Wastewater “Refining” Utilizing Minimal Liquid Discharge

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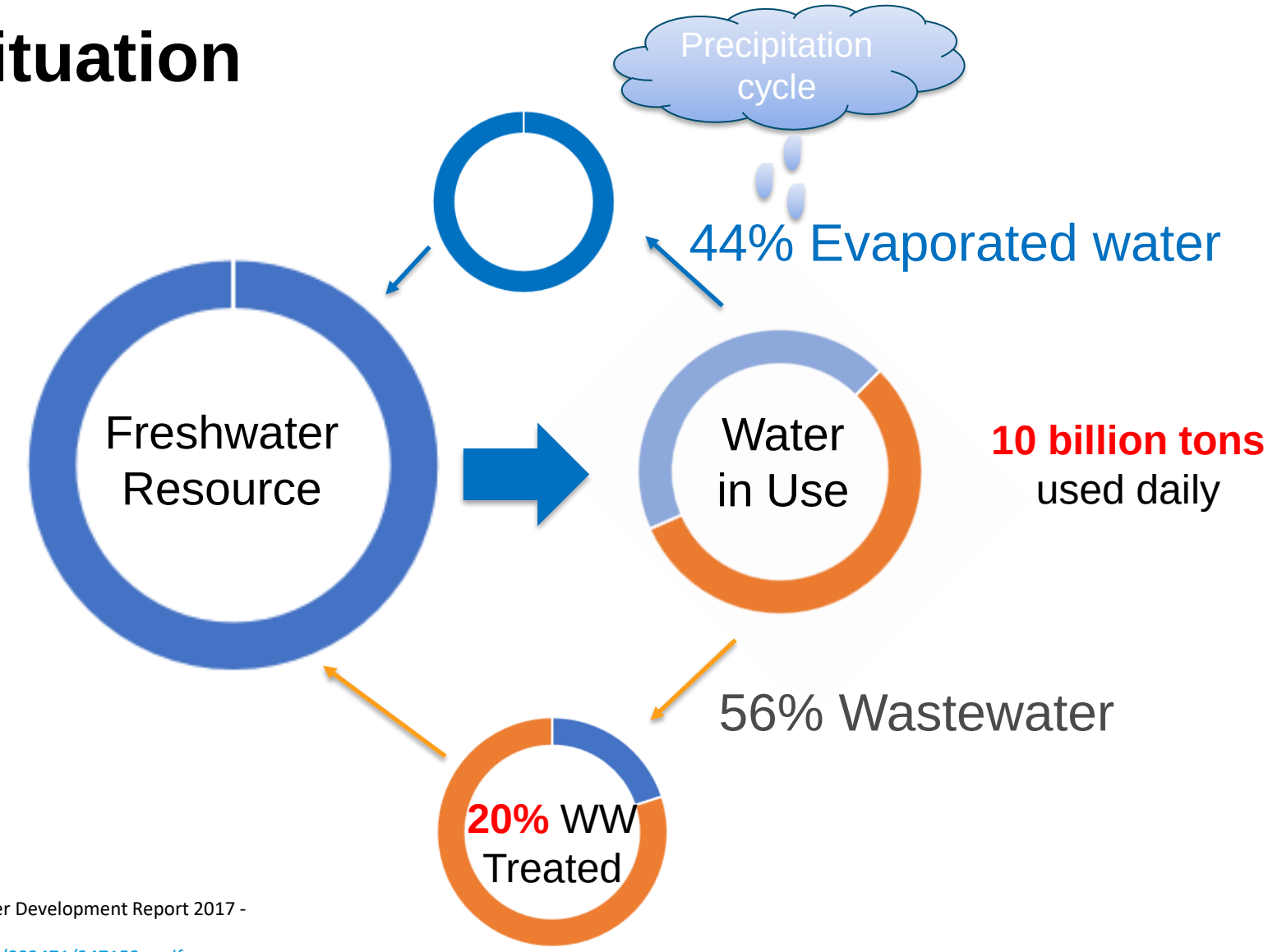
Agenda

