Water & Energy Management

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OSMOTEC

YEAR ZERO

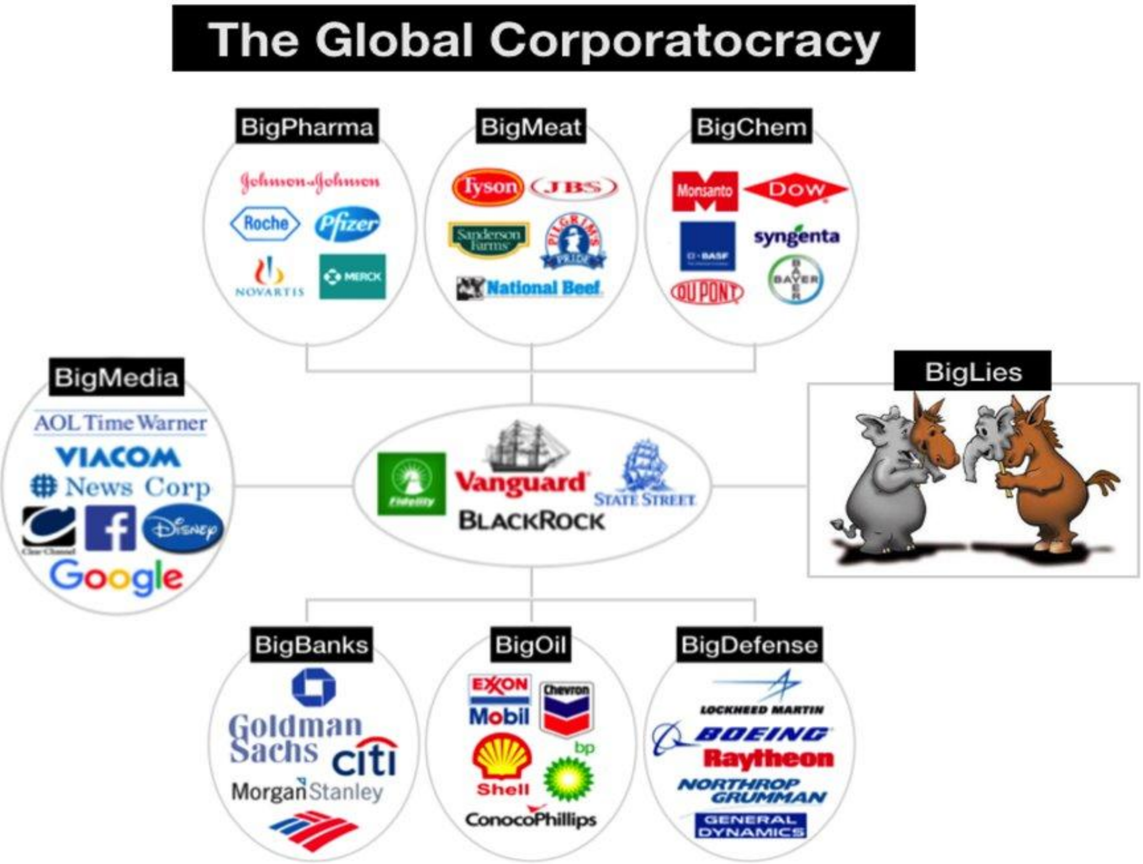
the year when wild animals are gone

100% of wild vertebrates will be gone by 2026

For more information please click on Reference 1 & Reference 2

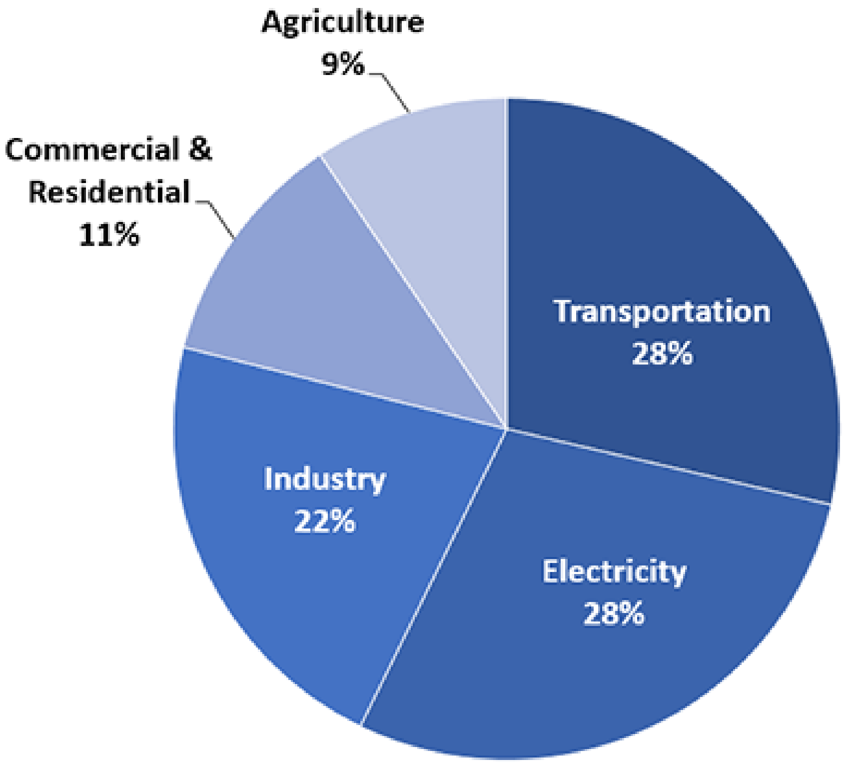
Worth $15T and Control $50T

250 BT Chemical = 7 x CO2 Pouring to Atmosphere



Worth $15T and Control $50T

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2016



Total Emissions
in 2020
over
35,000
Million Metric Tons
of CO_2 equivalent

China 28%,
USA 14%,
Europe 10%,
Iran 2%

More than just temperature
climate change and ocean acidification

- Carbon dioxide (CO_2) from the atmosphere is being absorbed in greater amounts in the surface ocean.
- As the surface ocean takes up more CO_2, it becomes more acidic (pH becomes lower).
- Lower pH affects ocean chemistry and makes it harder for many marine animals to build their skeletons and shells.
- The oceans are going to feel the effects of CO_2 for a long time—it takes tens of thousands of years for oceans to recover their pH once it has been changed.

Plastic Pollution by COVID-19

- For instance, an estimated monthly use of 129 billion face masks and 65 billion gloves would be necessary to protect citizens world wide
- use of reusable masks significantly reduces the amount of waste by 95%, followed by reusable masks with disposable filters (60%).
- estimated recommended monthly consumption of 65 billion gloves globally ((14 Mt CO_2 eq)
- synthetic rubber gloves produced in Malaysia, the production of each kilogram of product consumes up to 10.0413 MJ of energy, with impacts highly dependent on energy production. In Thailand, the total carbon footprint emission of 200 pieces of rubber glove was about 42 kg CO_2-eq

