
Green water use 19 ± 20%
Ocean precipitation 380 ± 20%
Blue water use 4.0 ± 30%
Land ice discharge 3.1 ± 40%
River discharge to ocean 46 ± 10%
Grey water use (pollution) 1.4 ± 40%
Ocean evaporation 420 ± 20%
Interbasin ocean circulation
5 000 ± 20%
Groundwater discharge to ocean 4.5 ± 70%
Vertical ocean circulation 2 100 ± 30%

Energy Investment by China (2020)



Energy Comparisons of
A Seawater Desalination Plant

One Jumbo Jet

Equal to 400 MLD Desalination Plant

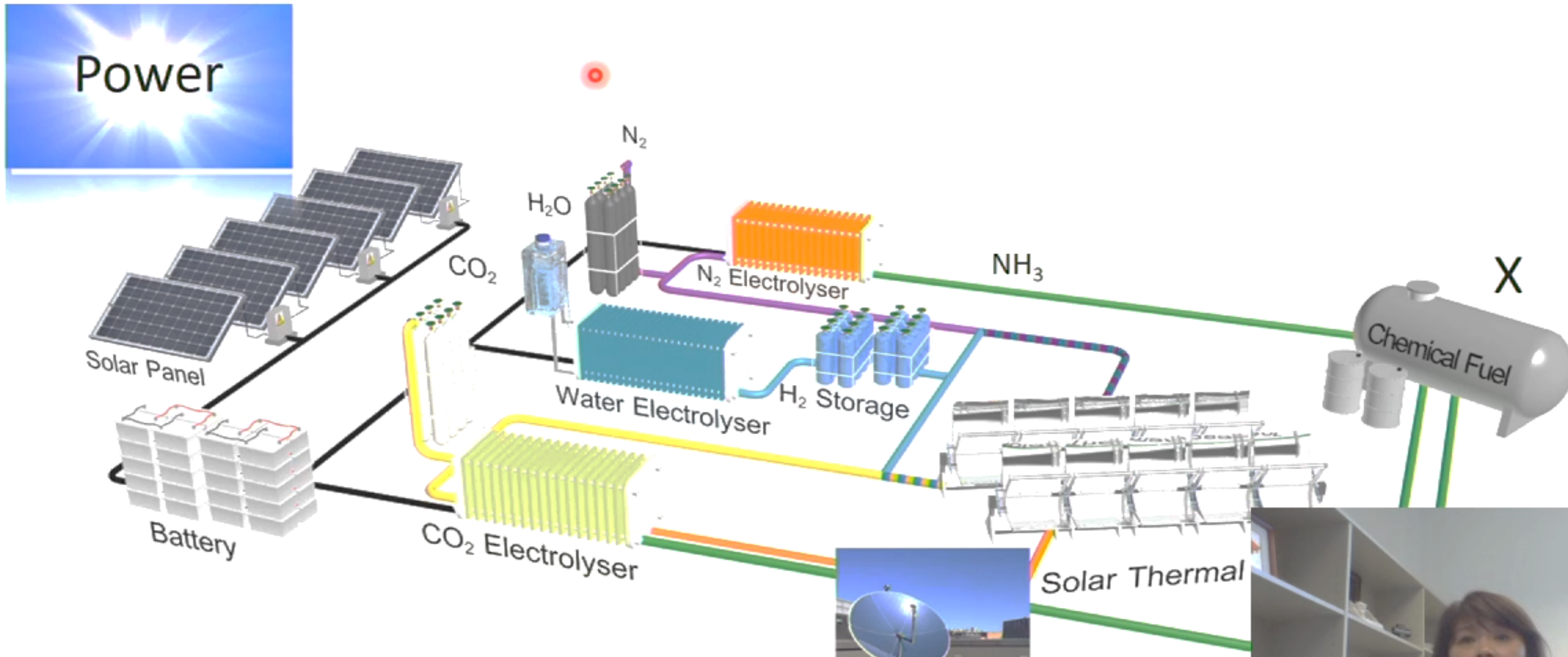
Taking Off Power	= 77 MW
Cruising Power	= 65 MW
Full Power of One Engine	= 26 MW
Full Power Requirement PSDP	= 24 MW

Water for 450,000 homes or 120,000 passengers in the air continuously and Jumbo's cannot use renewable energy

=  +  + 

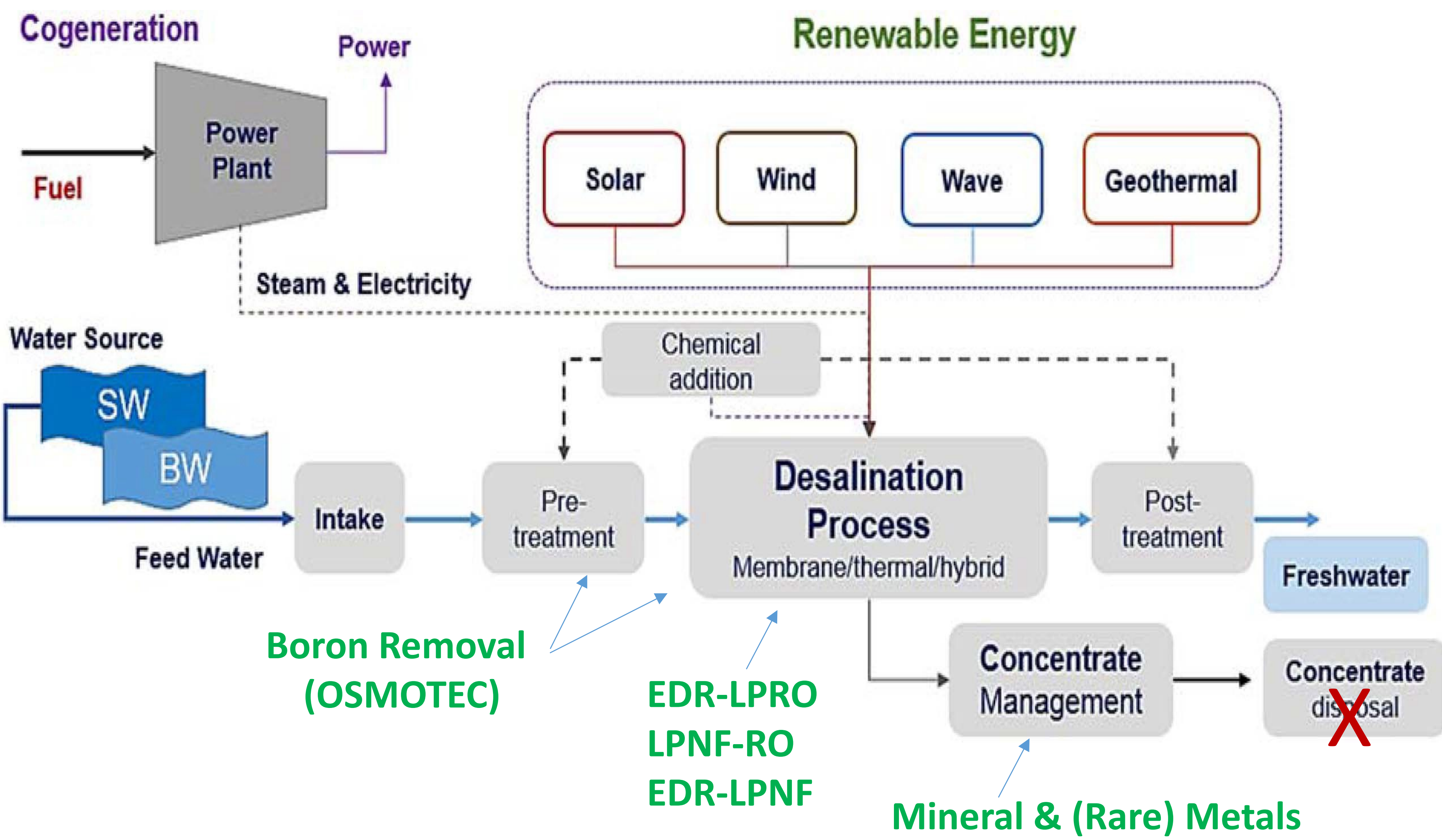
Solar Power to Chemical Fuel

Power-to-X - processes and technologies that converts renewable energy into various forms of chemical energy carriers (X)



Drawn by Dr Jian (Jeffery) Pan

Generic diagram for Desalination Processes powered by Renewable Energy sources.



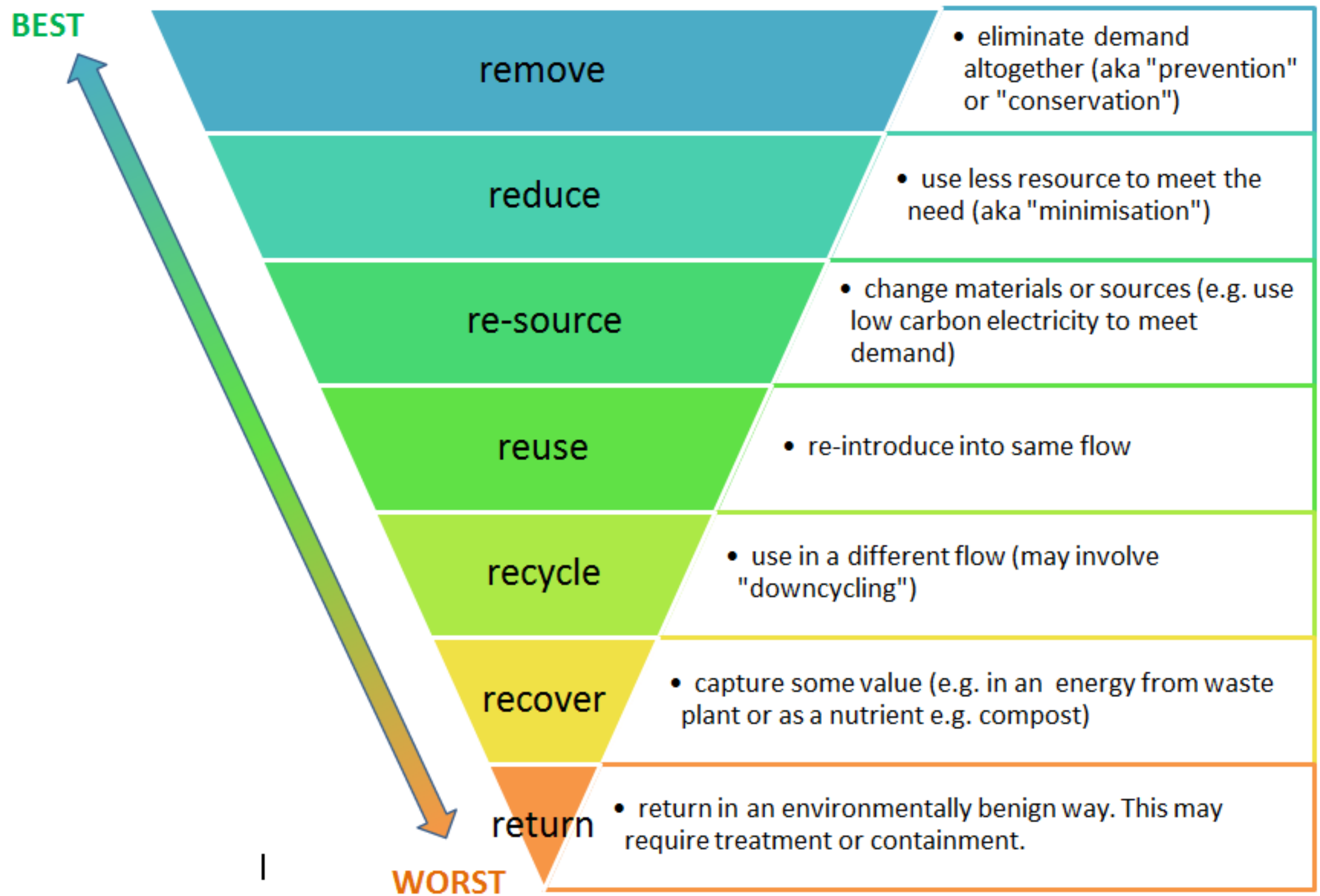
Water & Energy Technologies to Save the World