- A Case for Change
- Introduce Water Refining
- Introduce MLD

Present situation



SOURCE: The United Nations World Water Development Report 2017 - Wastewater: the untapped resource
http://unesdoc.unesco.org/images/0024/002471/247153e.pdf

www.theworldcounts.com/stories/average-daily-water-useage

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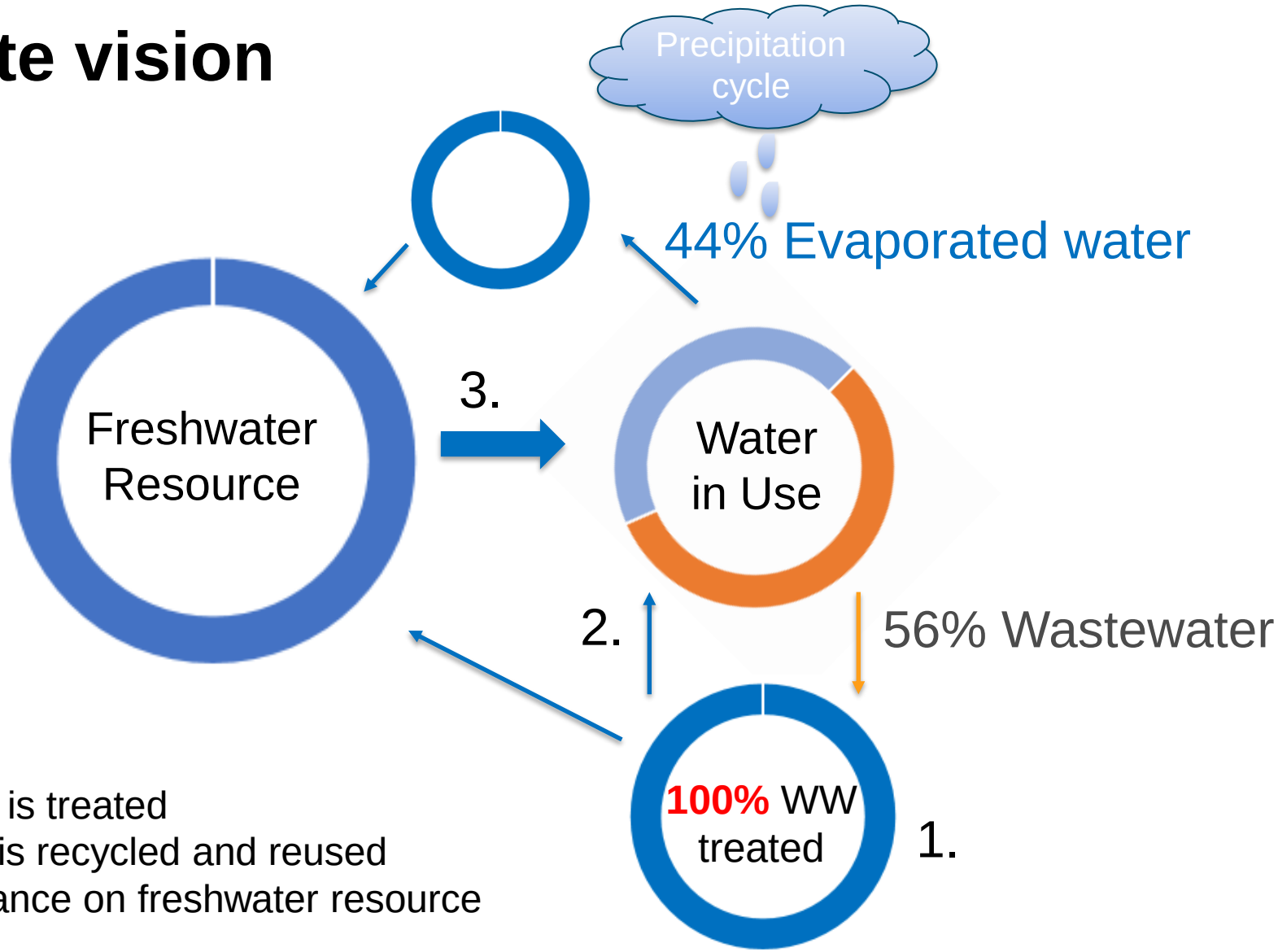
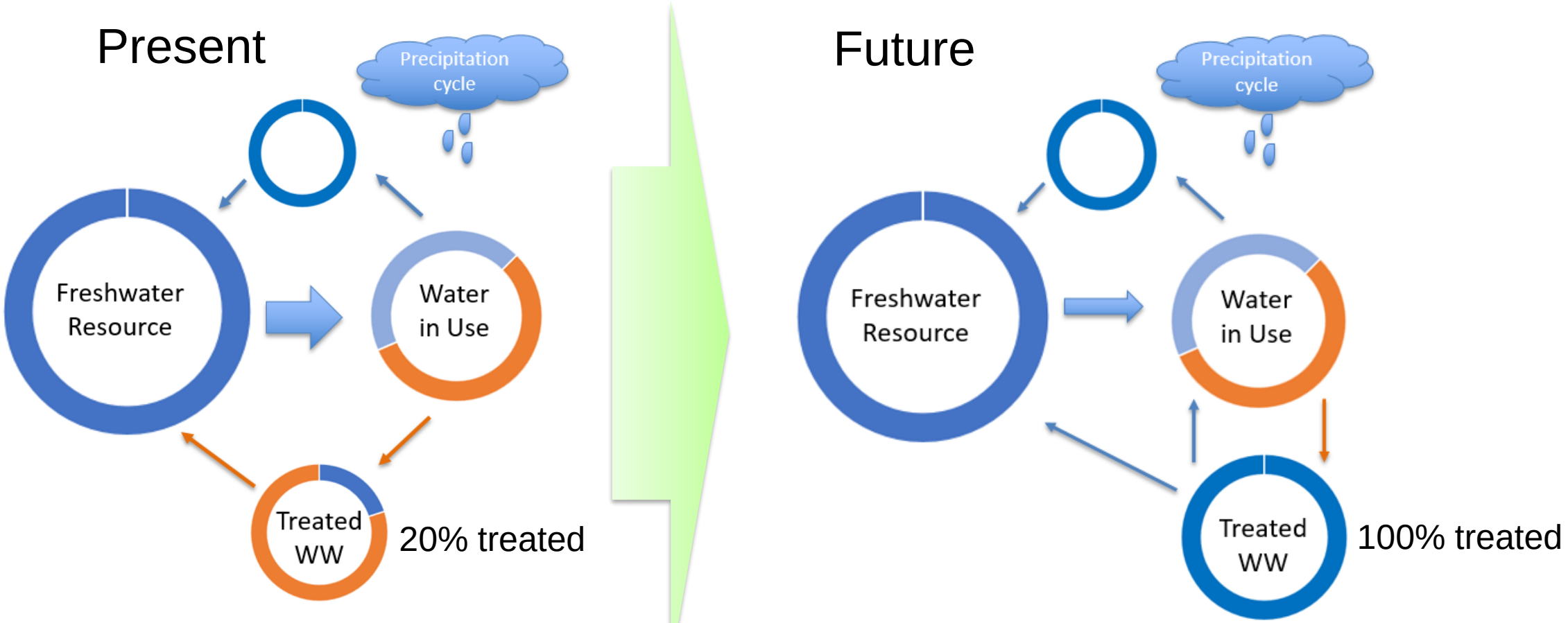
Future state vision



1. 100% of WW is treated
2. Treated WW is recycled and reused
3. Reduced reliance on freshwater resource



6 CLEAN WATER AND SANITATION

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, **halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally**

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Zero Liquid Discharge (ZLD)

An extreme wastewater treatment process

PROS

- ✓ Maximize water recovery for reuse
- ✓ Meet stringent government discharge regulations

CONS

- Expensive
  - High OPEX – energy intensive, CO_2 footprint
  - High CAPEX
- Waste-salt management

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Wastewater Treatment → Wastewater Refinery

"…**water treatment** is primarily about **taking things out of water**, whereas **water refining** is about **separating impaired water sources into their different fractions** and **finding a value** for each of them."