Water Used in meet production in 2020

285,240,789

Tons of meat eaten

GLOBALLY, THIS YEAR

IN 2020 | THIS MONTH | THIS WEEK | TODAY

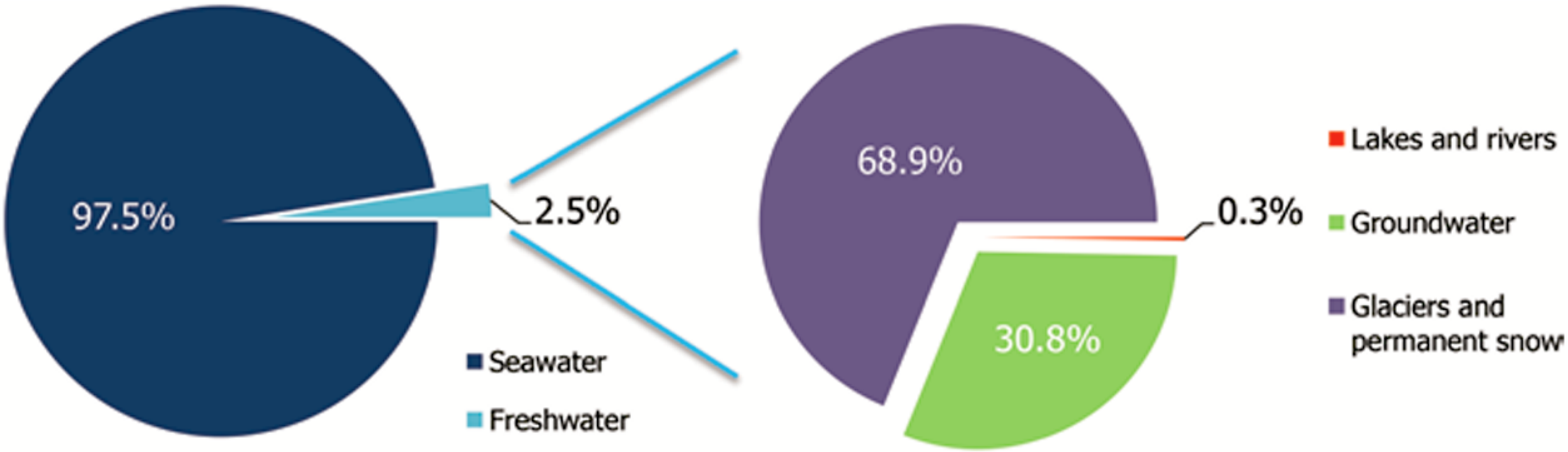
1,873,708,726,900

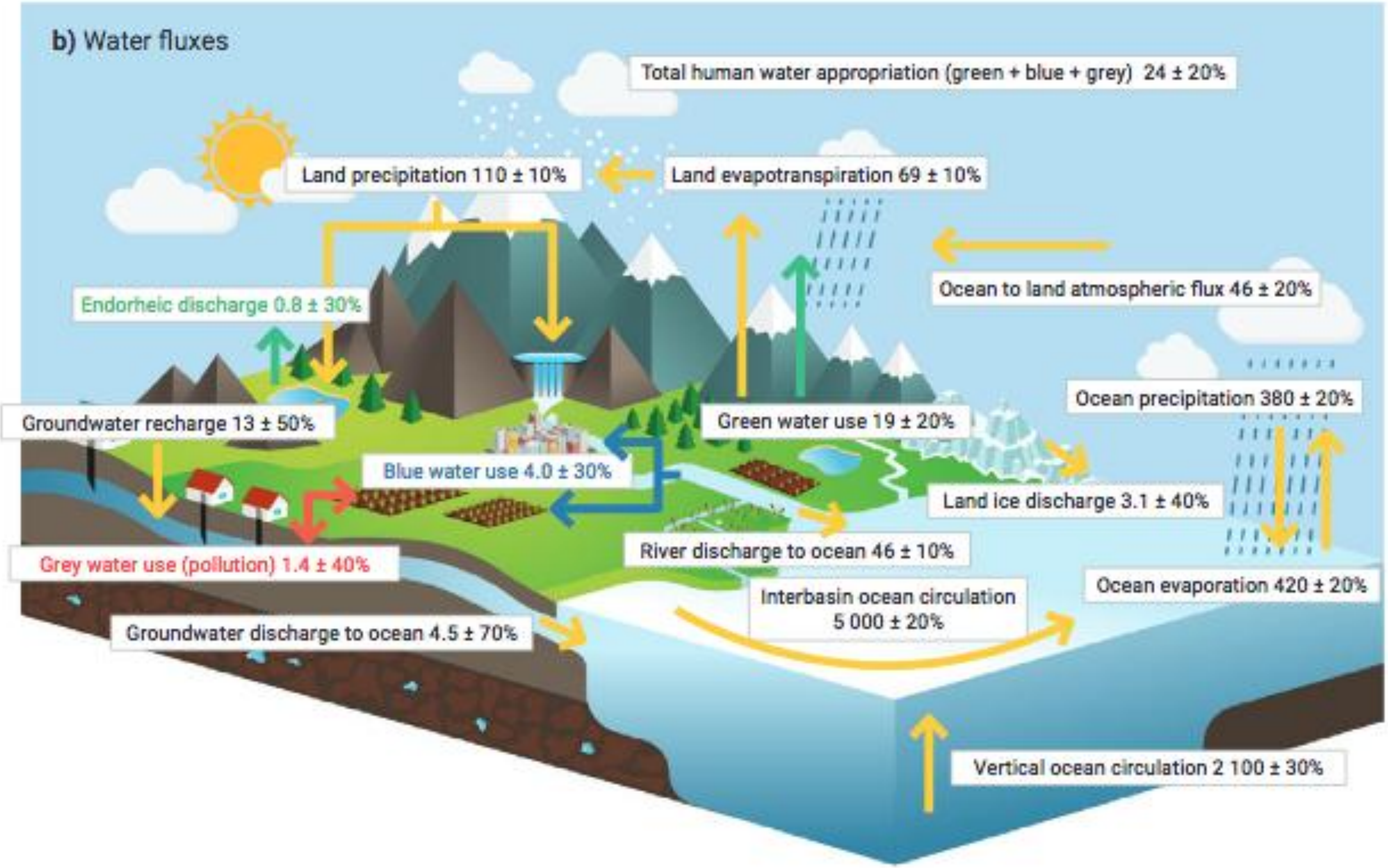
Tons of water used in meat production

GLOBALLY, THIS YEAR

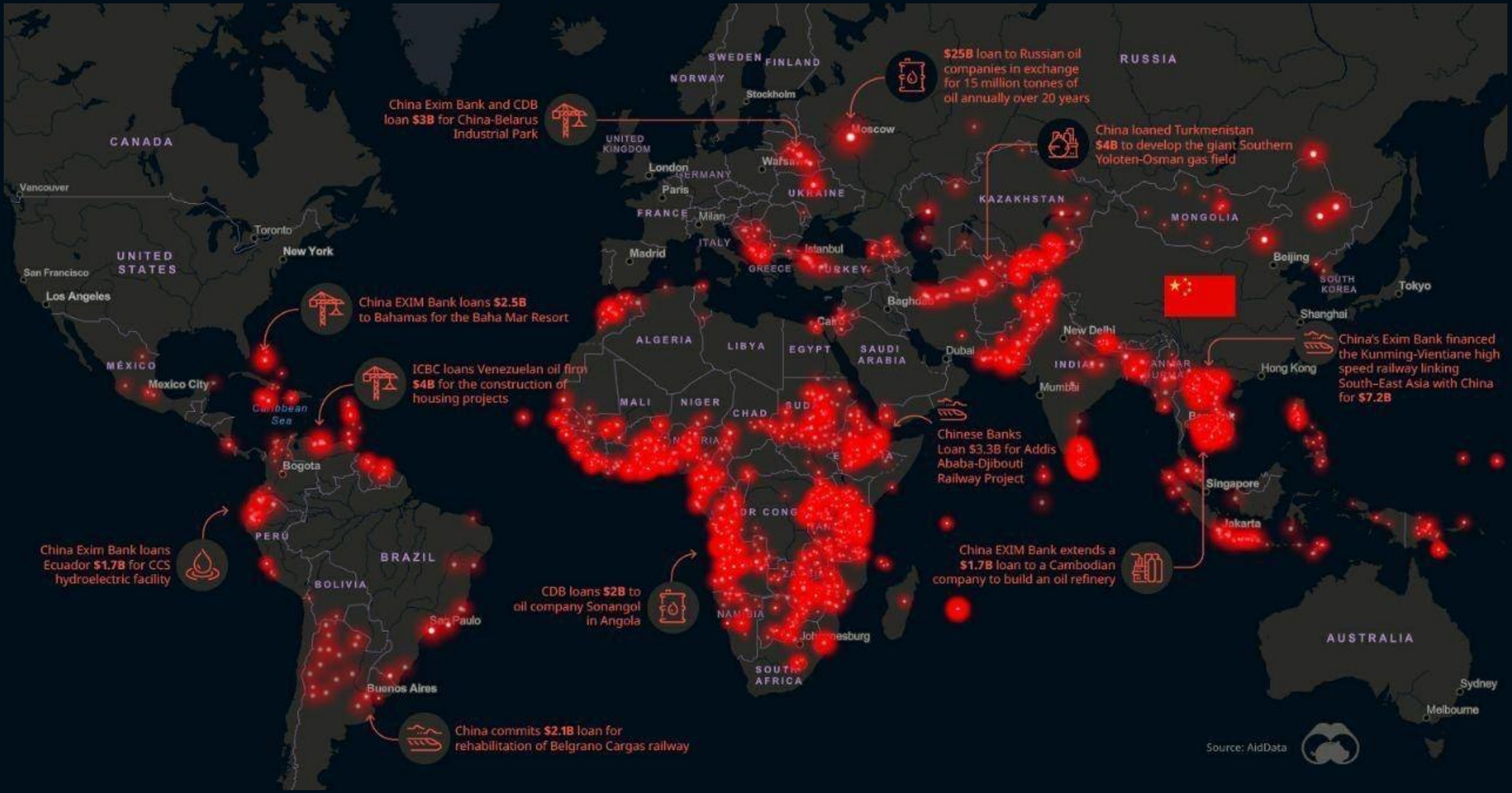
IN 2020 | THIS MONTH | THIS WEEK | TODAY

Available Freshwater




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%
Grey water use (pollution) 1.4 ± 40%
River discharge to ocean 46 ± 10%
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)



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. Chemical industries also consume 20% of total energy.
- **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,...)

BEST

remove	• eliminate demand altogether (aka "prevention" or "conservation")
reduce	• use less resource to meet the need (aka "minimisation")
re-source	• change materials or sources (e.g. use low carbon electricity to meet demand)
reuse	• re-introduce into same flow
recycle	• use in a different flow (may involve "downcycling")
recover	• capture some value (e.g. in an energy from waste plant or as a nutrient e.g. compost)
return	• return in an environmentally benign way. This may require treatment or containment.

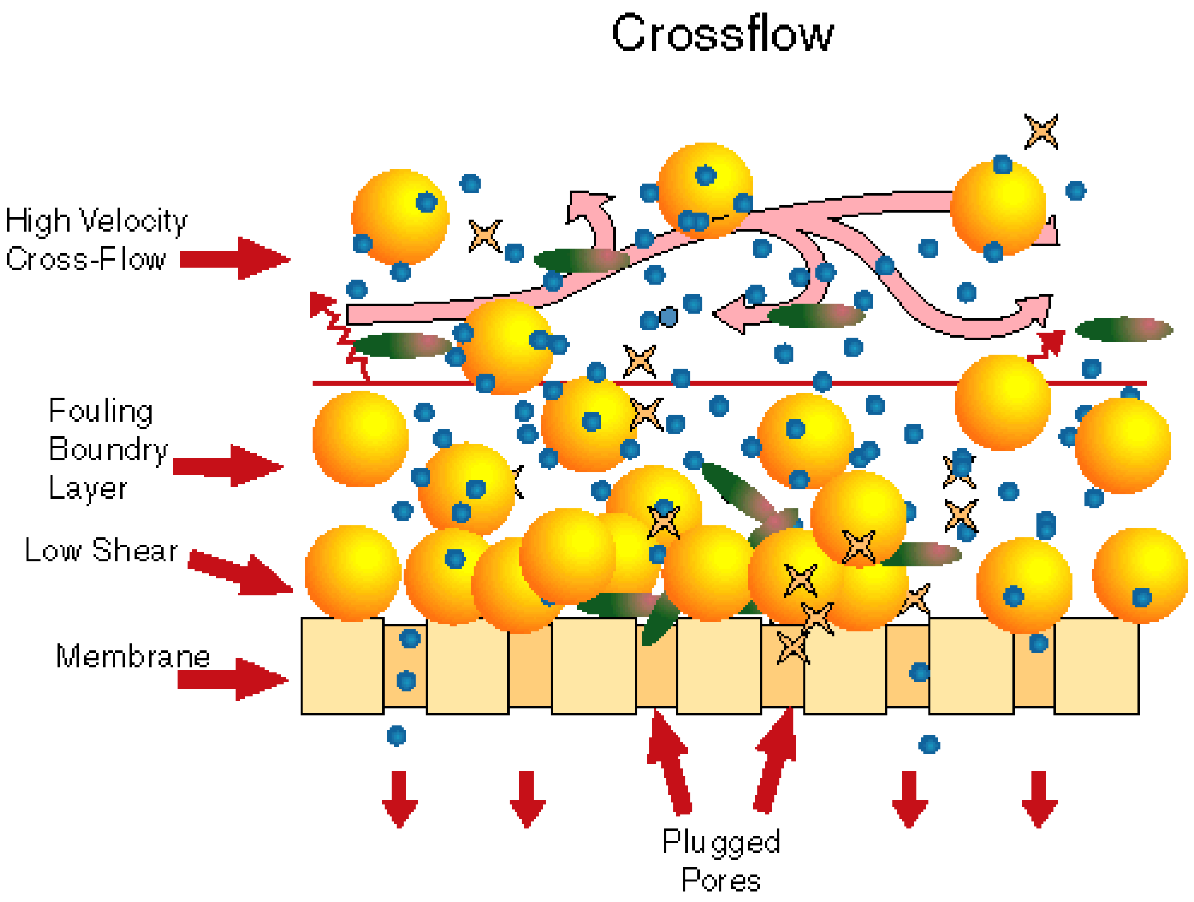
WORST

OSMOTEC

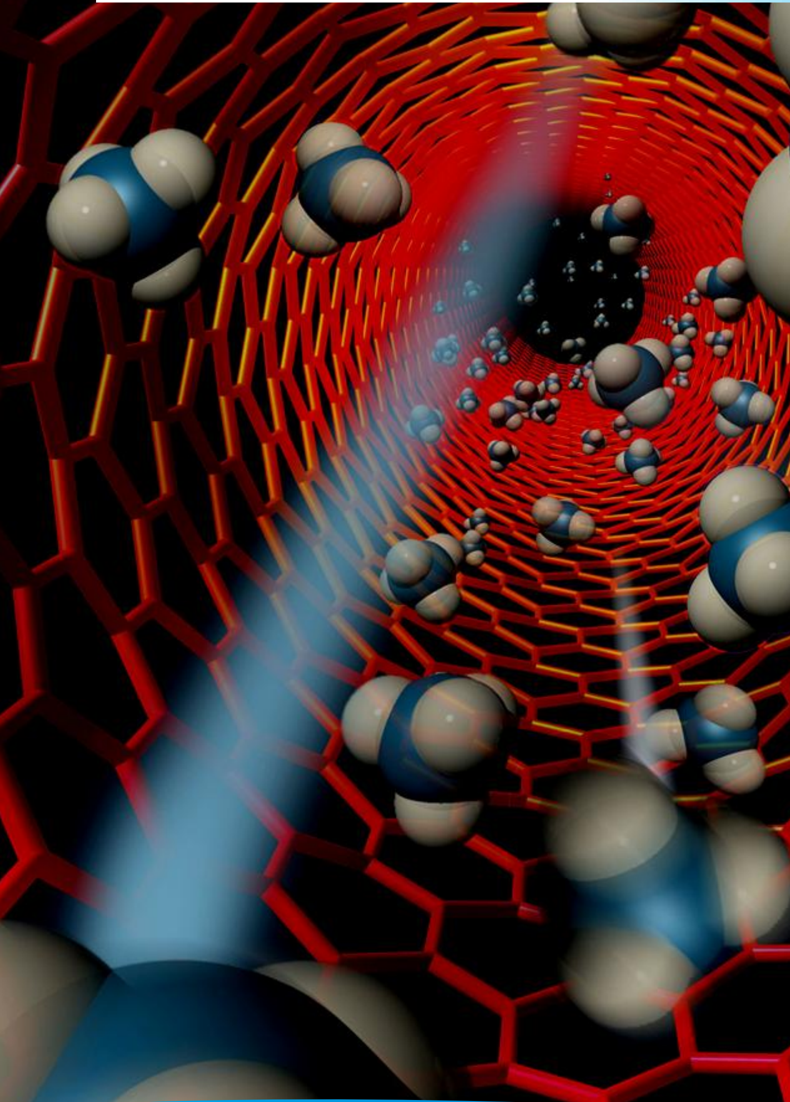
Top 10 Technologies

- 1. Nano-engineering membrane
- 2. Aquaporins
- 3. Bio-polymers from wastewater
- 4. Biogas recovery
- 5. Microbial fuel cells
- 6. Vapour transfer irrigation
- 7. Ultrasonic sludge pre-treatment
- 8. Phosphorous recovery
- 9. Decentralised wastewater treatment
- 10. Forward osmosis

Fouling Mechanism



Nanotube Membrane



Despite improvements, reverse osmosis membranes still offer disappointingly low flux rates. New developments such as nano-composite membranes and carbon nano-tubes will significantly reduce the energy required in desalination.