(Report by Global Water Intelligence)

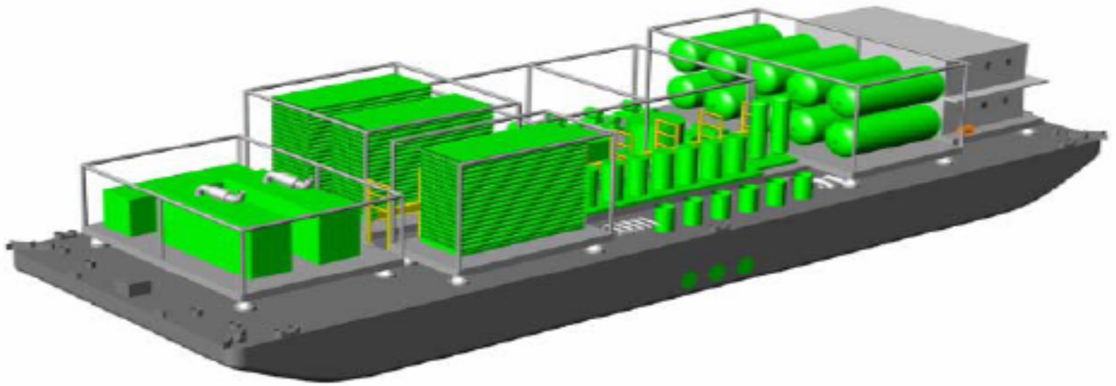
The technologies address some of the greatest challenges facing the water & Energy sectors today. These include:

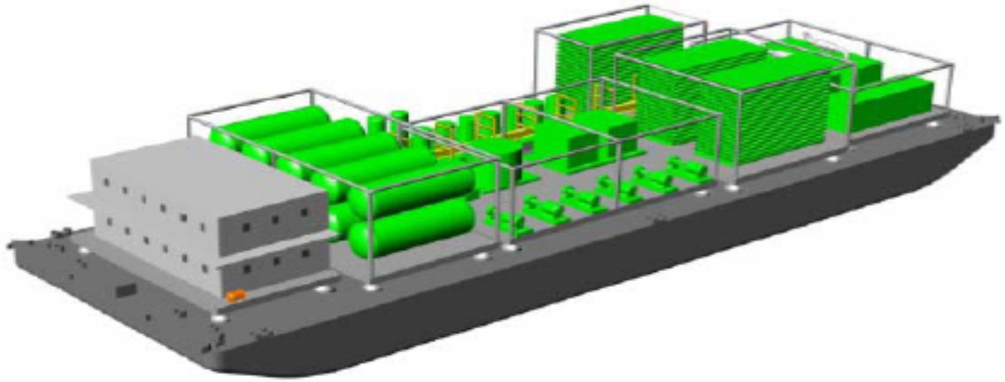
- **Water scarcity:** the world's freshwater resources are fixed, but both population and per capita consumption of water is growing. By 2025 one in three people around the world will experience either water scarcity or water stress.
- **Energy consumption:** In some parts of the world the process of treating and moving water represents 17-20% of total energy consumption.
- **Salt intrusion:** over-exploitation of our natural water resources has resulted in a build up of salt in our water systems.
- **Materials recycling:** Water & Energy Systems contain materials that may be valuable if recycled but are damaging to the environment if they are not.

Hierarchy (Water, Energy,…)

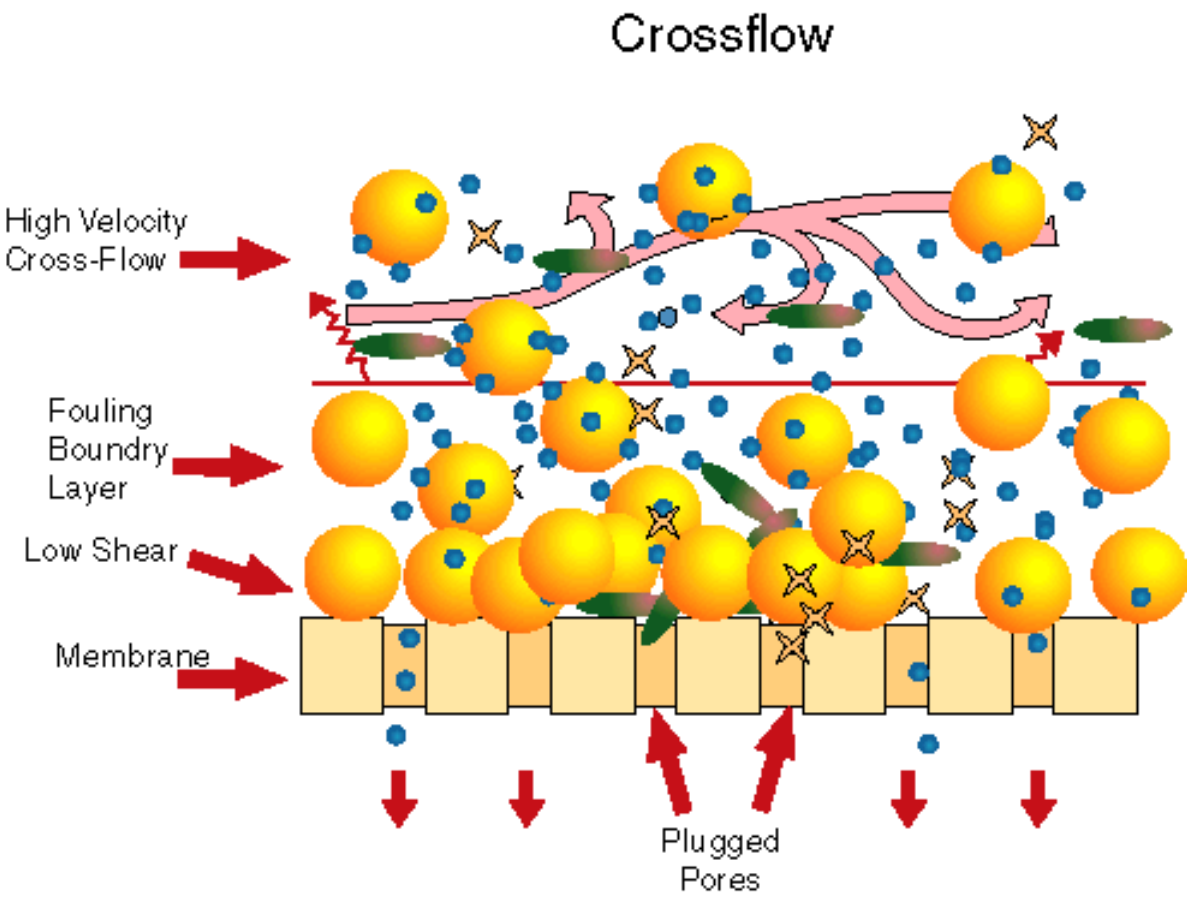


Mobile Seawater Desalination Plant
(Membrane Solution) – 25 MLD



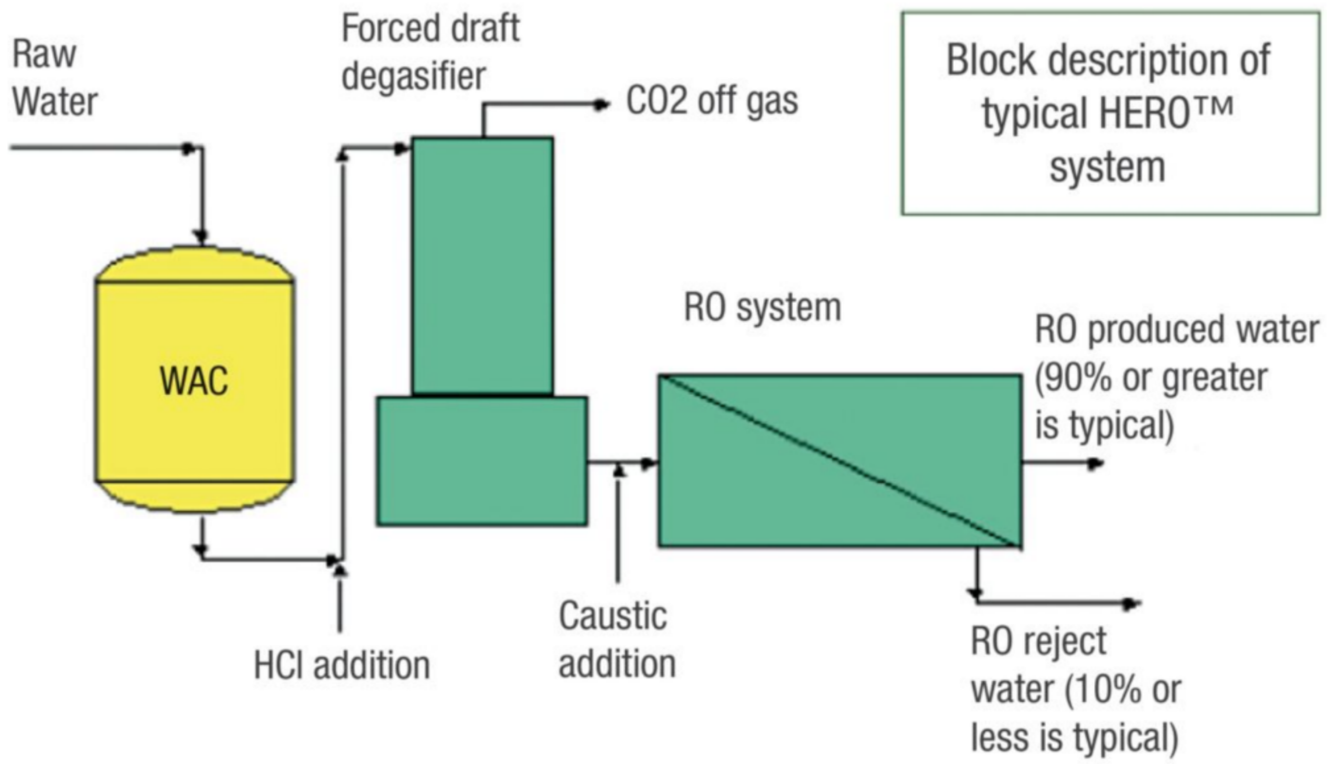


Fouling Mechanism



High Efficiency Reverse Osmosis (HERO)