Source: "An Apotheosis for Water" by Christopher Gasson, Global Water Intelligence, Oct 21, 2021, Vol 22, issue 10

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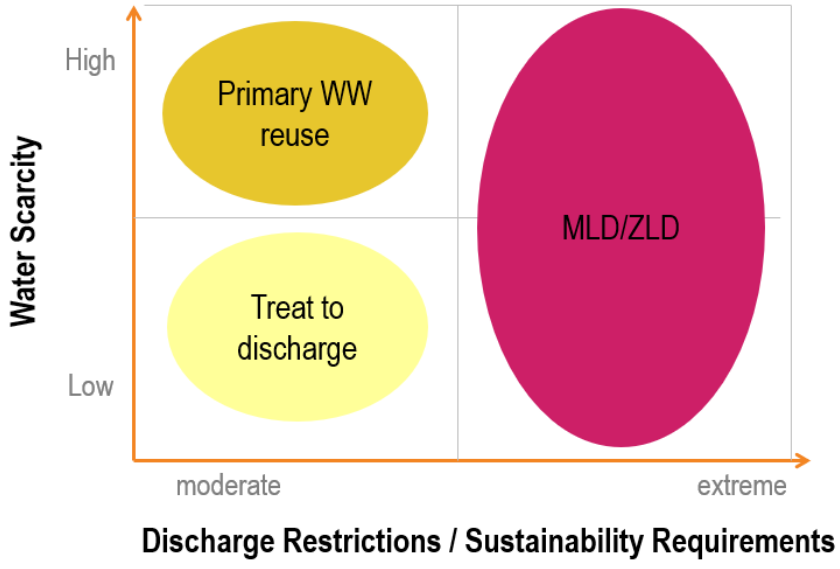
Regulation Driven → Value Driven

Wastewater Treatment – *regulation driven*



Wastewater Refinery – *value driven*

Income	Expenses

• Refined water
• Refined salts
• Refined organics
• Biogases
	• Equipment
	• Energy
	• Raw Materials
	  • Fresh water
	  • Chemicals
	• Labor
	• Discharge costs

"Maximize"	"Minimize"

Three Industries Practicing Zero-Liquid Discharge

The challenge they face

	Textile WW - India	Coal-to-Chemical Industrial Park Brine WW - China	Power Flue-gas desulfurization WW - China
WW volume (m^3/h)	100	600	22
WW TDS (mg/L)	8,000	7,000	15,000
Waste salts (kg/d)	19,200	100,800	1,720
# trucks / day			
Main Salts:	NaCl or Na_2SO_4	NaCl, Na_2SO_4 (50:50)	NaCl

 = large dump truck with 12,700 kg capacity

How can treating these challenging waters to ZLD be affordable??