Two firms from the University of California, NanoH2O and Porifera, are at the cutting edge of this technology.

Nano Ceramic Membrane

Nano ceramic membranes™ ("gills") are formed into a loop pair separated by a spacer to allow for airflow.

▼

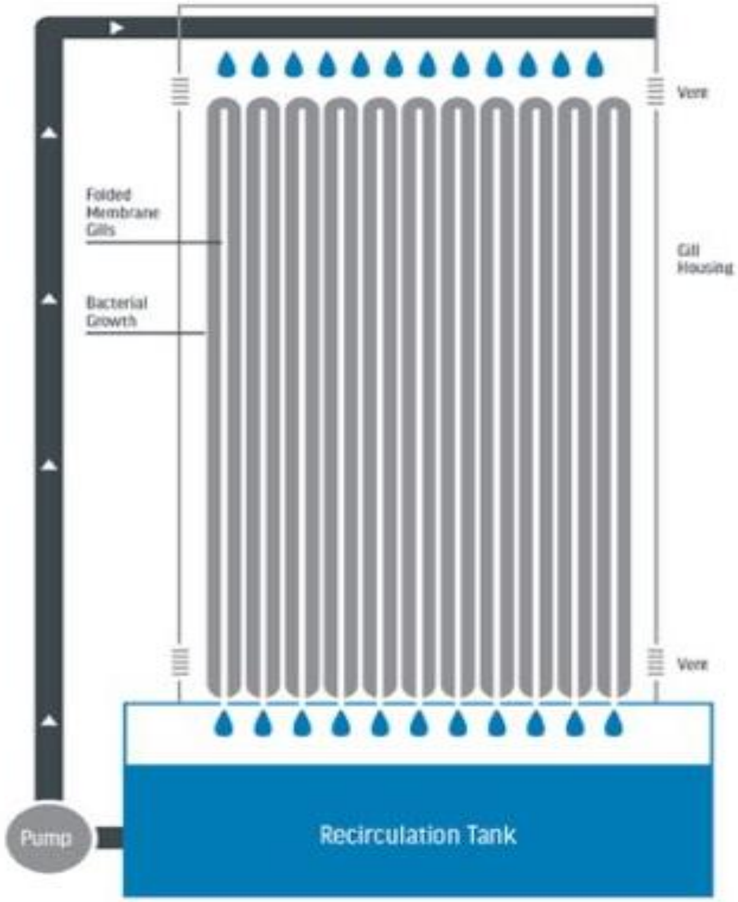
Creating an air/liquid interface the gills are compacted vertically in a treatment core.

▼

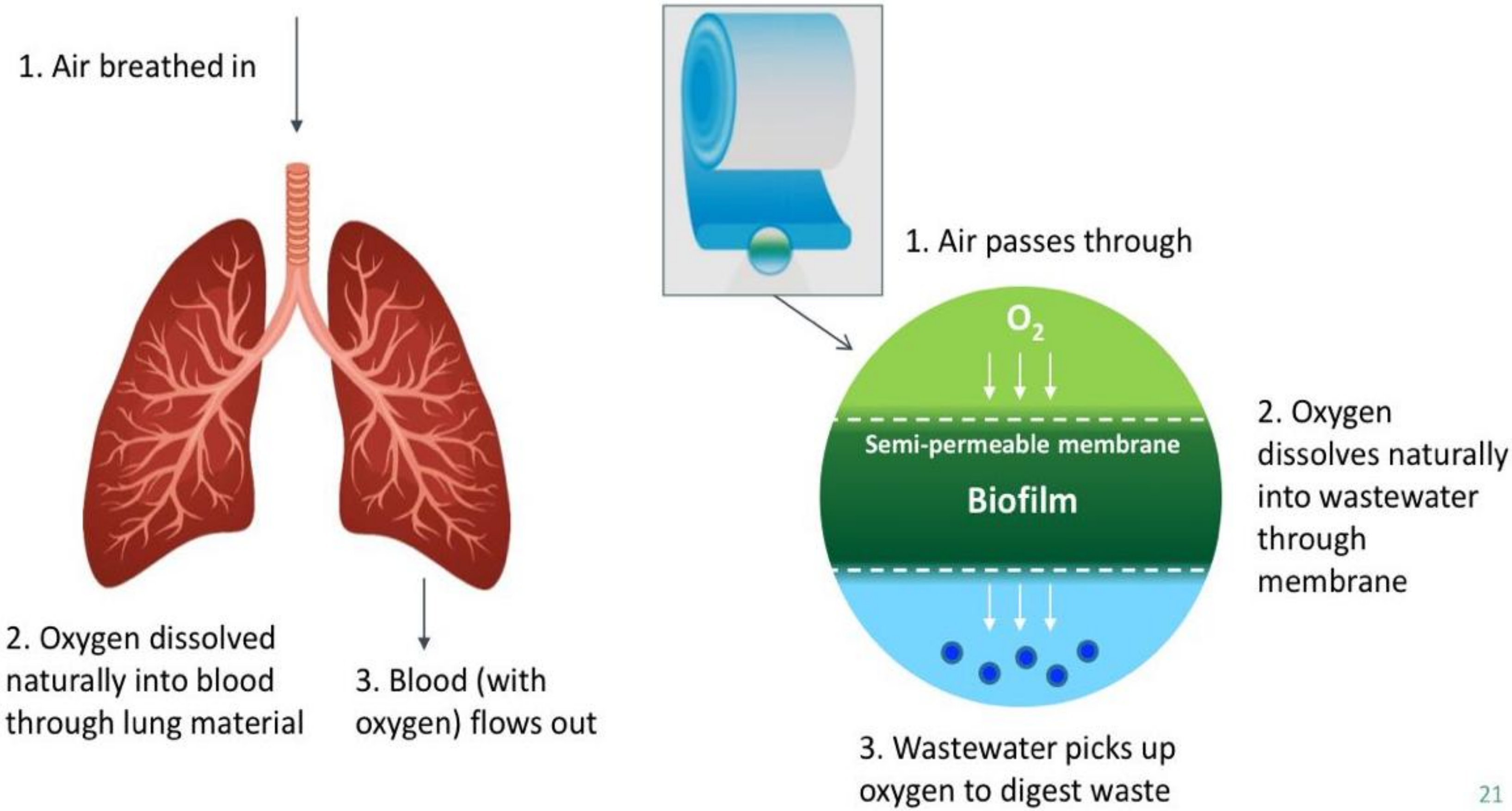
Wastewater is dispersed over the gills and then gravity fed through this core.

▼

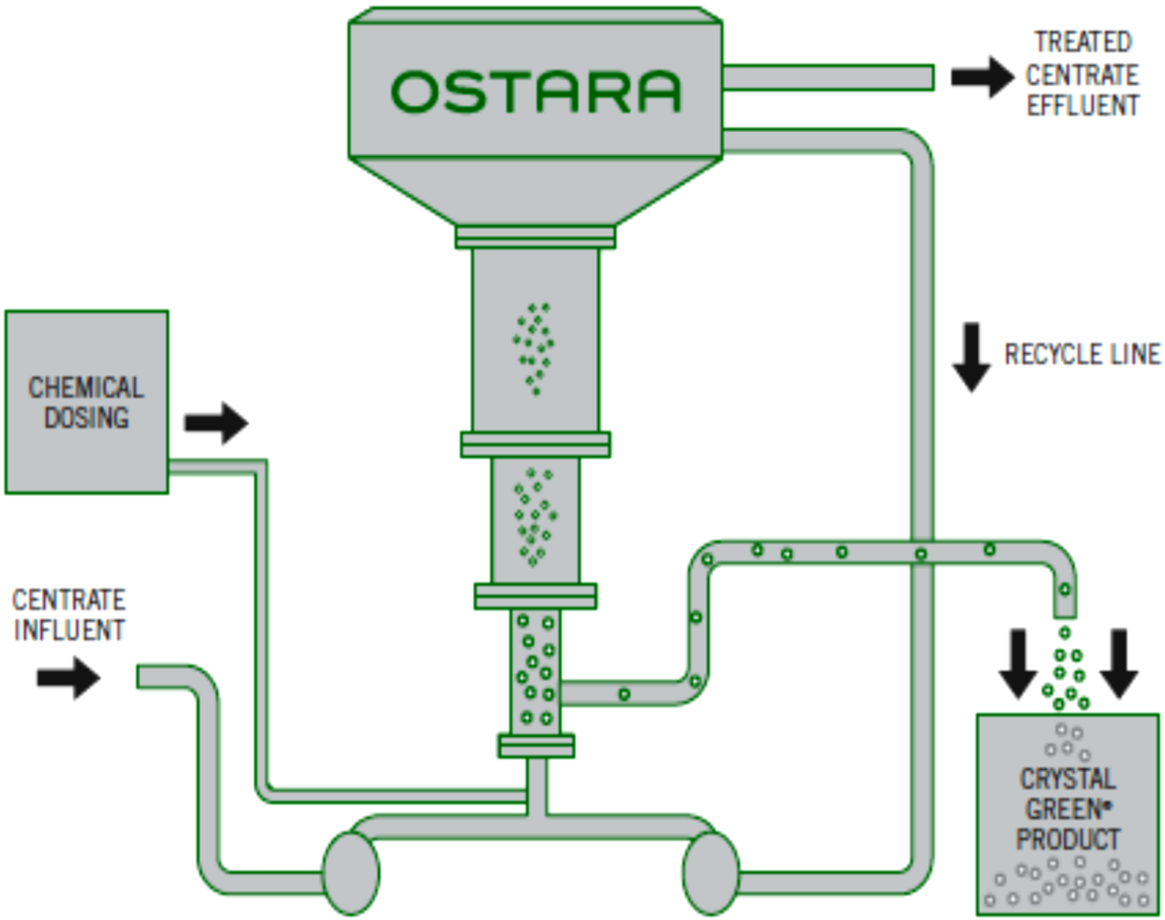
Nutrients are quickly removed as wastewater contacts the biomass on the gills.