UP to 95% recovery



One of major drawbacks in the RO

SCALING

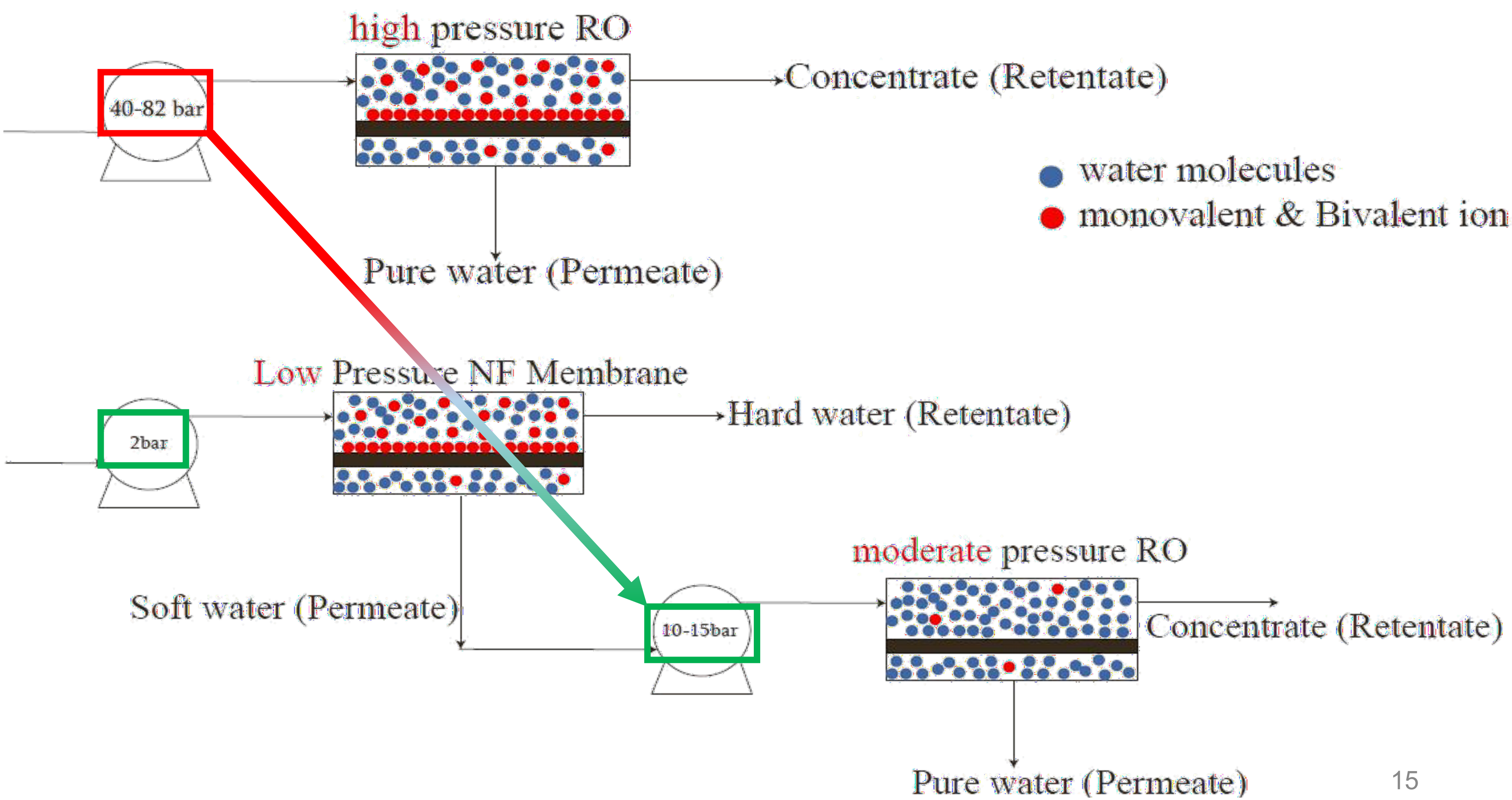
Scaling occur when dissolved compounds exceed their solubility limits and precipitate on the membrane.

results of scaling

- higher pressure drop across the system
- higher salt passage
- low permeate flow and lower permeate water quality

An example of a common scale that tends to form on an RO membrane is calcium carbonate ($CaCO_3$)

Low pressure water softening



Energy consumption with ROSA software

Feed solution:
TDS=7000;
$MgCl_2$
$CaCl_2$
NaCl

	NF/RO	RO
Pressure (bar)	10.19	36.45
Electrical energy(kWh/m^3)	0.5	1.49

* Water recovery 80%

* Total decrease in TDS=99.9%

Reduce 67% energy consumption

MD Configurations

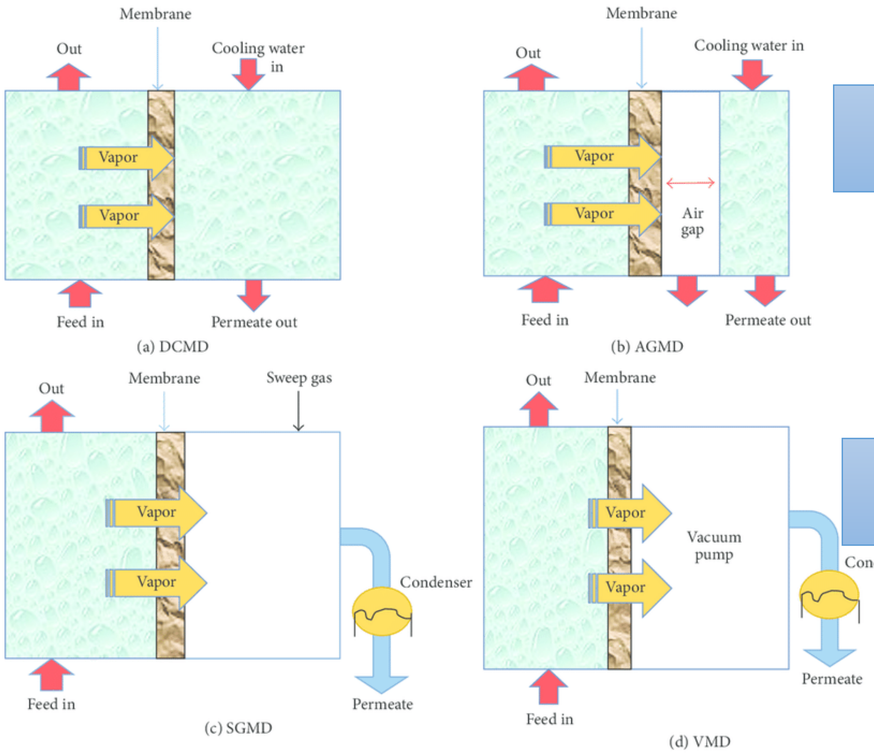
There are 4 configurations for Membrane Distillation

DCMD:
Direct Contact MD

AGMD:
Air Gap MD

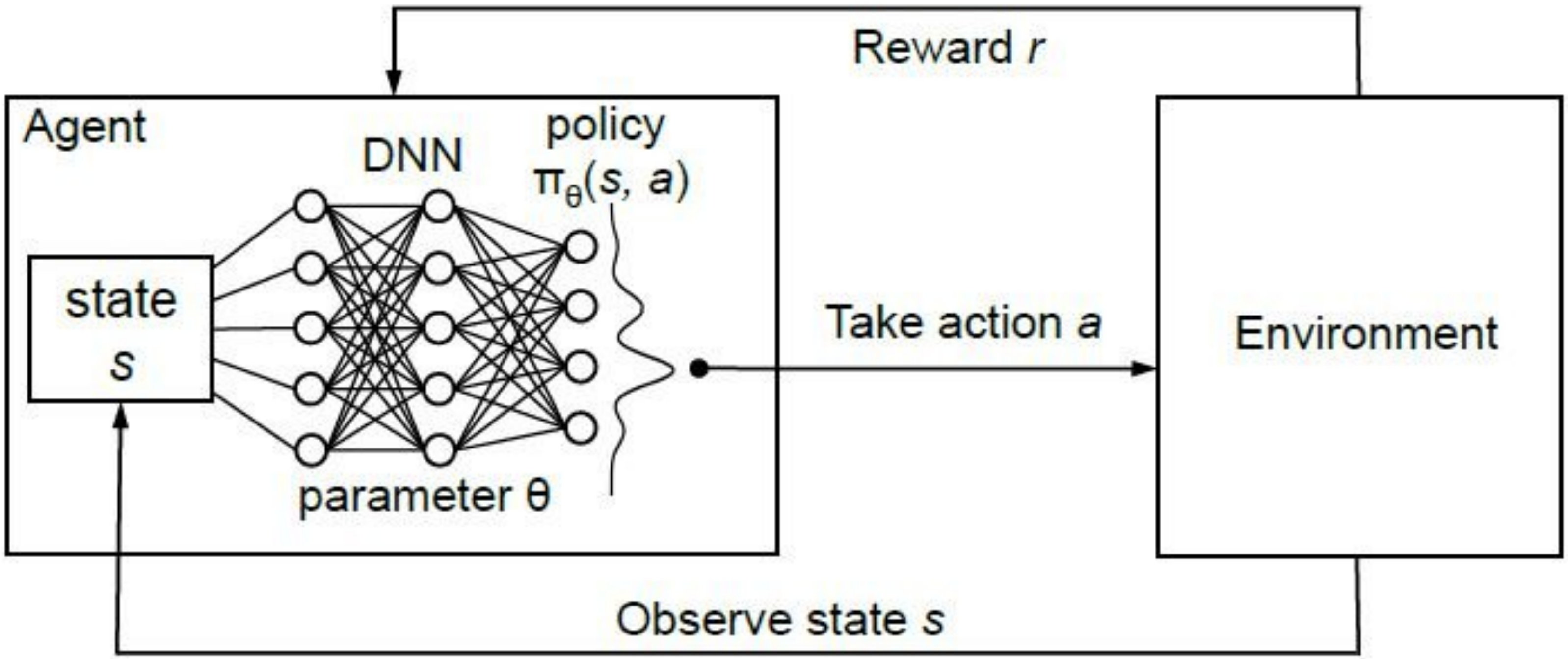
SGMD:
Sweeping Gas MD

VMD:
Vacuum MD



ARTIFICAL INTELIGENCE (AI)