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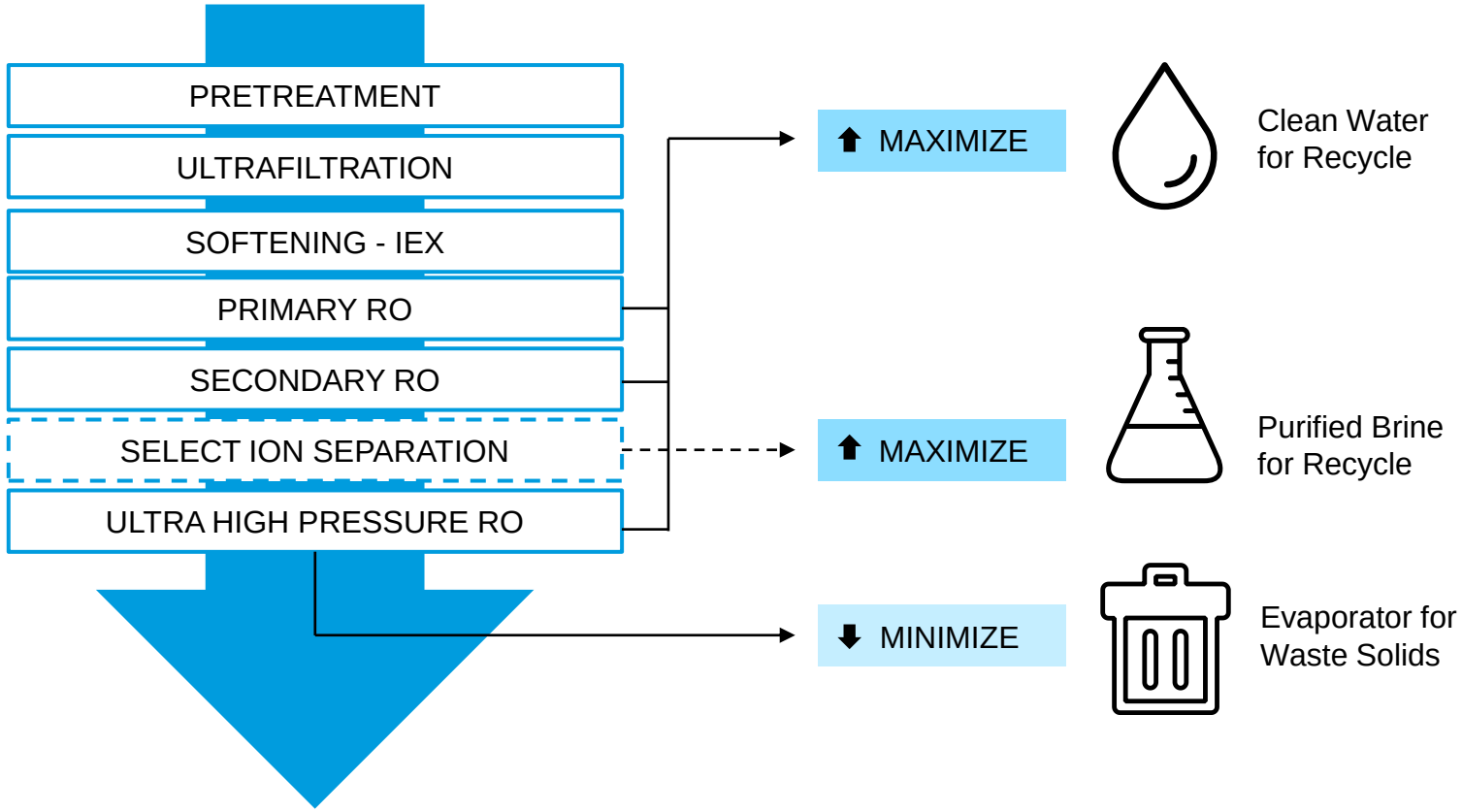