MABR Inspired by nature



Phosphorus Recovery

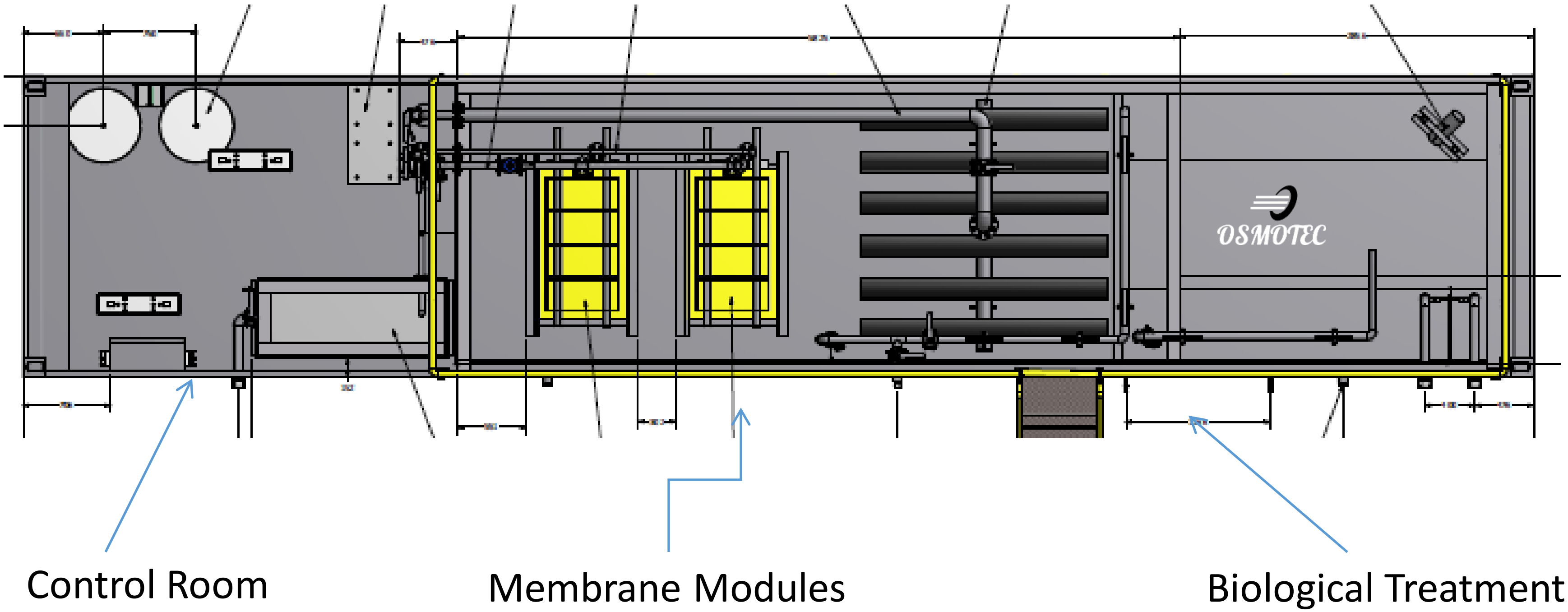


Decentralized Wastewater Treatment

His technology stands behind 80% of anaerobic (oxygen-free) water treatment systems used worldwide and enables efficient purification of highly polluted used water while producing renewable energy

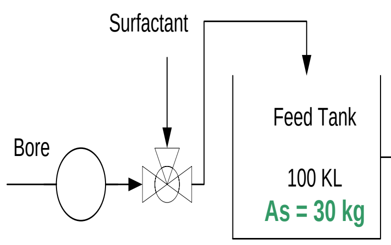
Sustainable society		
Anaerobic Technology	Environmental capacity building New sanitation (concepts) Water and waste treatment Cradle to cradle Closing nutrient cycles Resource recovery Bio-energy Digestion Environmental risk assessment	DESAR
Sustainable technology		

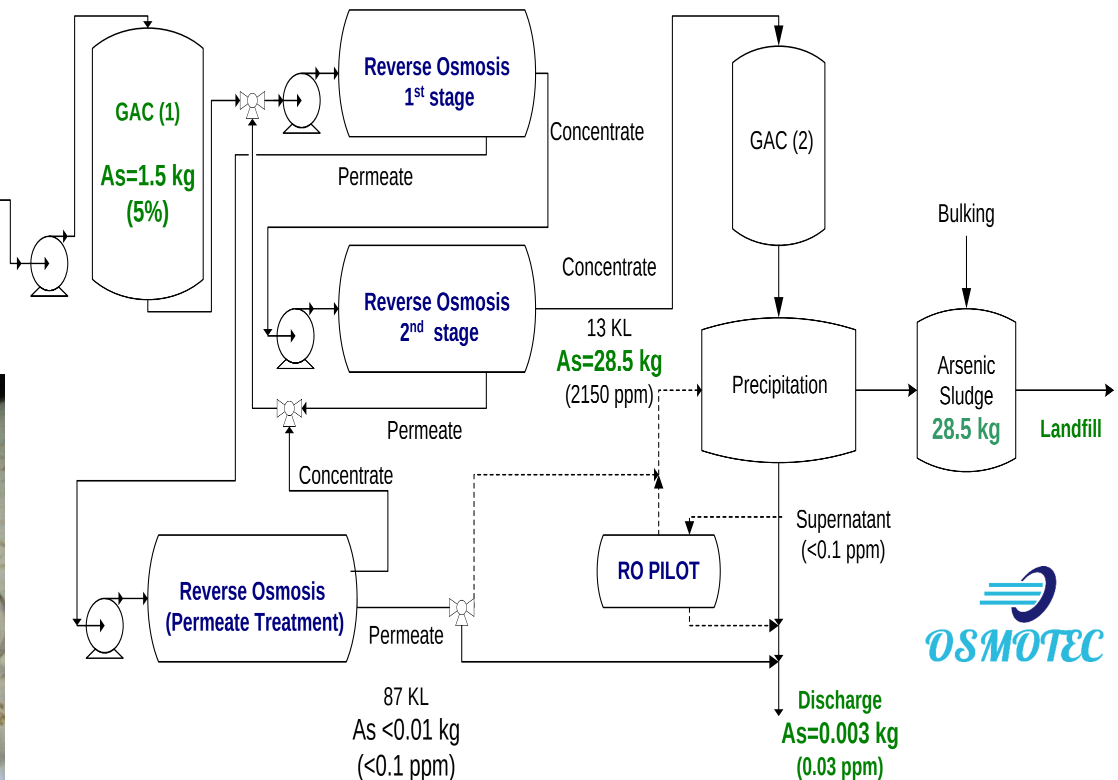
Modular Mobile Hybrid – STP
Sewage Treatment Plant (50 kl/d)



MMH – 50

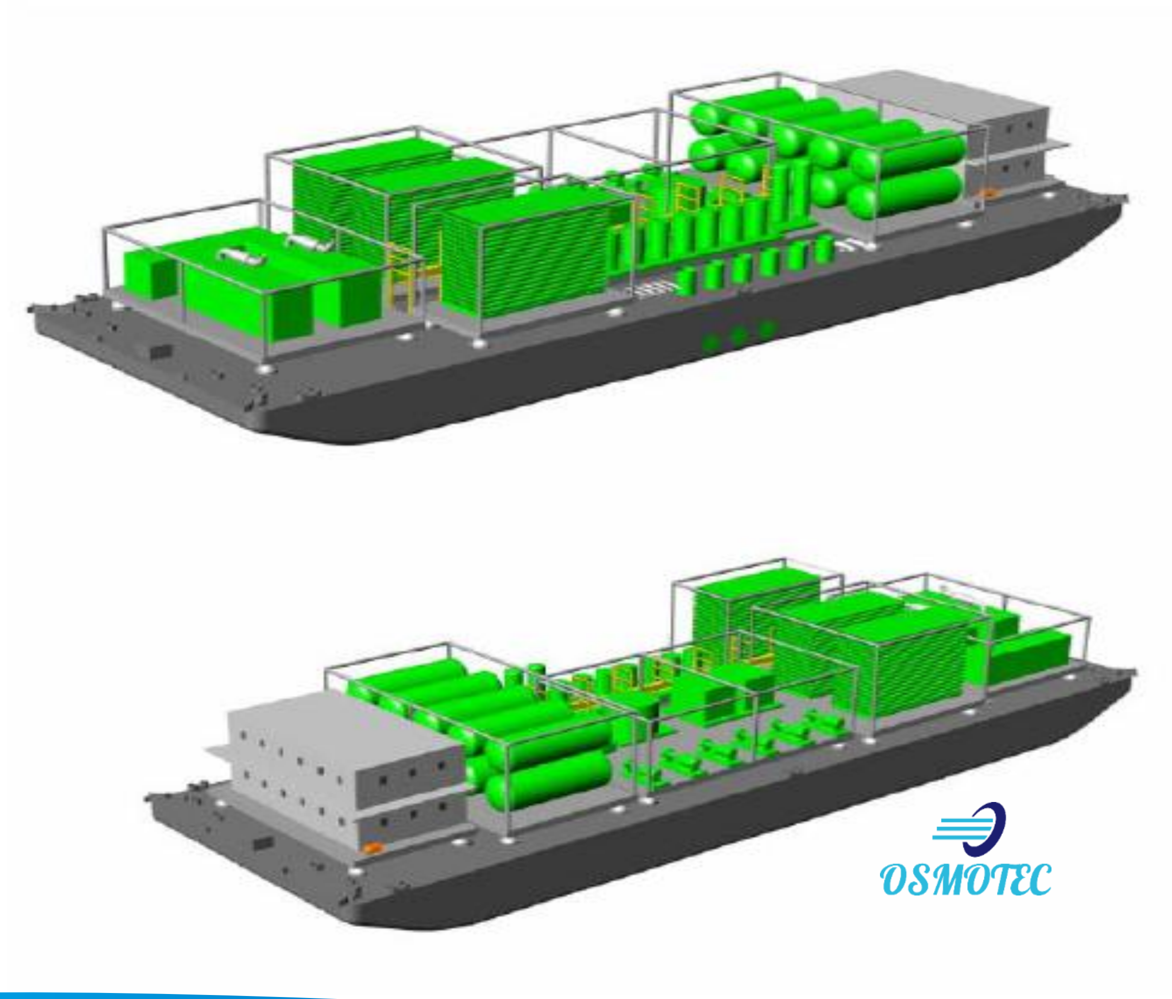
Heavy Metal/Industrial Treatment Plant
(Hybrid Membrane System Solution)