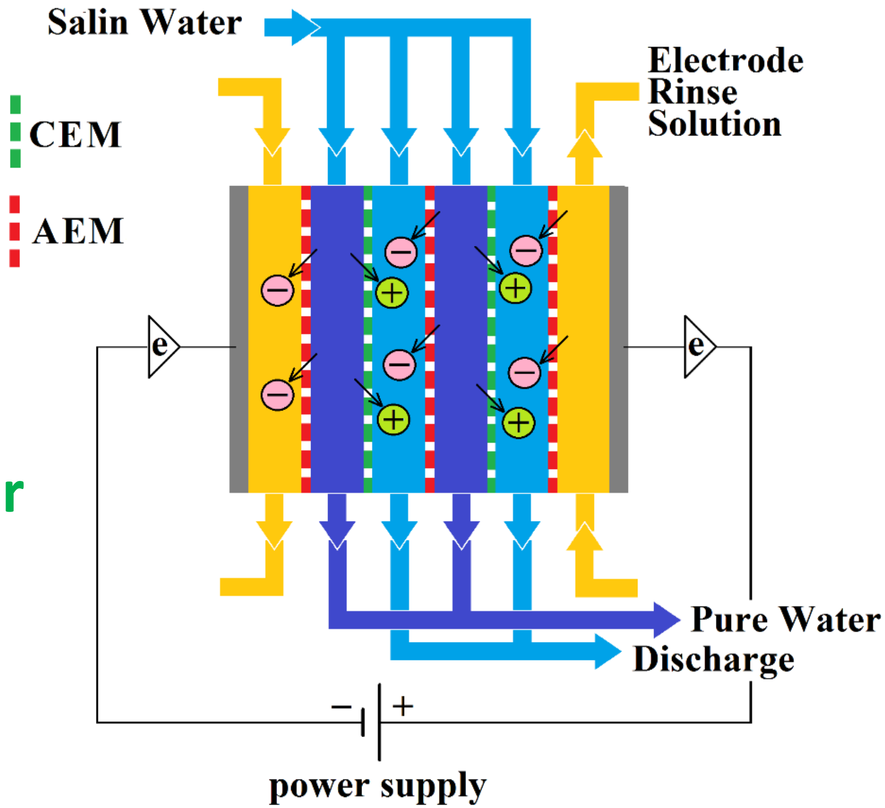
UP to 20% less OPEX



Optimized Electrodialysis (OED)

UP to 75% less Brine recovery

Modified Flow Spacer



Leakage Free Slut

Mesh Free Spacer

Why optimized Electrodialysis?

Item	Electrodialysis	Reverse Osmosis	Thermal Methods
Pressure (P)	0.5 - 1 bar	30 – 60 bar	(-1) - 4 bar
Temperature (T)	(-4) (saline water) - 50°C	10 – 45 °C	40 – 100 °C
Material	Polymeric (Cheap)	SS – FRP (Expensive)	SS (Expensive)
Energy Consumption	5-10 kw/m³	3-5 kw/m³	5-12 kw/m³
Piping	Low Pressure	High Pressure	High Pressure
Life Time	7-10 years	0.5 to 2 years	5 – 15 years
Instrumentation & Control	Simple	Complex	Complex
Pretreatment	Simple	Complex	Simple
Maintenance	Easy - Cheep	Complex - Expensive	Expensive
Chemical Consumption	Rarely	Continuously	Continuously
Capital cost	Low	High	Average

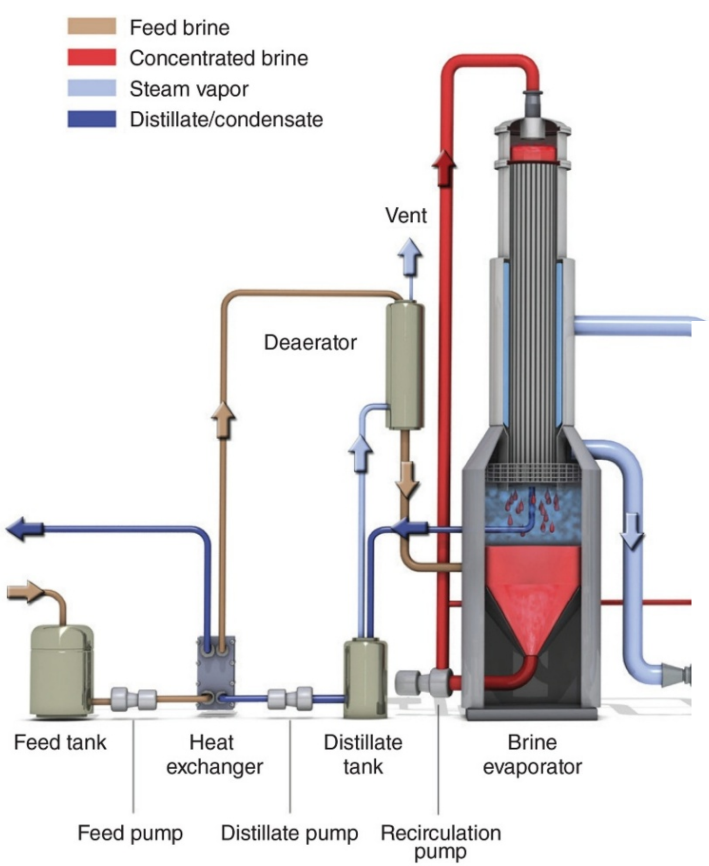
Water & Energy Management Issues

Eleanor Beevor July 2018 "And as this figure rises, the volume of renewable water resources available per capita drops. It is already critically low. 35% of the population are living in areas experiencing water shortages and droughts"

A recent report suggested that over **90%** of Iran's water was consumed by agriculture, but that the sector's efficiency rate of water usage was **35%**. The average global efficiency rating is **75%.**

"Sanctioning prevents investment in many essential infrastructures, including those related to water management and agriculture. Weak water infrastructures will lead to inefficient use of water, such water leakage or not recycling wastewater.

Zero Liquid Discharge (ZLD)



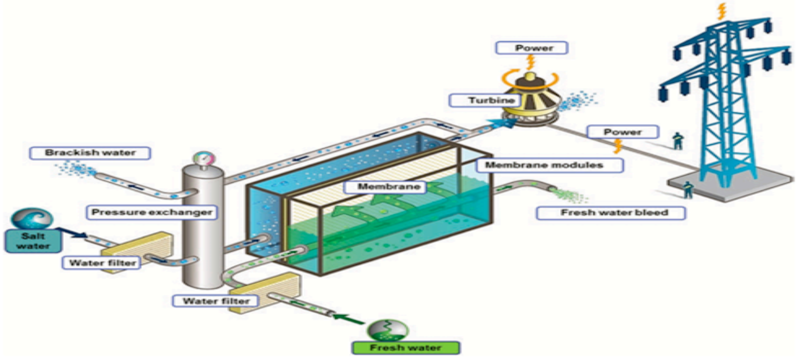
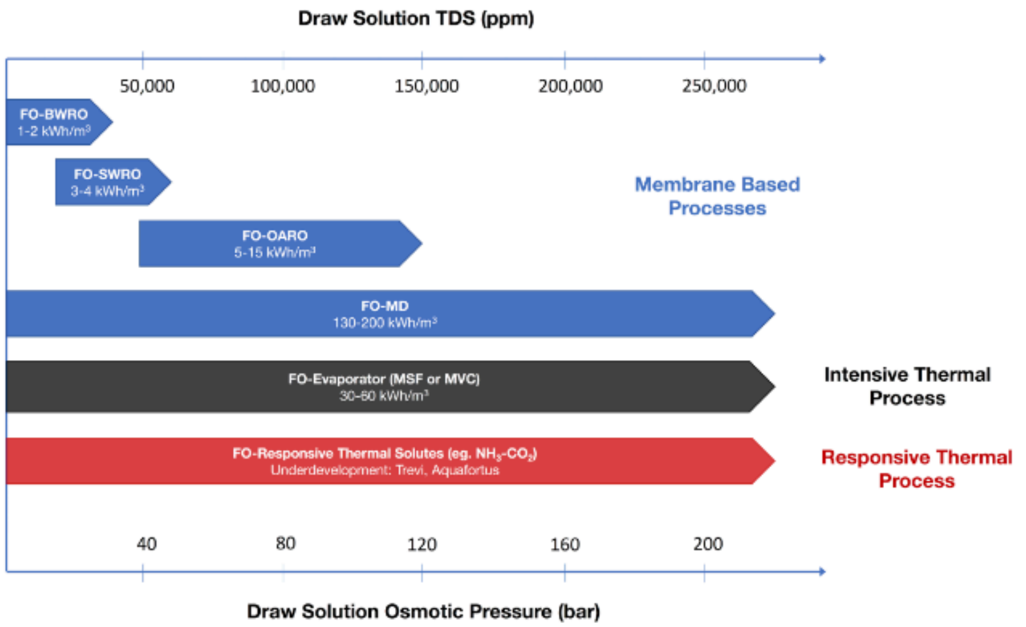