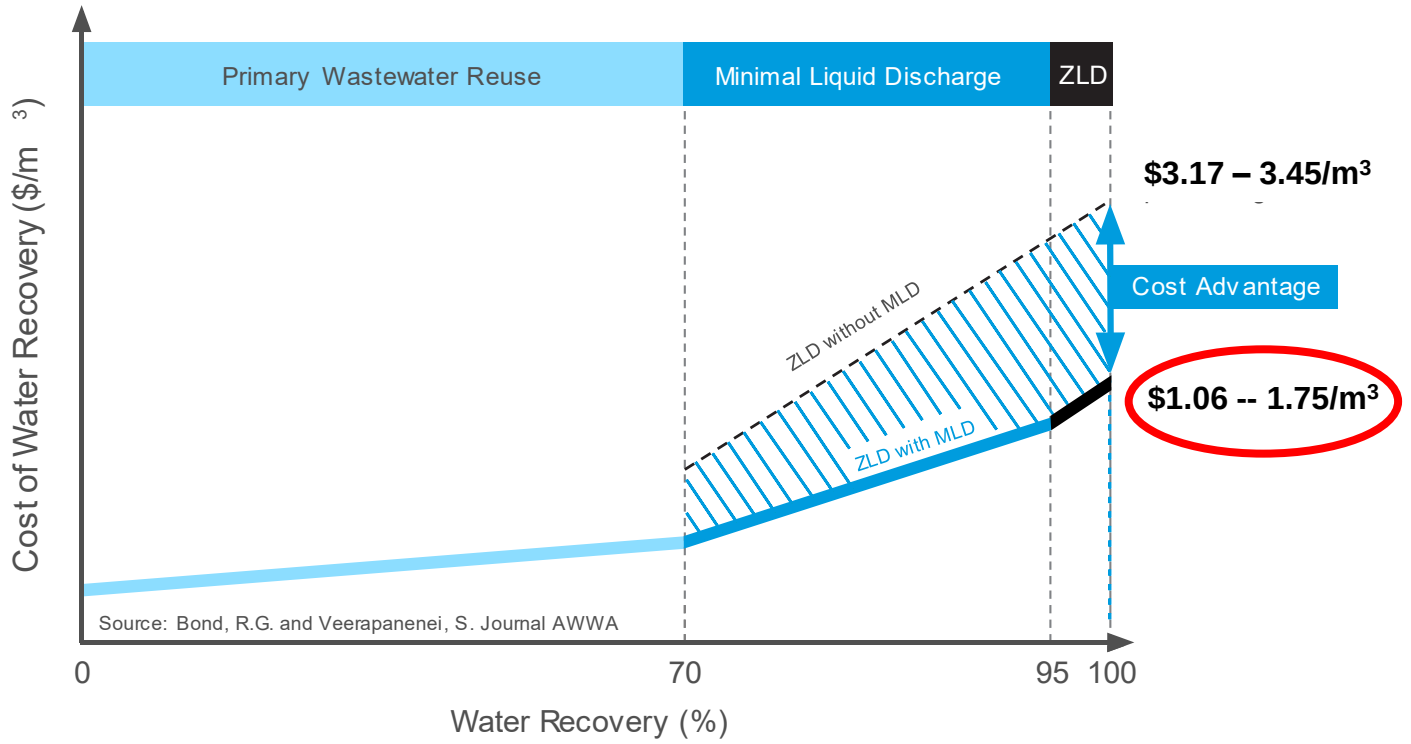
Minimal Liquid Discharge (MLD)