OSMOTEC

Mobile Seawater Desalination Plant
(Membrane Solution) – 25 MLD



Energy Comparisons of
A Seawater Desalination Plant

One Jumbo Jet

Equal to 400 MLD Desalination Plant

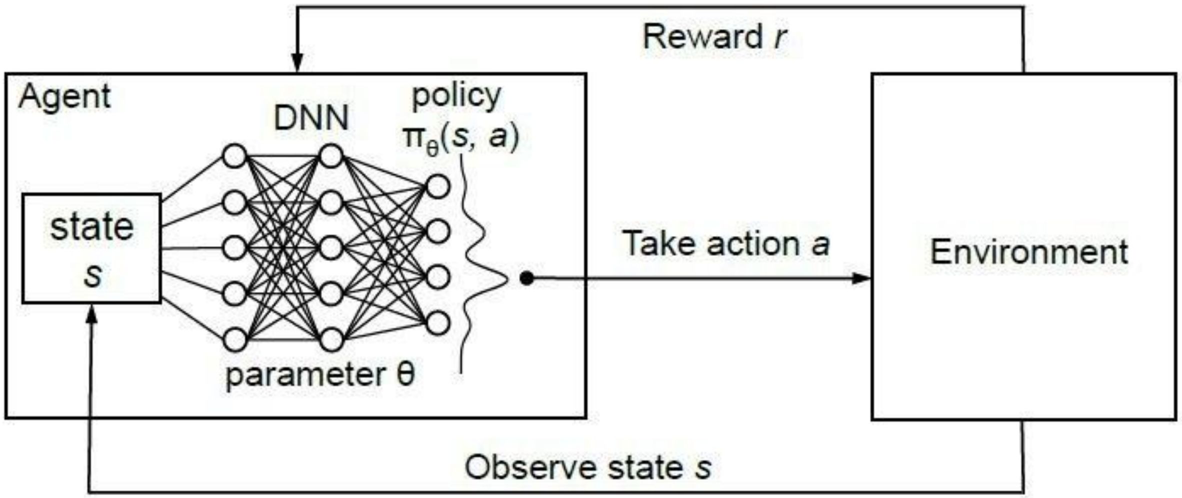
Taking Off Power	= 77 MW
Cruising Power	= 65 MW
Full Power of One Engine	= 26 MW
Full Power Requirement PSDP	= 24 MW

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

=  +  + 

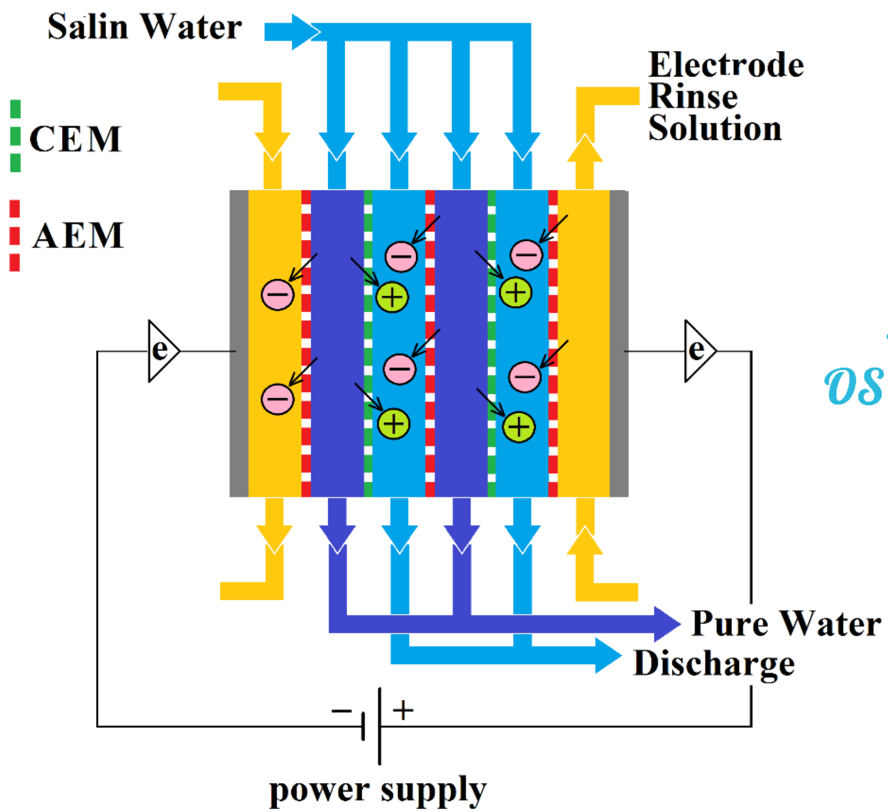
ARTIFICAL INTELIGENCE (AI)

UP to 20% less OPEX



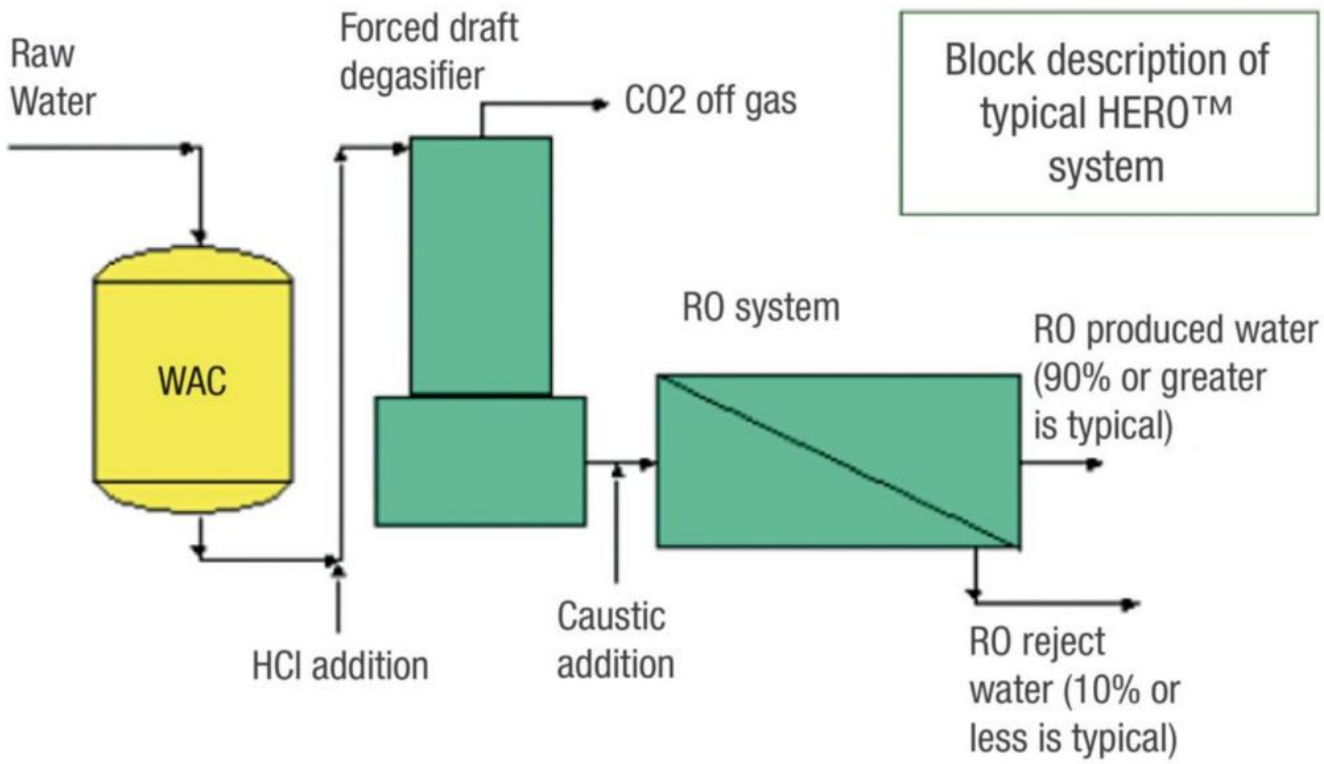
Optimized Electrodialysis (OED)

UP to 75% less Brine recovery



High Efficiency Reverse Osmosis (HERO)

UP to 95% recovery



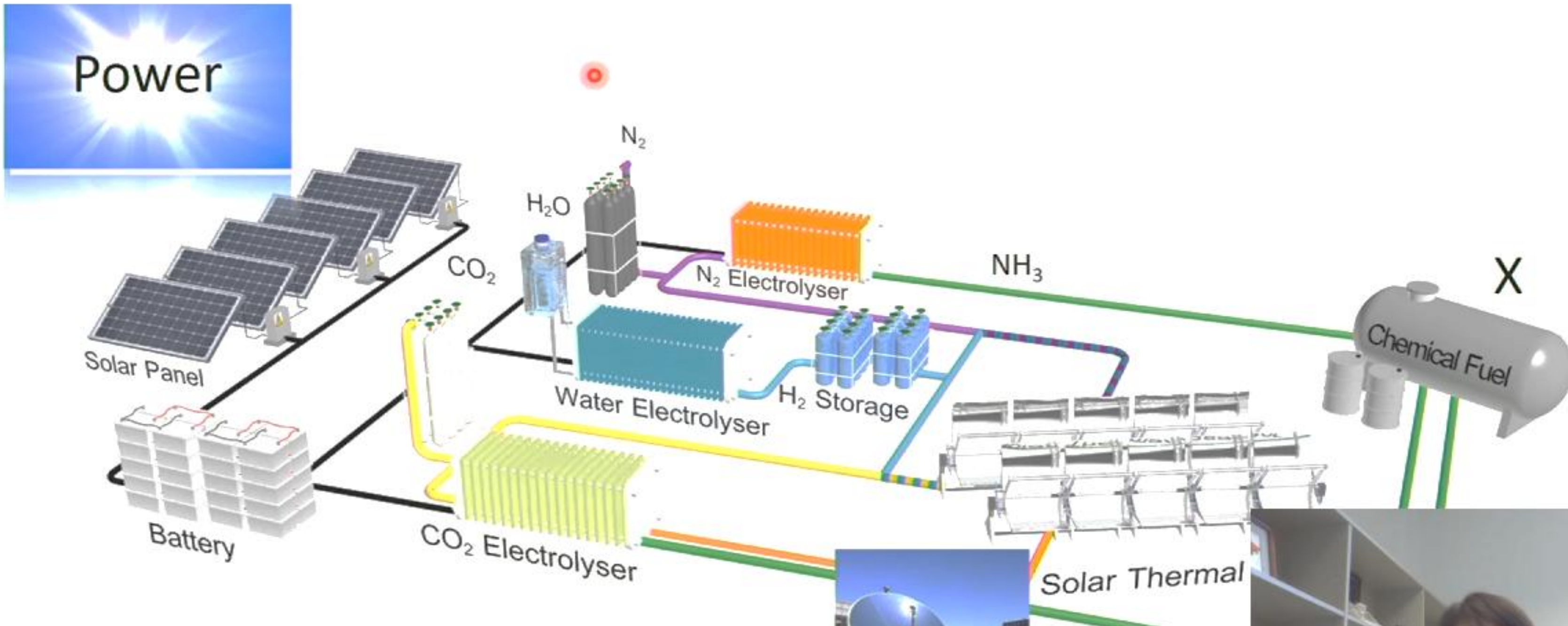
Polyethylene Terephthalate Production

Pilot case study result

- Sustainable production approach was conducted in chemical industry.
- Environmental performance evaluation (EPE) was followed by implementations.
- Soft cooling water consumption was reduced by 151,428 m^3/year (46.7%).
- Energy consumption was reduced by 117,848 kWh/year.
- The total cost saving was $104,905/year and the payback period was 6 months.

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

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.