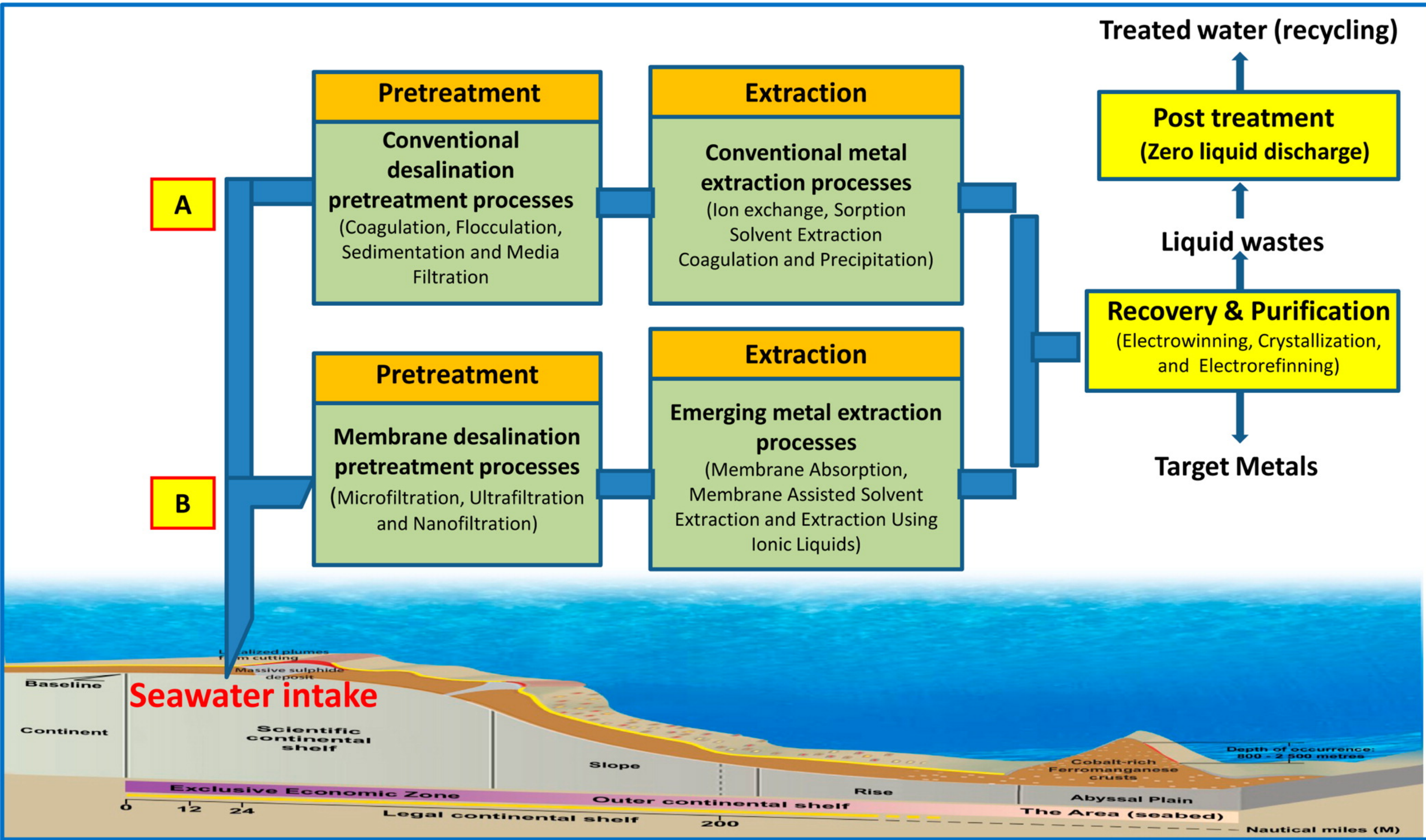
Figure 7.3.7 Pressure retarded osmosis (PRO) system adopted by Statkraft (2014).



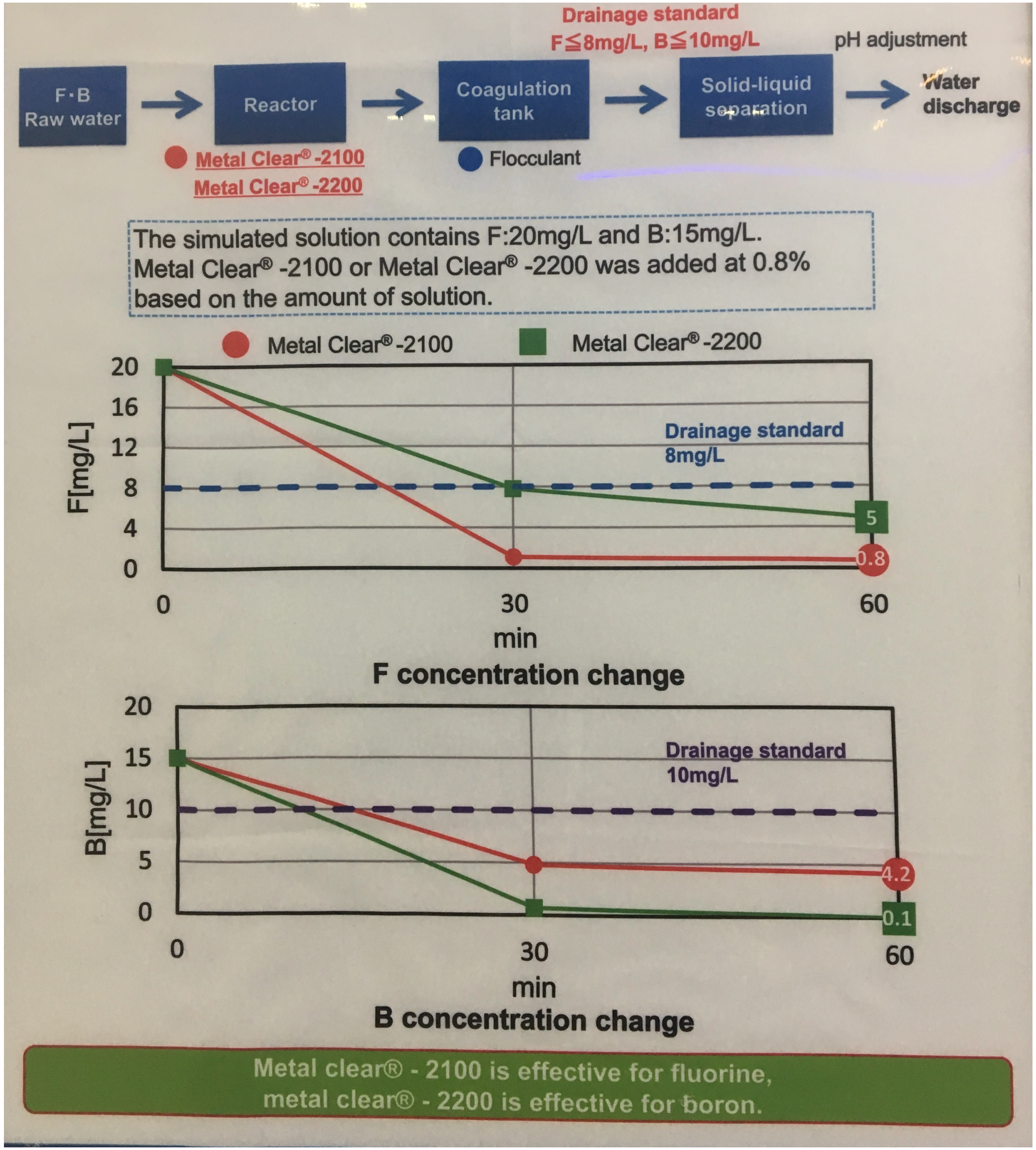
ZLD Current Case Study

- State of the Art of Thermal Brine Concentration
- Advanced Technologies for Membrane Brine Concentration
- Non-thermal & Non-membrane Brine Concentration Technologies
- Brine Concentration for Harvesting of Minerals
- Brine Concentration for Harvesting of Rare Metals
- Brine Concentration for Zero Liquid Discharge
- Case Studies for Brine Concentration
- Case Studies for Zero Liquid Discharge
- Lowering Cost and Energy Use Barriers for Brine Concentration
- The Future of Brine Concentration – Next Generation Technologies
- Advanced Technologies for Mining of Sodium Chloride
- Advanced Technologies for Mining of Calcium and Magnesium Salts
- Market Survey for Ocean Brine Minerals
- Case Studies for Mining of Minerals
- Advanced Technologies for Mining of Lithium, Rubidium and Cesium
- Advanced Technologies for Mining of Other Rare Metals
- Market Survey for Mining of Rare Metals form Ocean Brine
- Case Studies for Mining of Rare Metals from Ocean Brine

ZLD Current Case Study

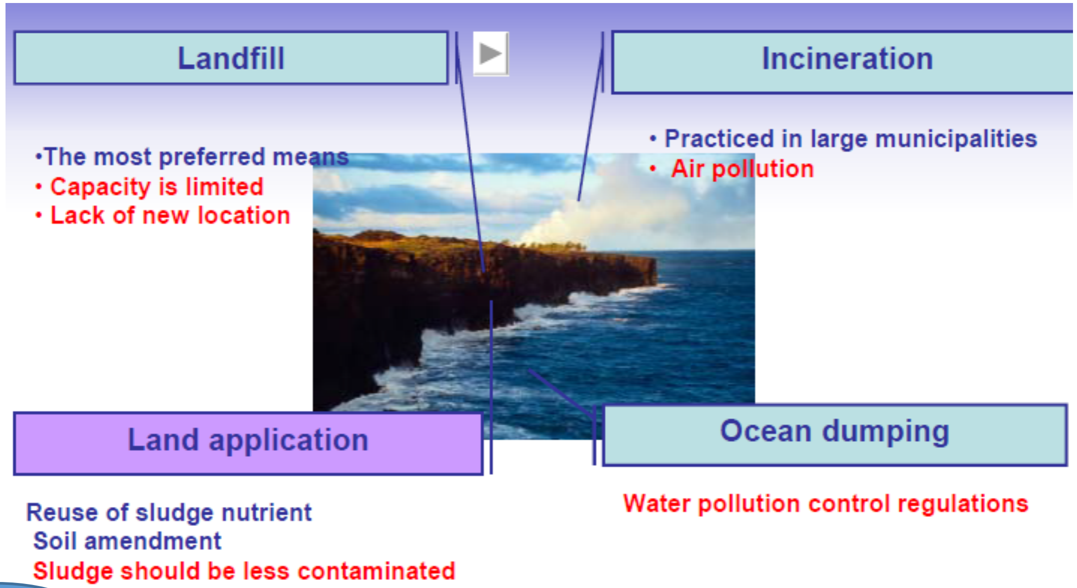


Boron Removal – Case Study



Sludge Treatment

- Thickening
- Digestion
- Conditioning
- Dewatering
- Drying
- Disposal (Incineration)