affordable water refining through membrane separation technology



The MLD Value Proposition

Minimal Liquid Discharge (MLD) utilizes **proven membrane separation technologies** that enable the capture of **more than 95% of liquid discharge for reuse at up to 60% of the cost of thermal treatment**.

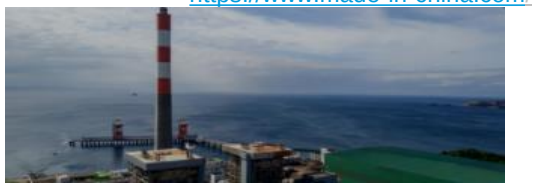


Three Industries Practicing Zero-Liquid Discharge

Cost of water recovery is off-set by the circular value in the wastewater

= large dump truck with 12,700 kg capacity
Industrial grade NaCl = $0.06/kg
Industrial grade Na_2SO_4 = $0.08/kg
https://www.made-in-china.com/

Cost of water recovery
w/ MLD: **$1.06-1.75/m³**



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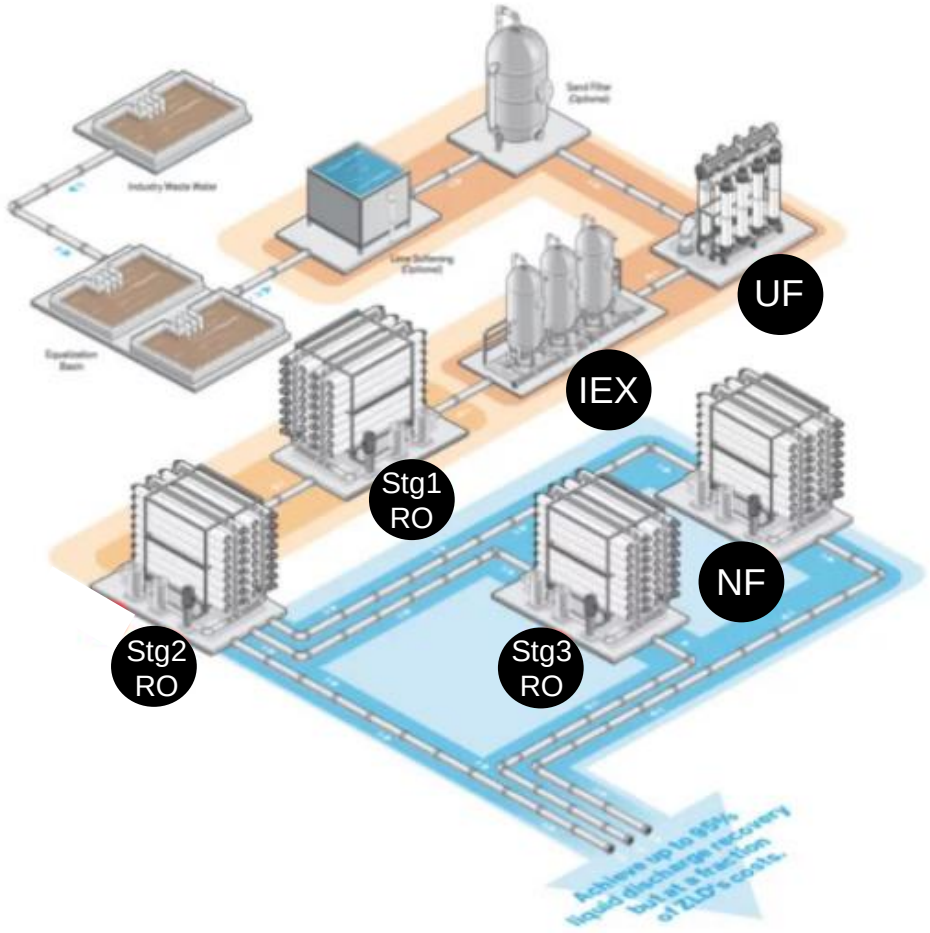
Main Salts:	NaCl or Na_2SO_4	NaCl, Na_2SO_4 (50:50)	NaCl
Circular value:	**Recovered: / $/m³** Fresh water: $0.56-1.00 NaCl (dye bath): $0.50 **Total Value: $1.06-1.50/m³**	**Recovered: / $/m³** Fresh water: $0.25 IG NaCl: $0.21 IG Na_2SO_4: $0.31 **Total Value: $0.77/m³**	**Recovered: / $/m³** Fresh water: $0.25 IG NaCl: $0.90 **Total Value: $1.15/m³**
Net cost*:	$ 0.25-0.69/m³	$ 0.98/m³	$ 0.60/m³

*Does not consider cost savings associated reduced landfill costs of waste salts

Wastewater Refinery

Proven technology exists – Let's go use them



Resource recovery
complements **water recovery**
to provide overall savings in a
Wastewater Refinery Systems

UF = ultrafiltration
IEX = ion exchange softening resins
Stg1 RO = stage 1 reverse osmosis
NF = nanofiltration