Efficiency improvement & emission mitigation
potentials China's petroleum refining industry

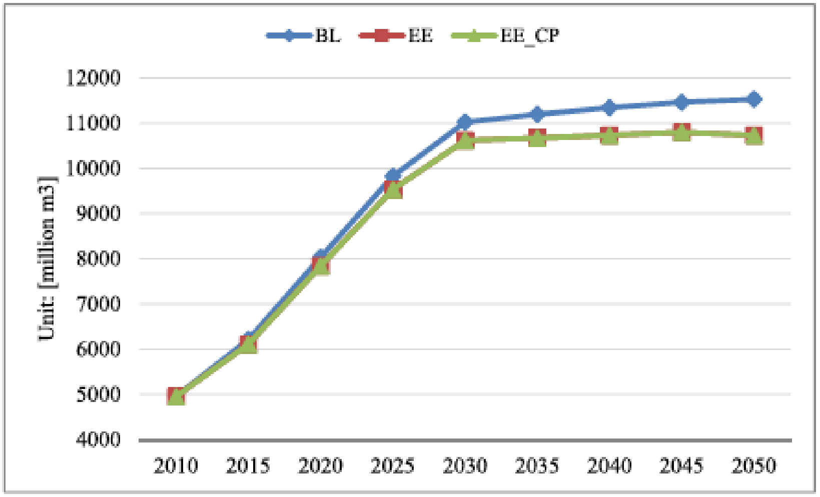
- Maximum cost-effective saving potential of circulation and softened water in 2050 is 7% and 80%, respectively

- Key conclusions related to CO_2 and air pollutants:

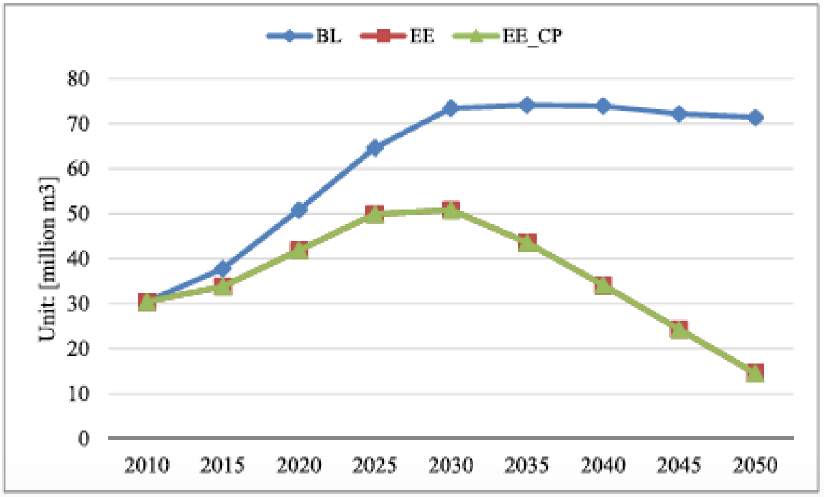
a) The maximum savings potential of CO_2 is 10%, 47% of CO_2 comes from process emissions, 39% and 50% of this CO_2 come from atmospheric and vacuum distillation and kerosene hydrogenation, refining, respectively.

b) Process emissions produce 57% of NO_x, 95% of SO_2, and 94% of PM2.5, and among the air pollutants emitted by processes, 65% of NO_x, 91% of SO_2, and 99% of PM2.5 come from catalytic cracking technologies. 3) Applying a carbon price is effective in reducing CO_2 emissions, but it does not work for air pollutants like NO_x, SO_2, and PM2.5.

Efficiency improvement & emission mitigation
potentials China's petroleum refining industry

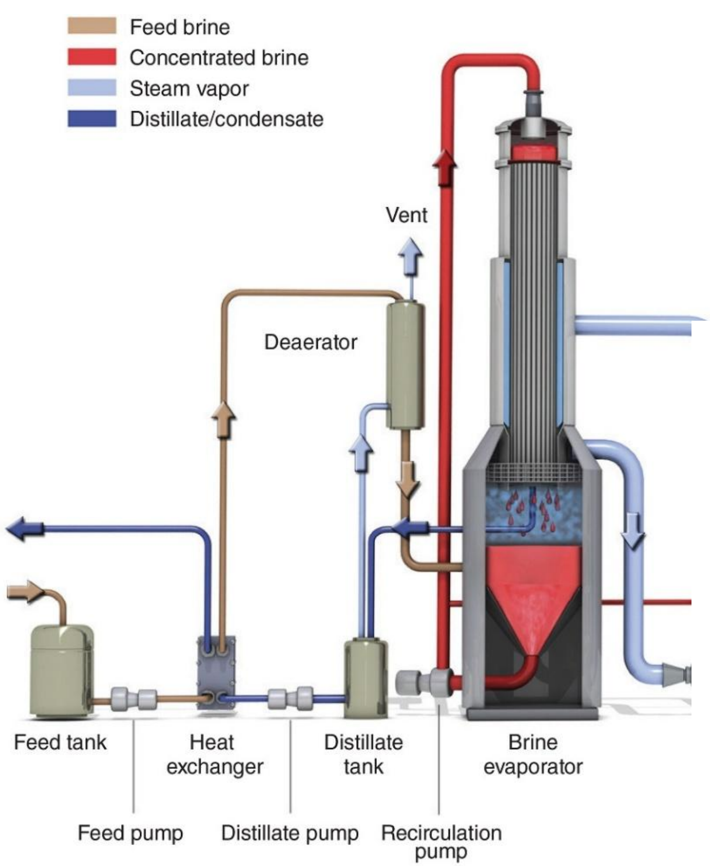


(a): Circulation water



(b): Softened water

Zero Liquid Discharge (ZLD)



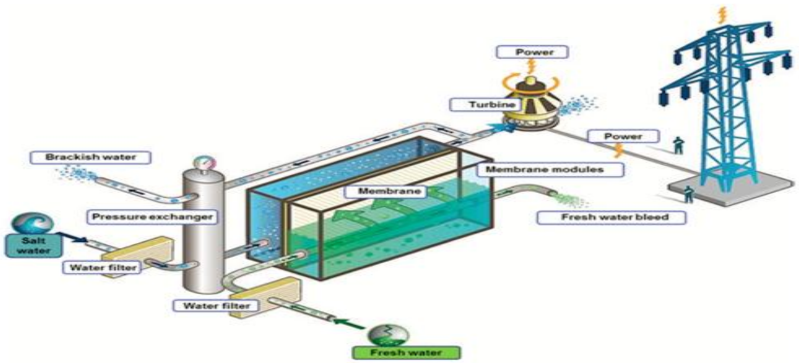
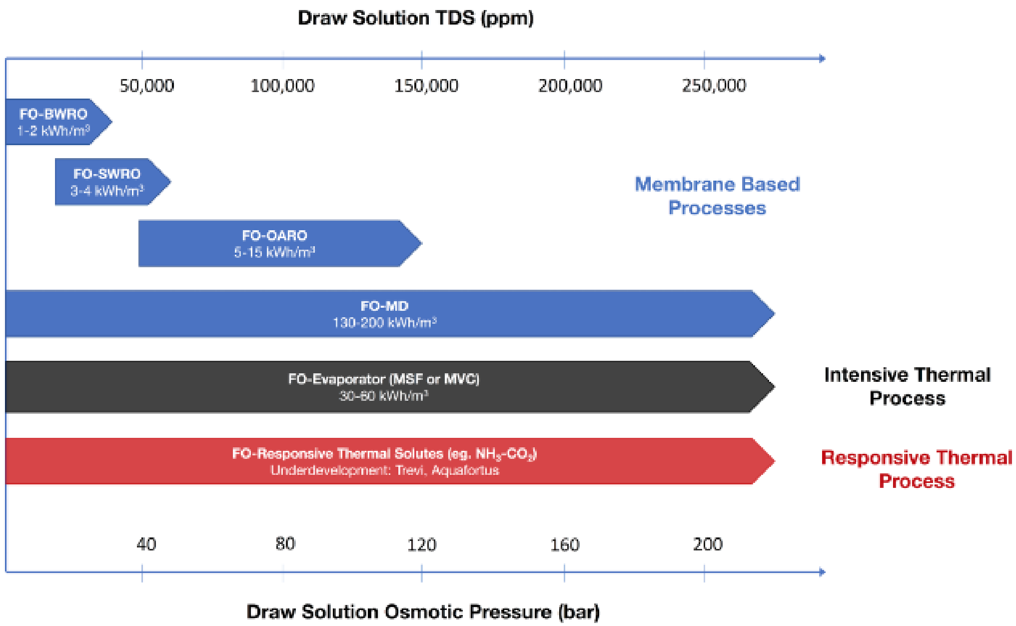
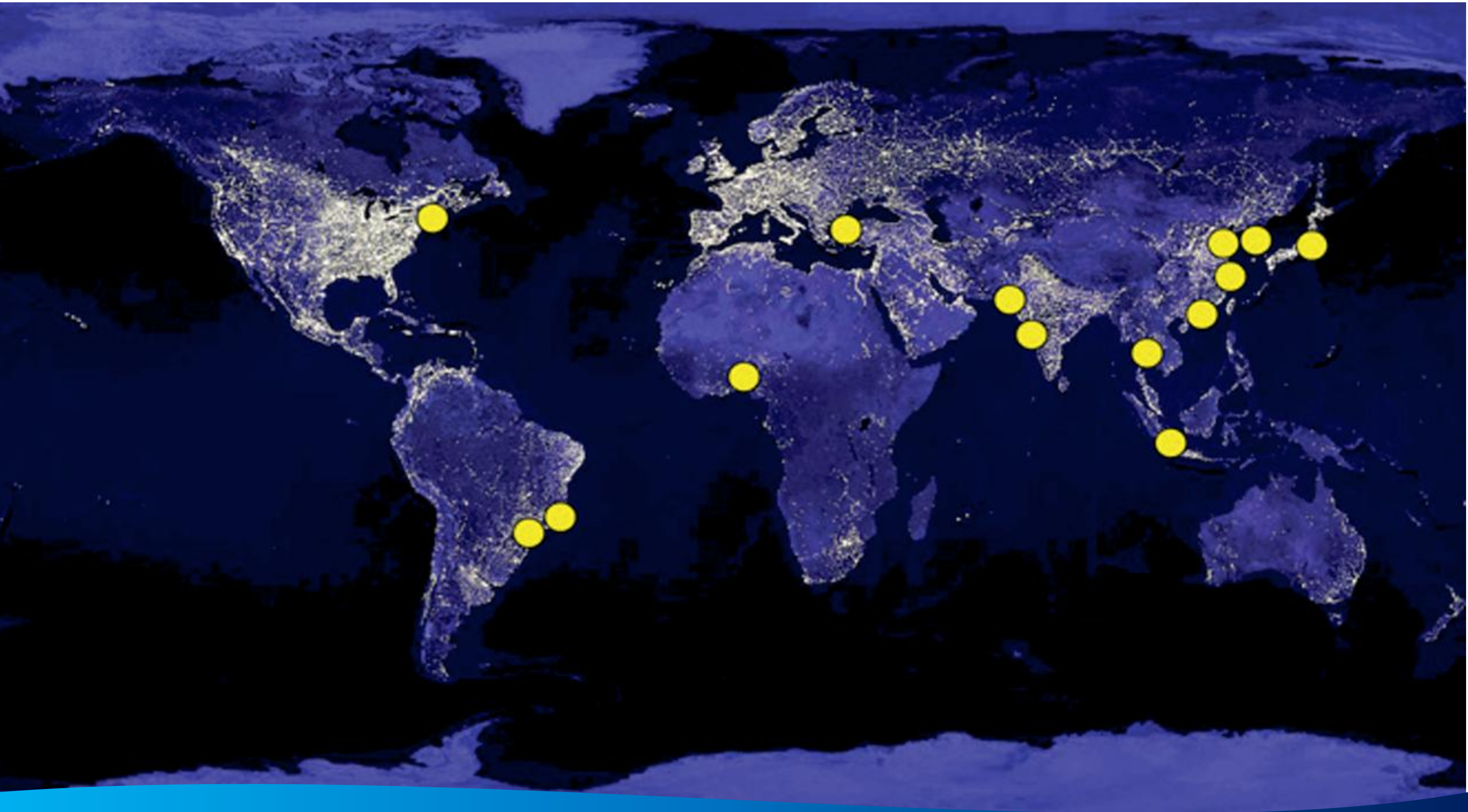


Figure 7.3.7 Pressure retarded osmosis (PRO) system adopted by Statkraft (2014).