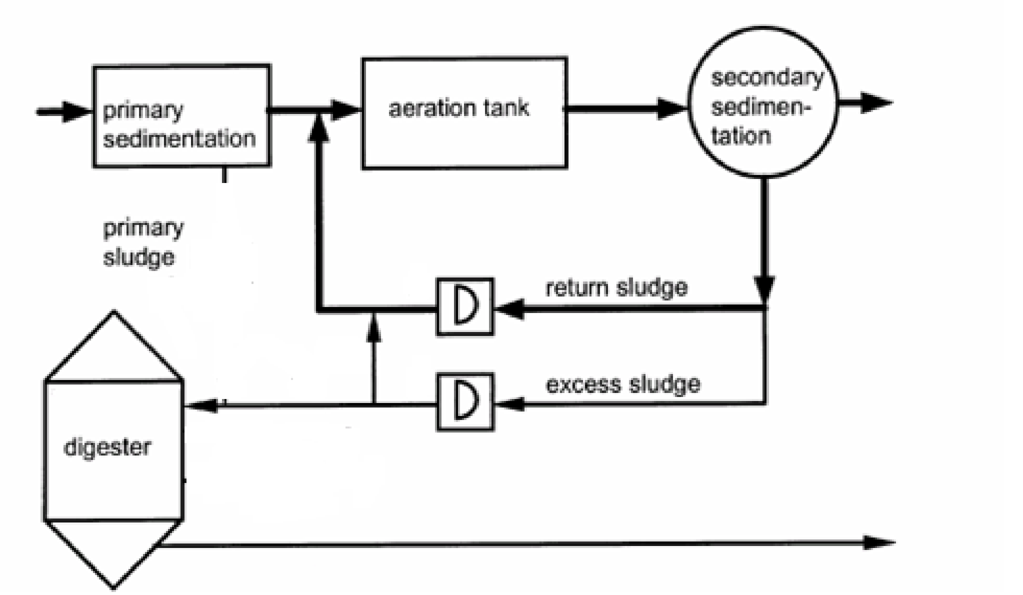


BEST SOLUTION:

SLUDGE REDUCTION !!!

Sludge Reduction

- Sludge pretreatment through:
  - Thermal
  - Mechanical
  - or chemical treatment



- Restricting/limiting sludge growth in an aeration tank

OUR SOLUTION:
Advanced Oxidation Processes(AOPs)

Sludge Reduction

Advanced Oxidation Processes(AOPs)

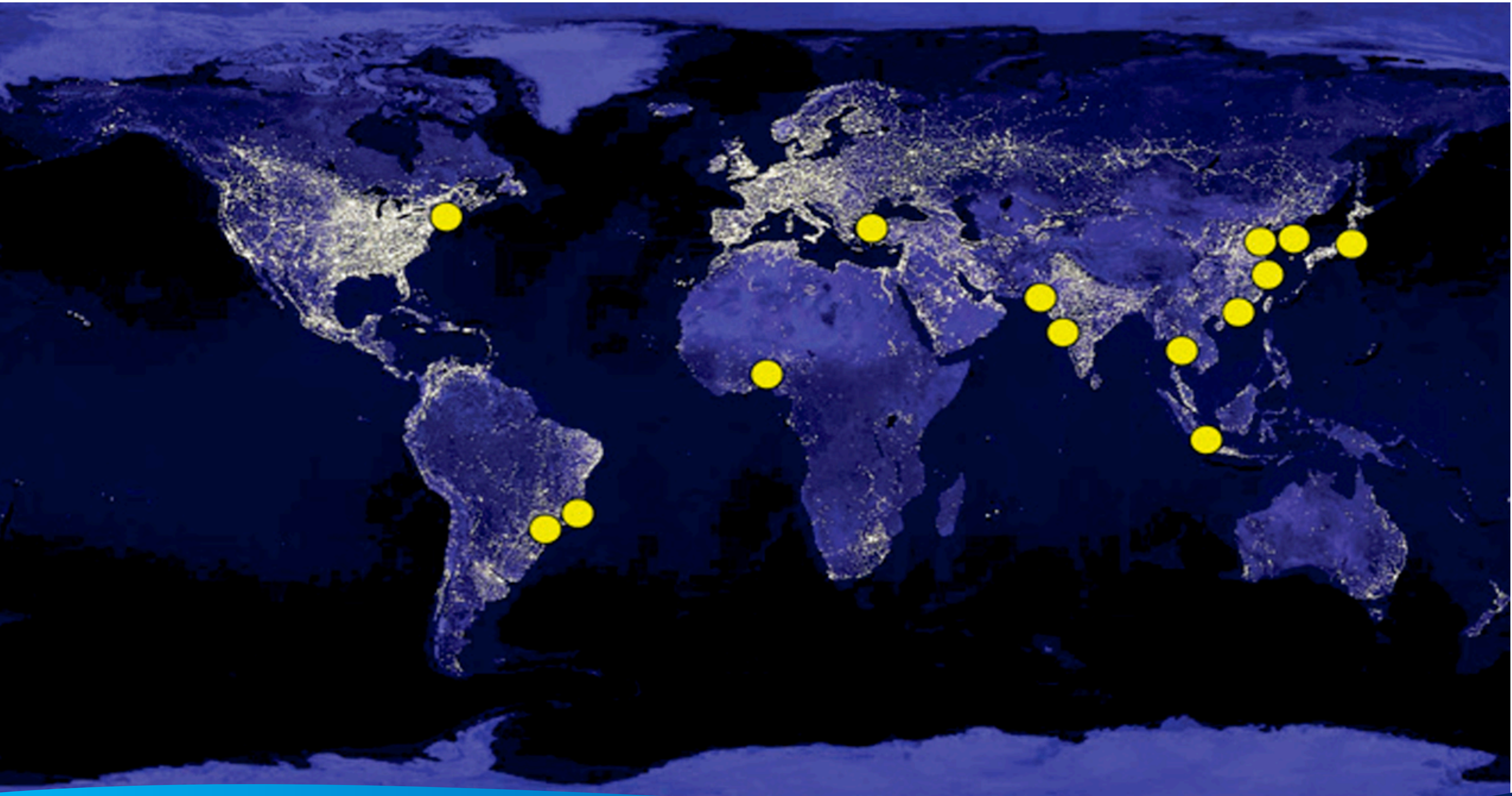
- Ozonation
- Hydrogen Peroxide
- Peroxone
- Fenton Reagent
- UV Radiation
- Ultrasounds
- Persulfate

OUR SUGGESTION:

COMBINATION OF AOPs DEPENDS ON THE SLUDGE CHARACTRISTICS

Hybrid WWT and Desalination by EDR, LPNF-RO and/or FO-RO

(Case Study – 14 Major Cities)



Hybrid WWT and Desalination by FO-LPRO
System Layout

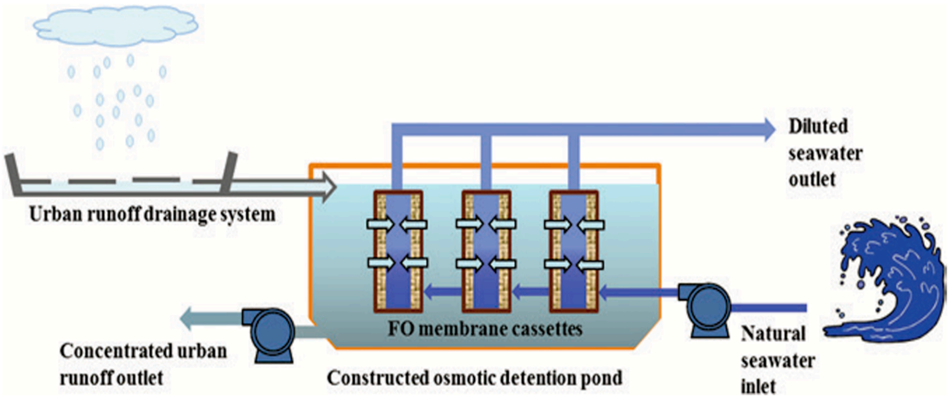


Figure 2.1.1 Diagram of the osmotic detention pond for the treatment of urban runoff in coastal regions.

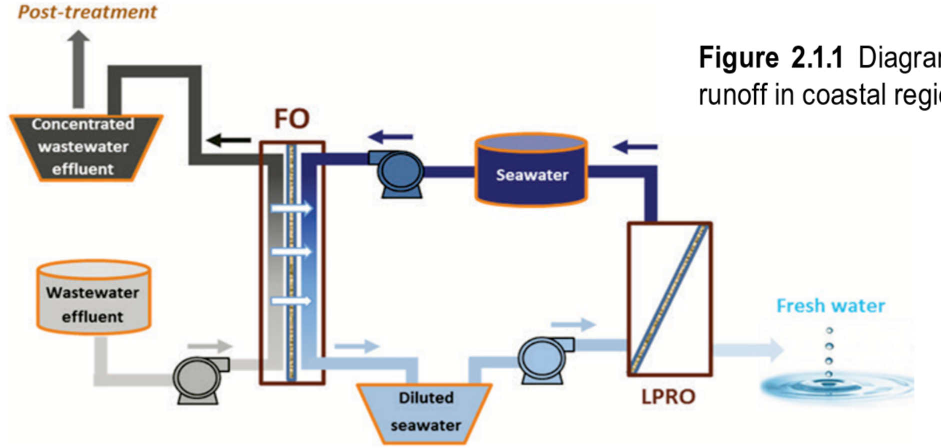


Figure 1.1.6 FO-LPRO system layout combining wastewater recovery and seawater desalination.