Hybrid WWT and Desalination by FO-RO

Case Study – 14 Major Cities



Hybrid WWT and Desalination by FO-LPRO
System Layout

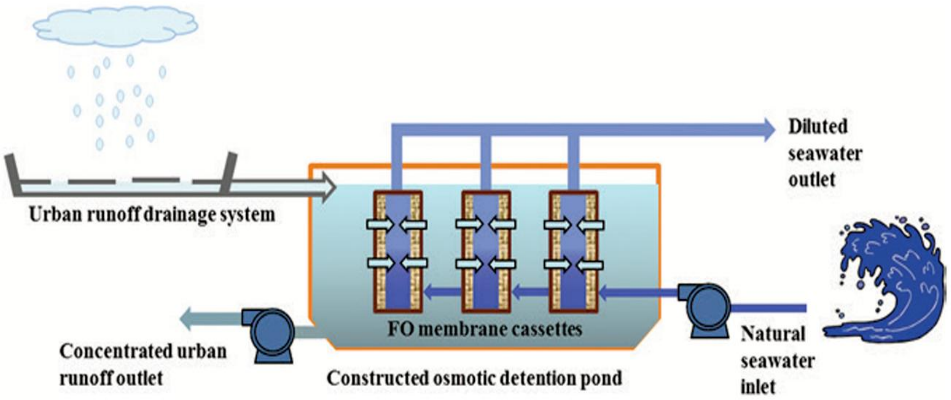


Figure 2.1.1 Diagram of the osmotic detention pond for the treatment of urban runoff in coastal regions.

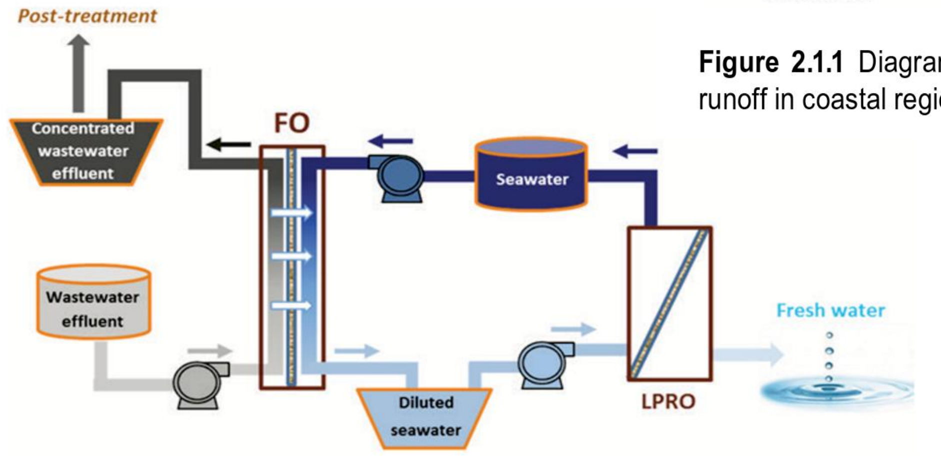


Figure 1.1.6 FO-LPRO system layout combining wastewater recovery and seawater desalination.

FO-LPRO Versus SWRO
Energy Consumption

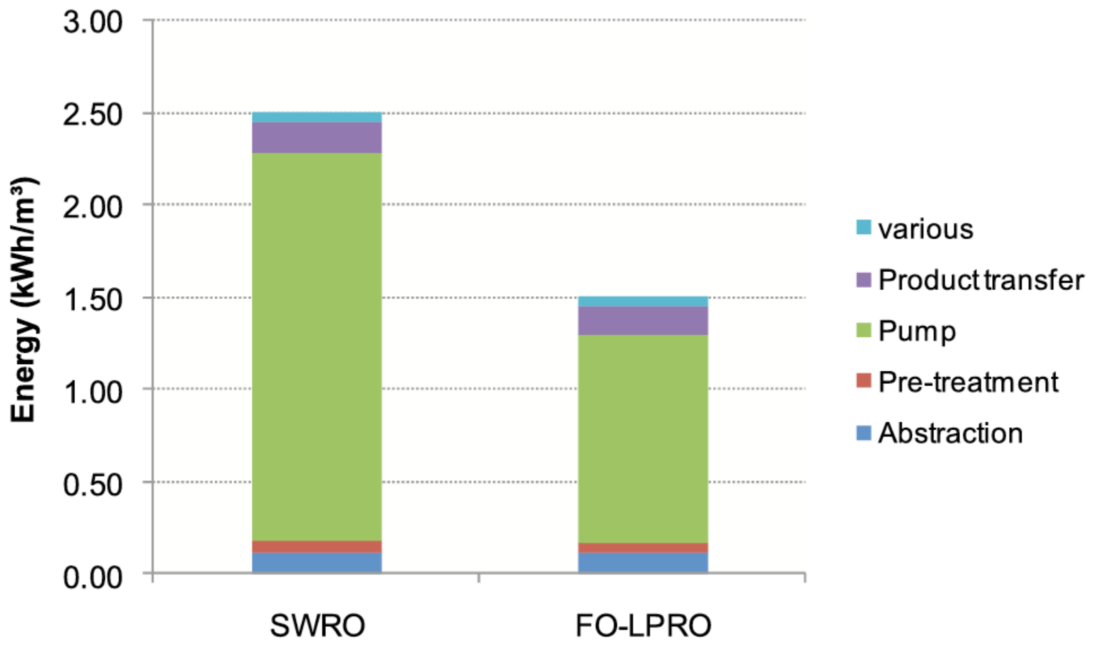
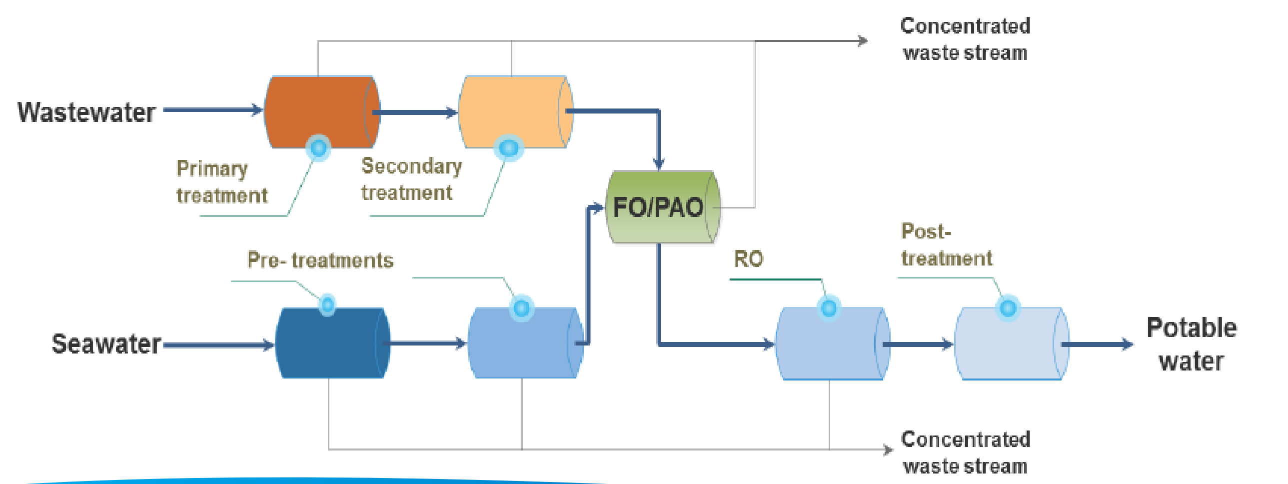
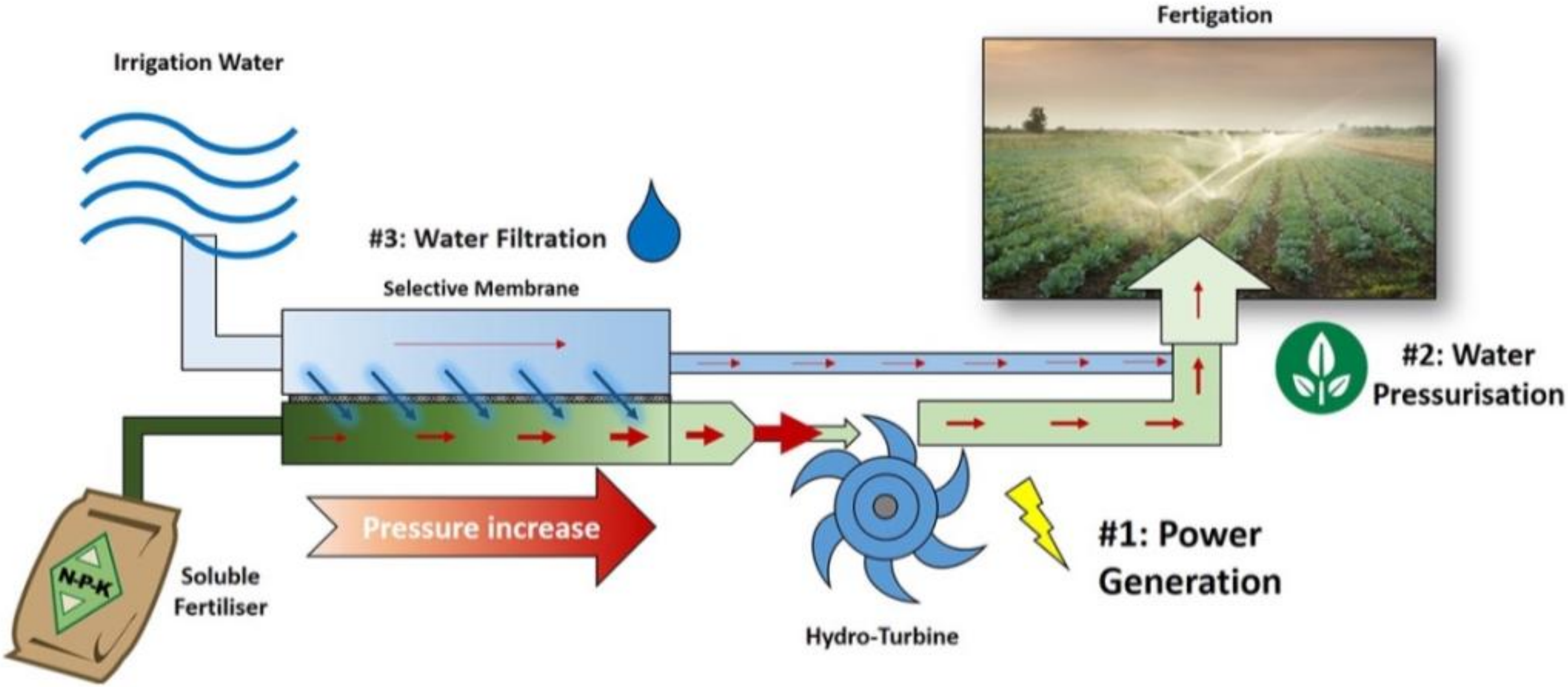


Figure 2.3.8 Comparison of energy consumption between desalination with RO and desalination with immersed FO-LPRO.

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.