FO-LPRO Versus SWRO

Energy Consumption

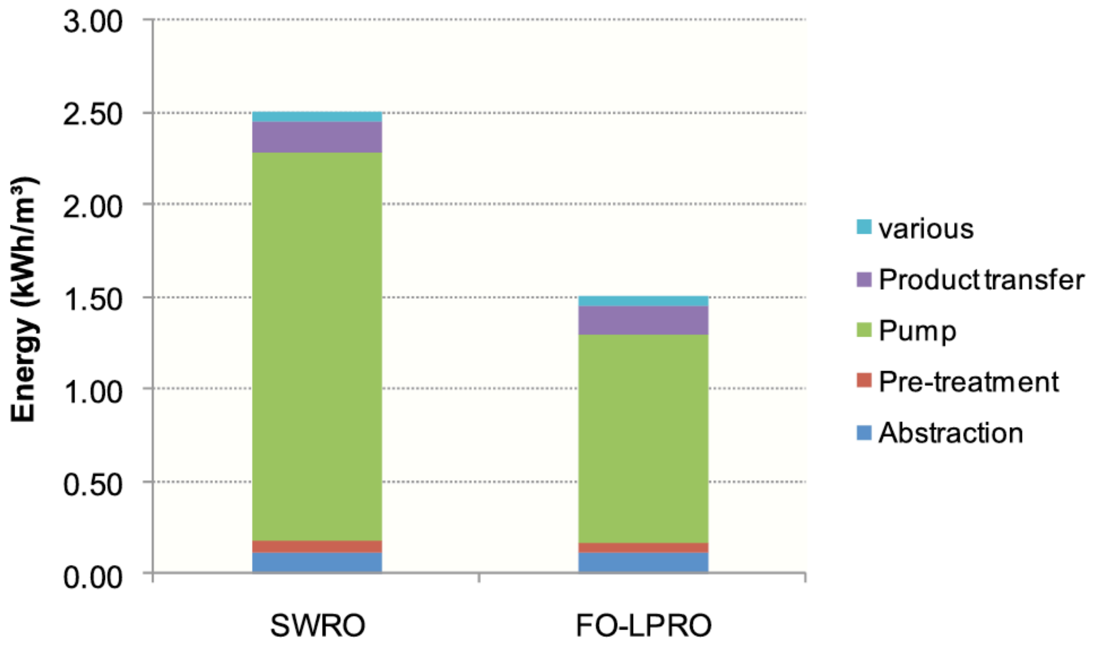
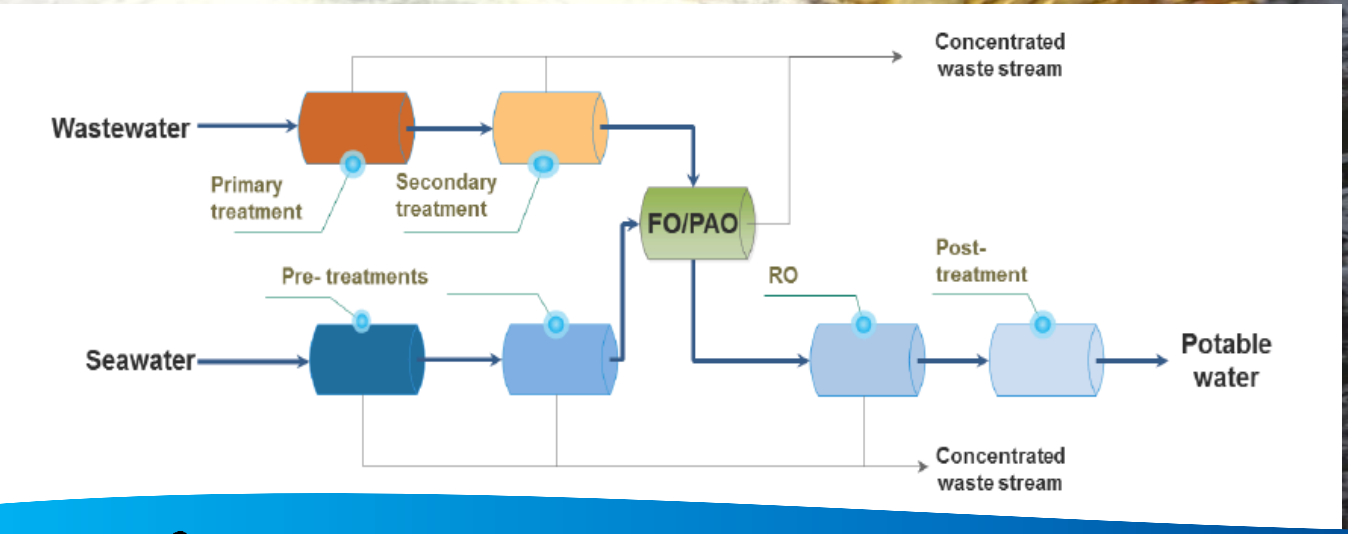
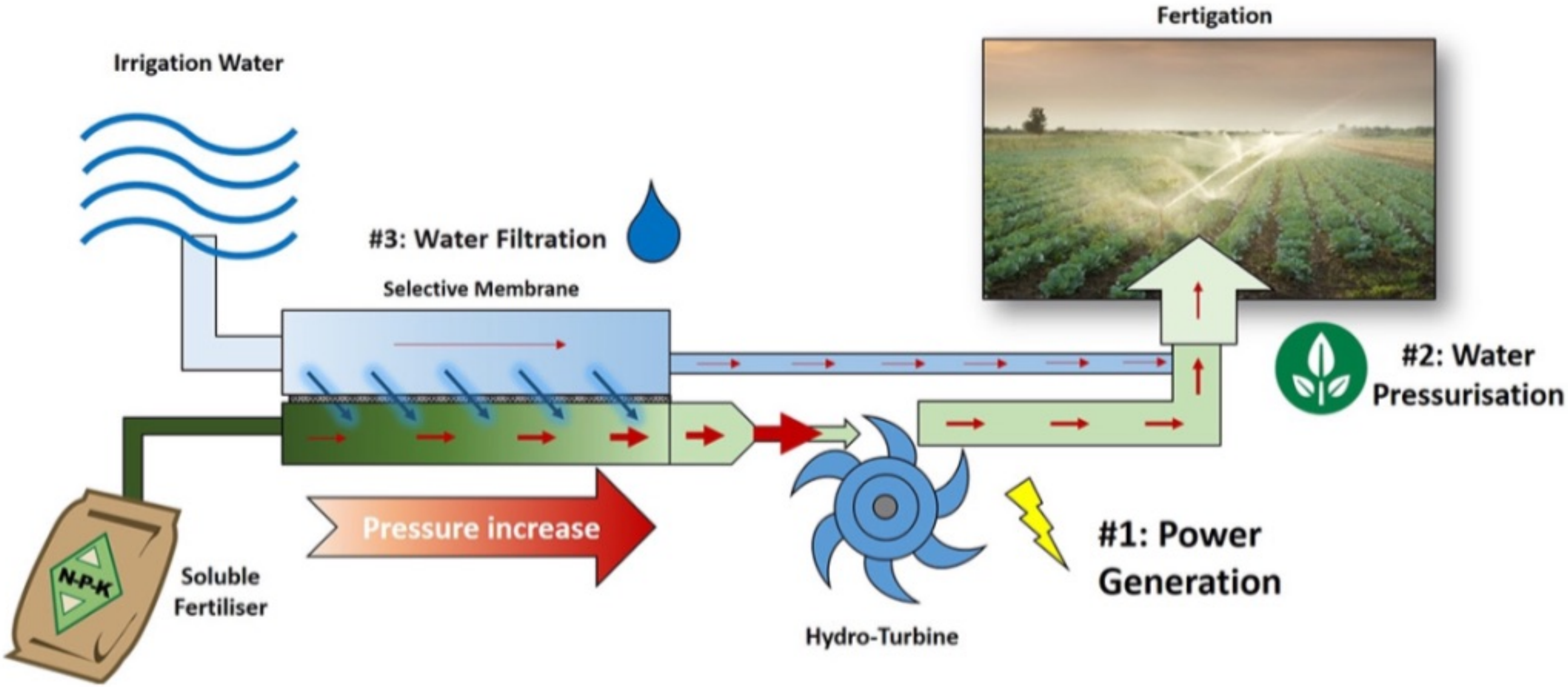


Figure 2.3.8 Comparison of energy consumption between desalination with RO and desalination with immersed FO-LPRO.

Hybrid FO-RO for industrial waste water reuse



Forward Osmosis Application
In irrigation systems



Summary
Water & Energy Hierarchy

Keeping parts for longer. Design for easier dismantling and recycling. Minimise number of materials in design and manufacture.

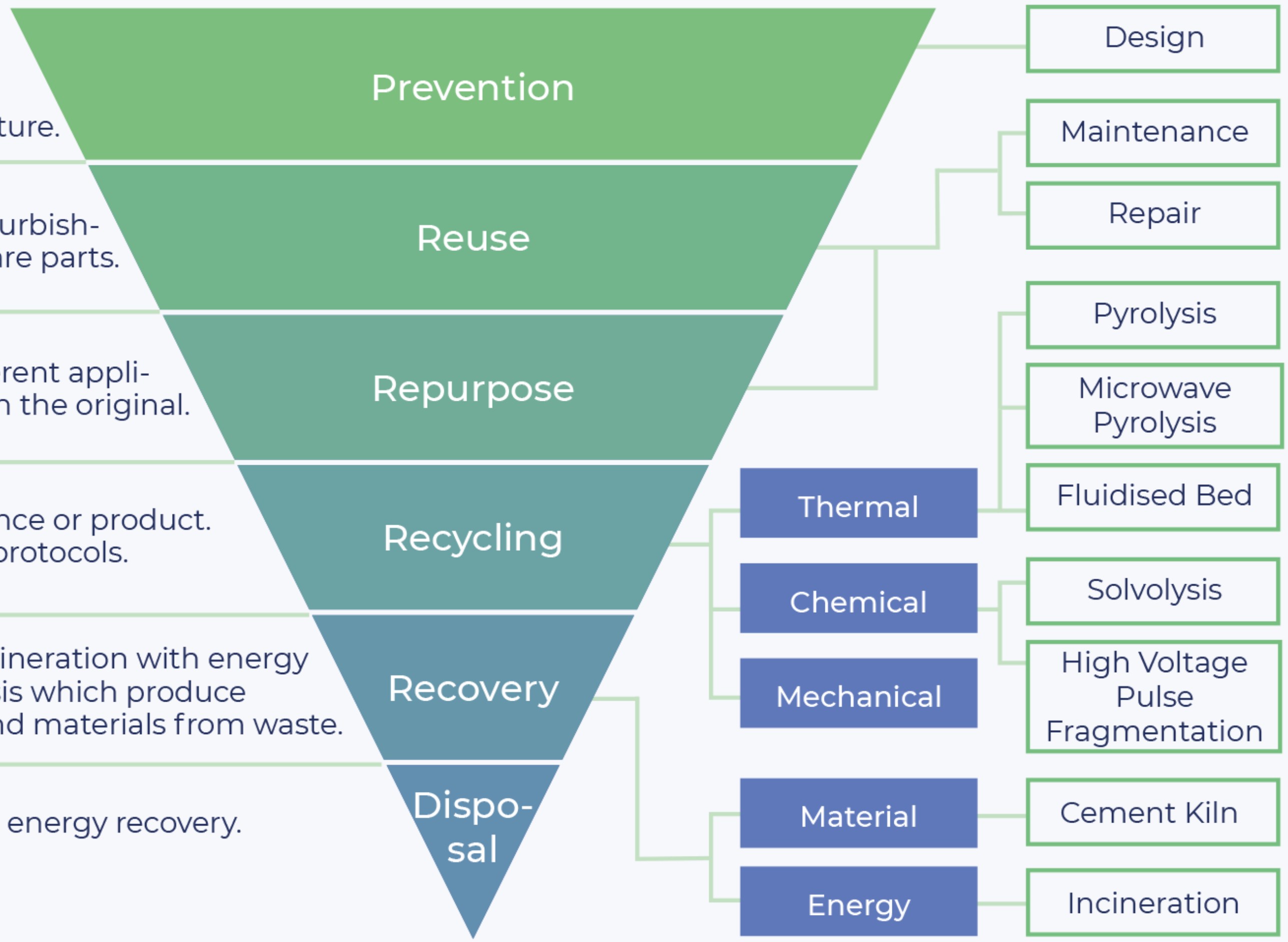
Checking, cleaning, repairing, refurbish-ing, repair for whole itelms or spare parts.

Re-use an existing part for a different appli-cation, usually of lower value than the original.

Turning waste into a new substance or product. Includes composting if it meets protocols.

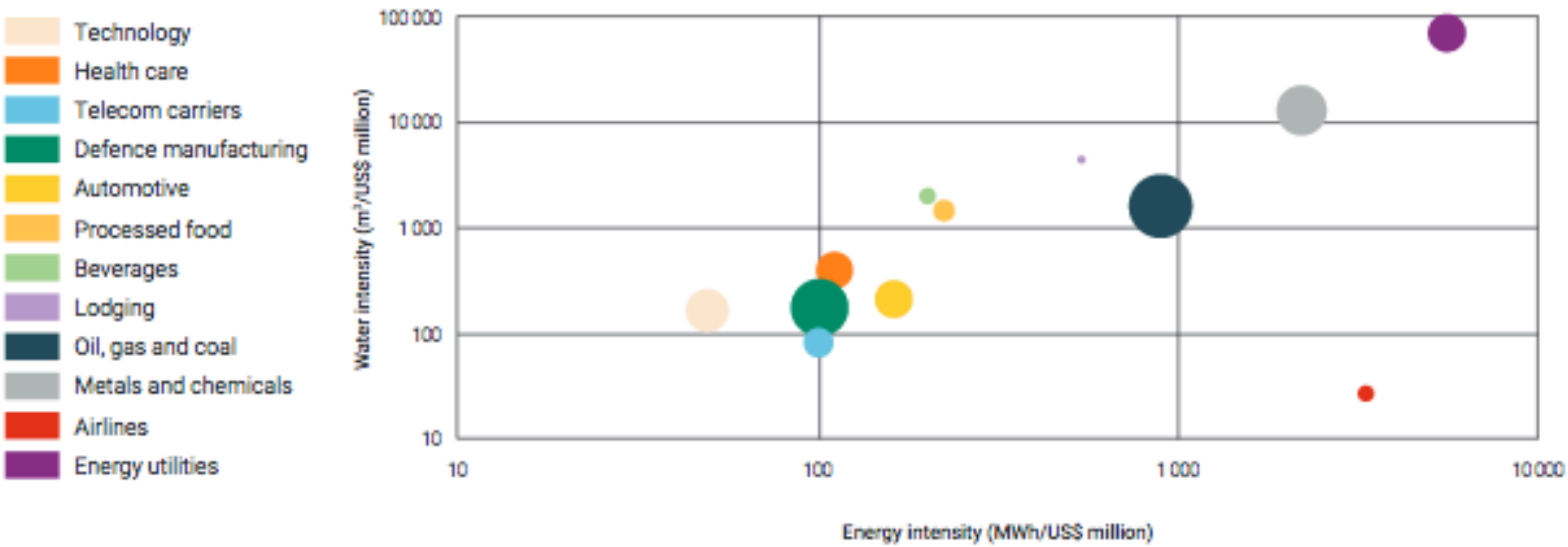
Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste.

Landfill and incineration without energy recovery.



Summary
Water & Energy Intensity

Figure 7.3 Water and energy intensity of major industries

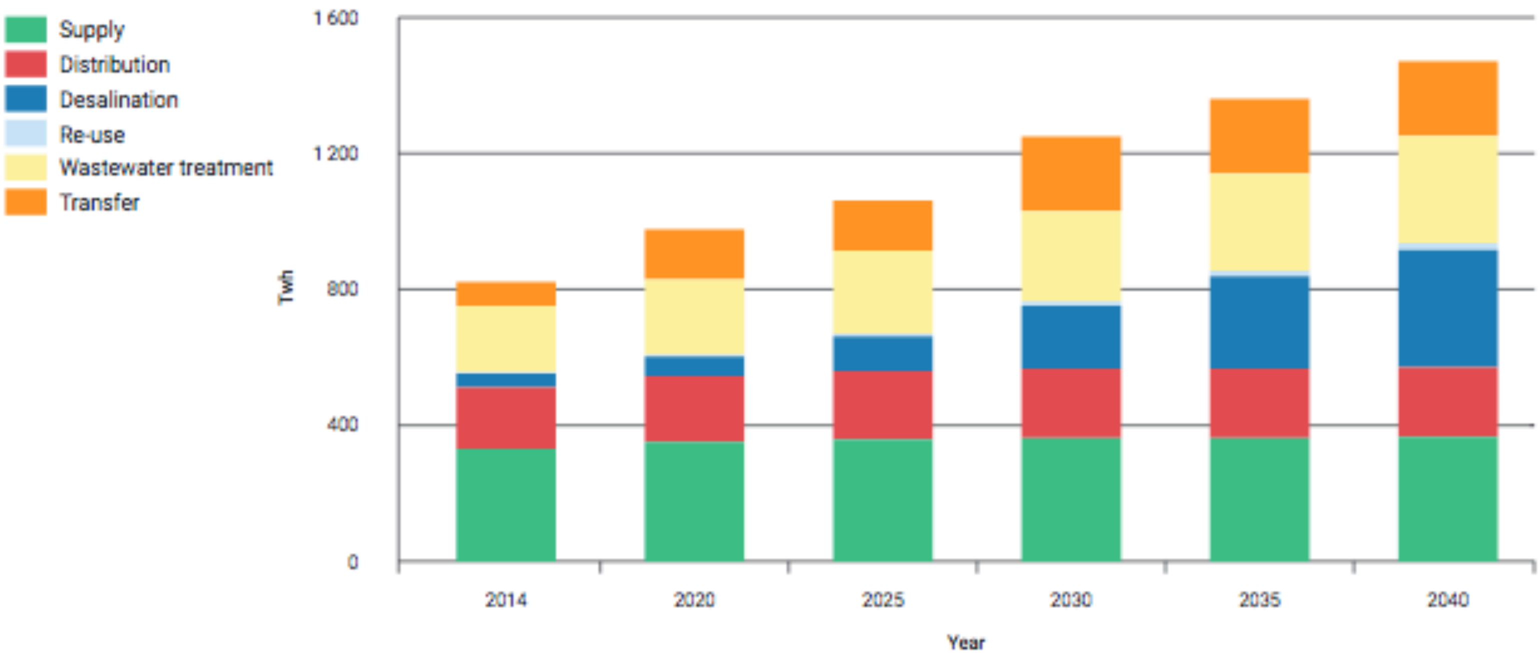


Note: Bubble area proportional to total industry revenue.

Source: Metzger et al. (2016, fig. 2, p. 4).

Summary
Electricity Consumption (Water Sector)

Figure 3.2 Electricity consumption in the water sector by process, 2014–2040



Conclusion
Water and Energy: A tale of two resources

- Improving efficiency W&E allow countries to reduce resource scarcity & maximize the benefits provided by existing W&E infrastructure.
- W&E efficiency “doing more and better with less”
- Without efficiency gains, demand 40% by 2030
- Energy uses about 8-40% of all freshwater withdrawn worldwide.
- Energy demand increases 30% by 2035, Water needs for energy production are set to grow at twice the rate of energy demand.

YEAR ZERO

The year when wild animals are gone

100% of wild vertebrates will be gone by 2026

For more information please click on Reference 1 & Reference 2

Conclusion | New Technologies Challenging Rules

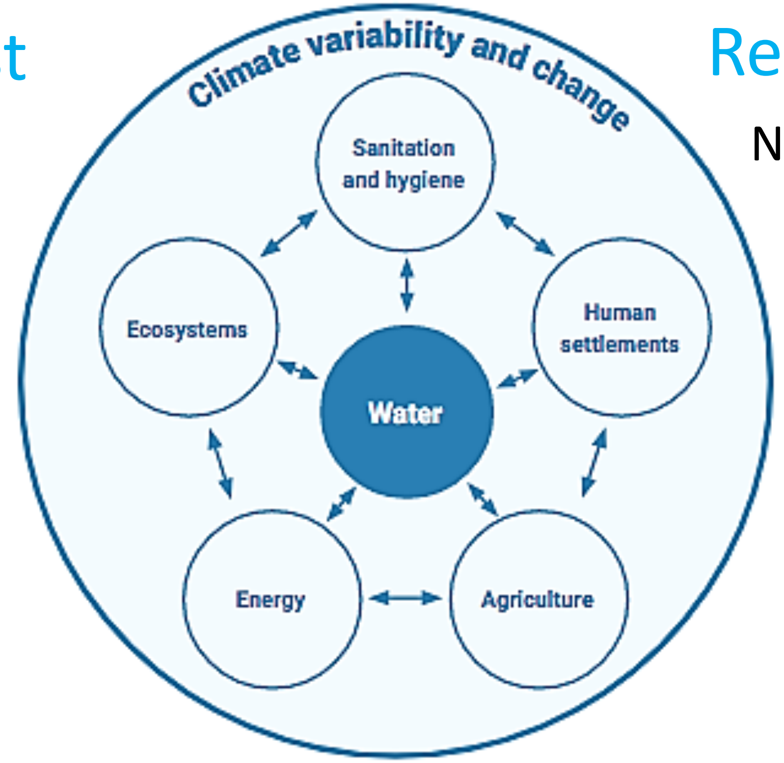
Reducing the Cost

H2 Fuel, Coal, Nuclear

Renewable, Solar

Artificial Intelligence

Hybrid Technologies



Reducing the waste

Nuclear, Acid Mine, Brine

Solar Panels, Turbine

Membrane Re-use

Recycle, biomaterial

The frightening merchant, the trembling of the soul, in the world, does not benefit, does not harm

تاجرترسنده دل، لرزنده جان، درجهان، نی نفع بیند، نی زیان


THANKS TO
ALL OF US
Maafushivaru
Island Maldive
Please Consider the Environment
OSMOTEC
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