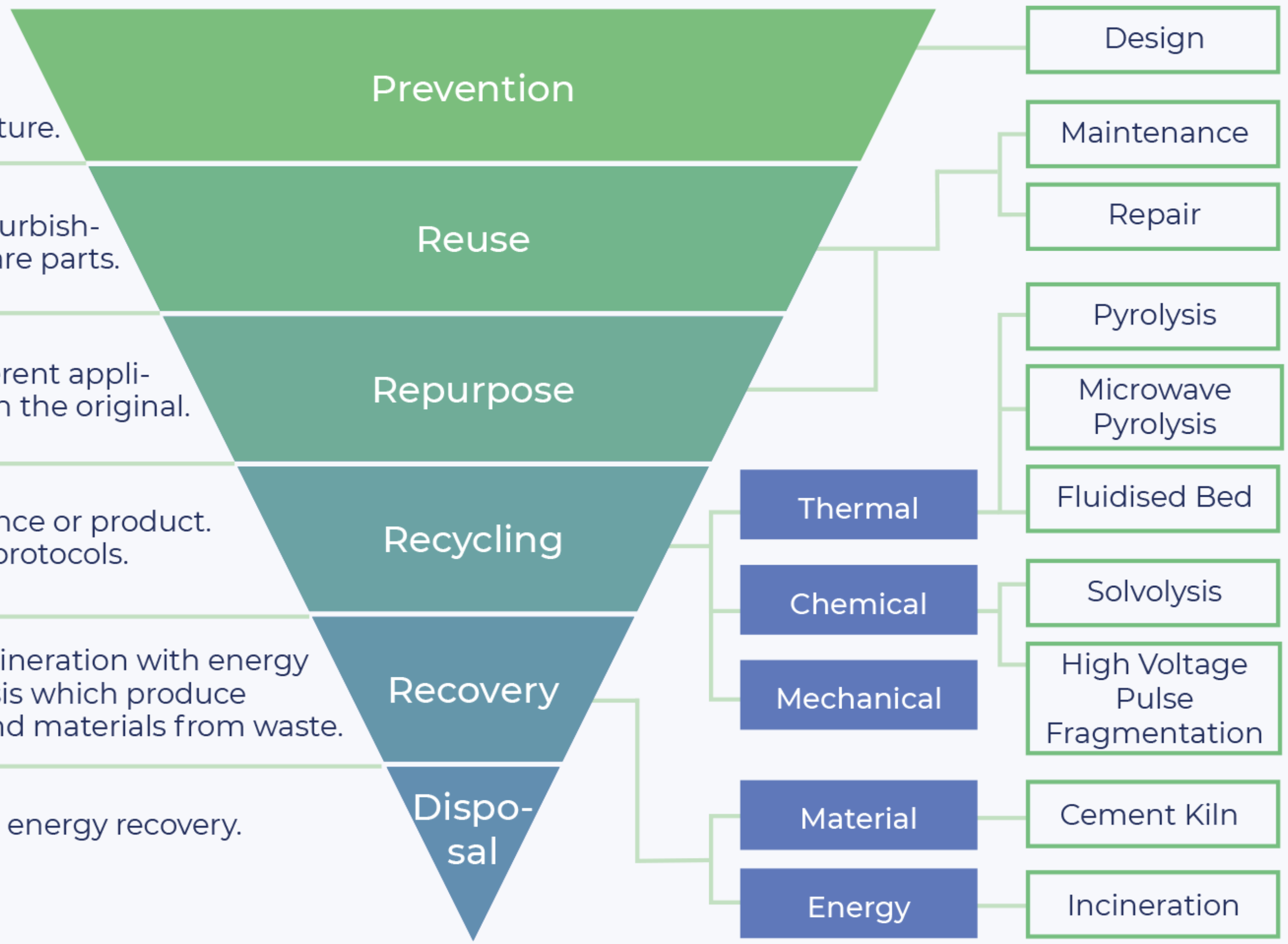
Checking, cleaning, repairing, refurbishing, repair for whole itelms or spare parts.

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

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

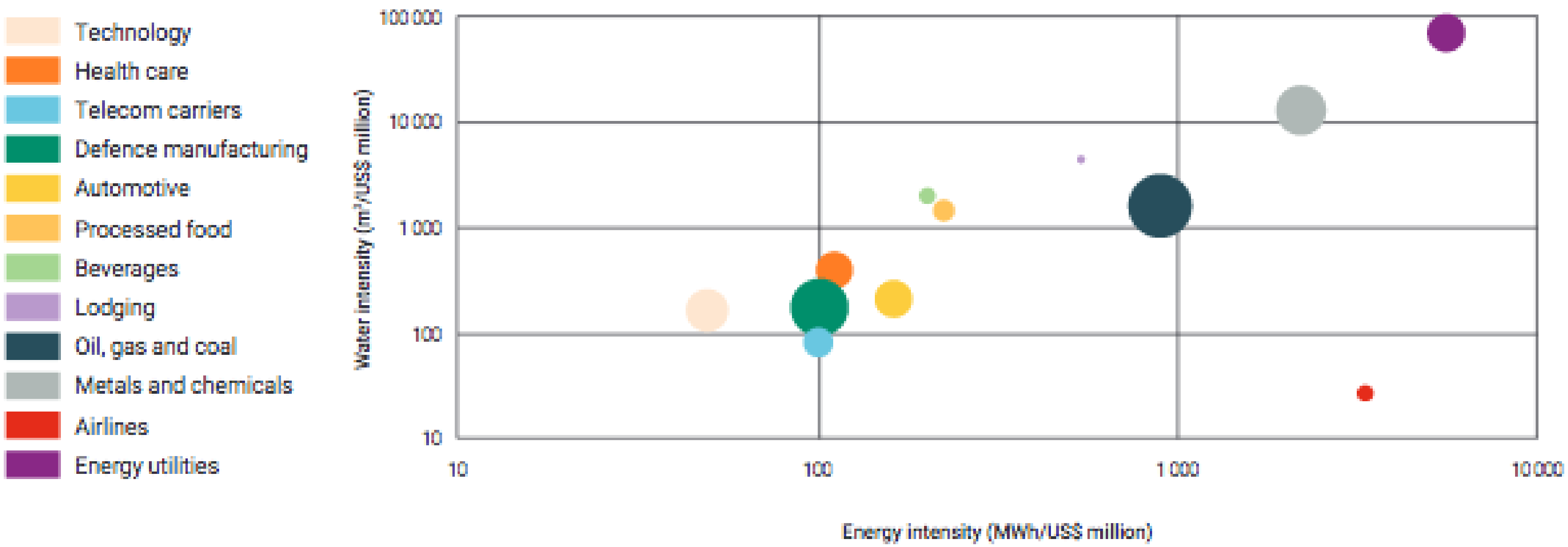
Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste.

Landfill and incineration without energy recovery.



Summary
Water & Energy Intensity

Figure 7.3 Water and energy intensity of major industries

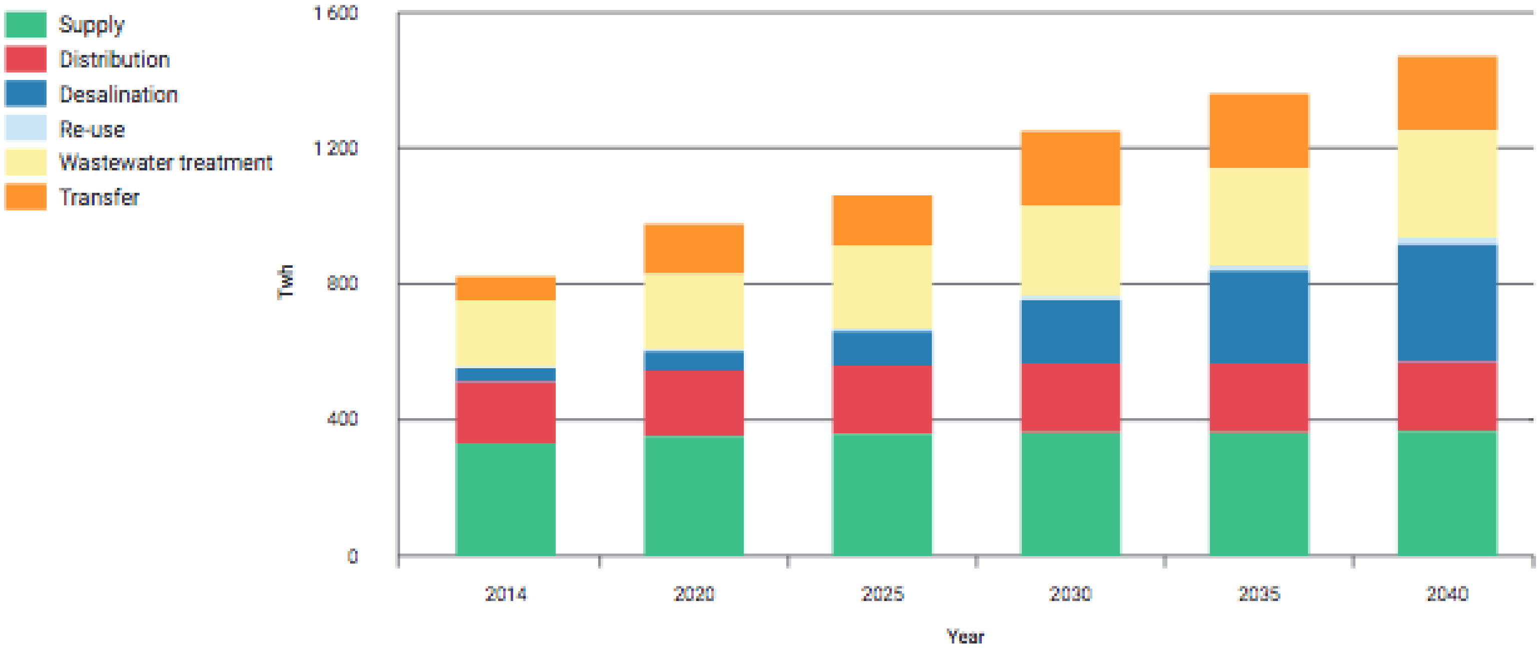


Note: Bubble area proportional to total industry revenue.

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.

Conclusion | New Technologies Challenging Rules

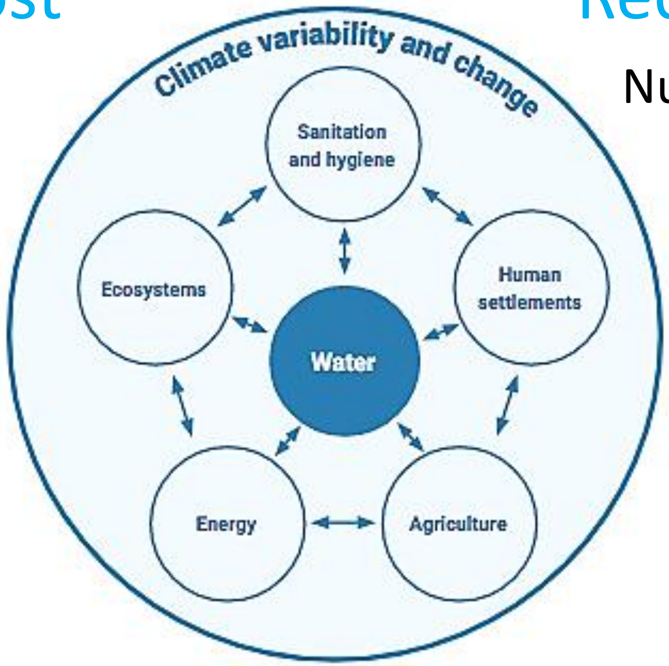
Reducing the Cost

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

700

Number of chemical contaminants

IN YOUR BODY, RIGHT NOW

6,427,559,655,407

Value in USD of synthetic chemicals produced

IN THE WORLD

IN 2020 | THIS MONTH | THIS WEEK | TODAY

151,642

Number of man-made chemicals on the market

RIGHT NOW, RIGHT NOW

NOW | IN 2020 | THIS MONTH | THIS WEEK | TODAY

THANKS TO ALL OF US

Maafushivaru Island Maldive

Please Consider the Environment