

Wastewater “Refining” Utilizing Minimal Liquid Discharge

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Singapore International Water Week – Spring 2022



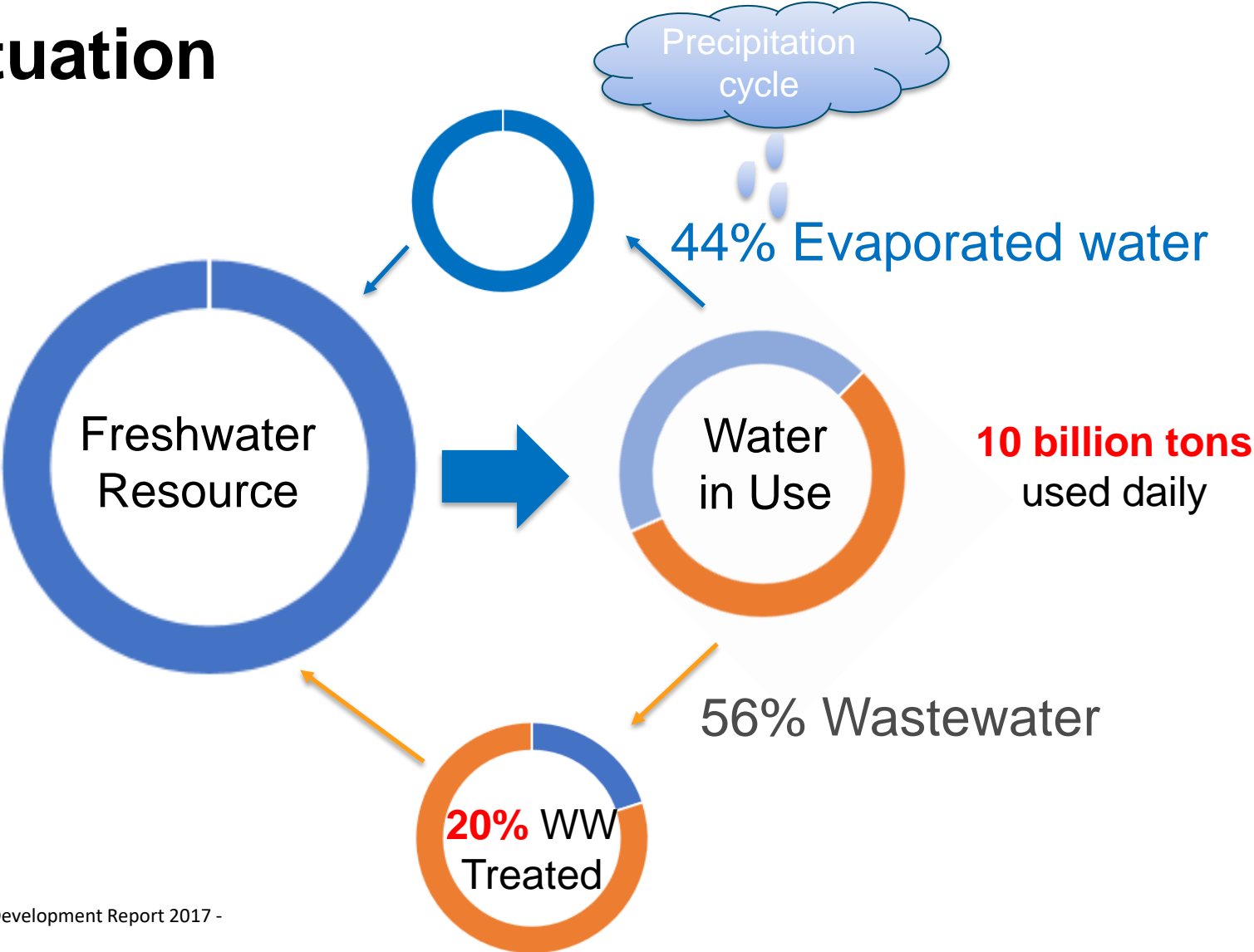
Agenda

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



◀ DUPONT ▶

Present situation



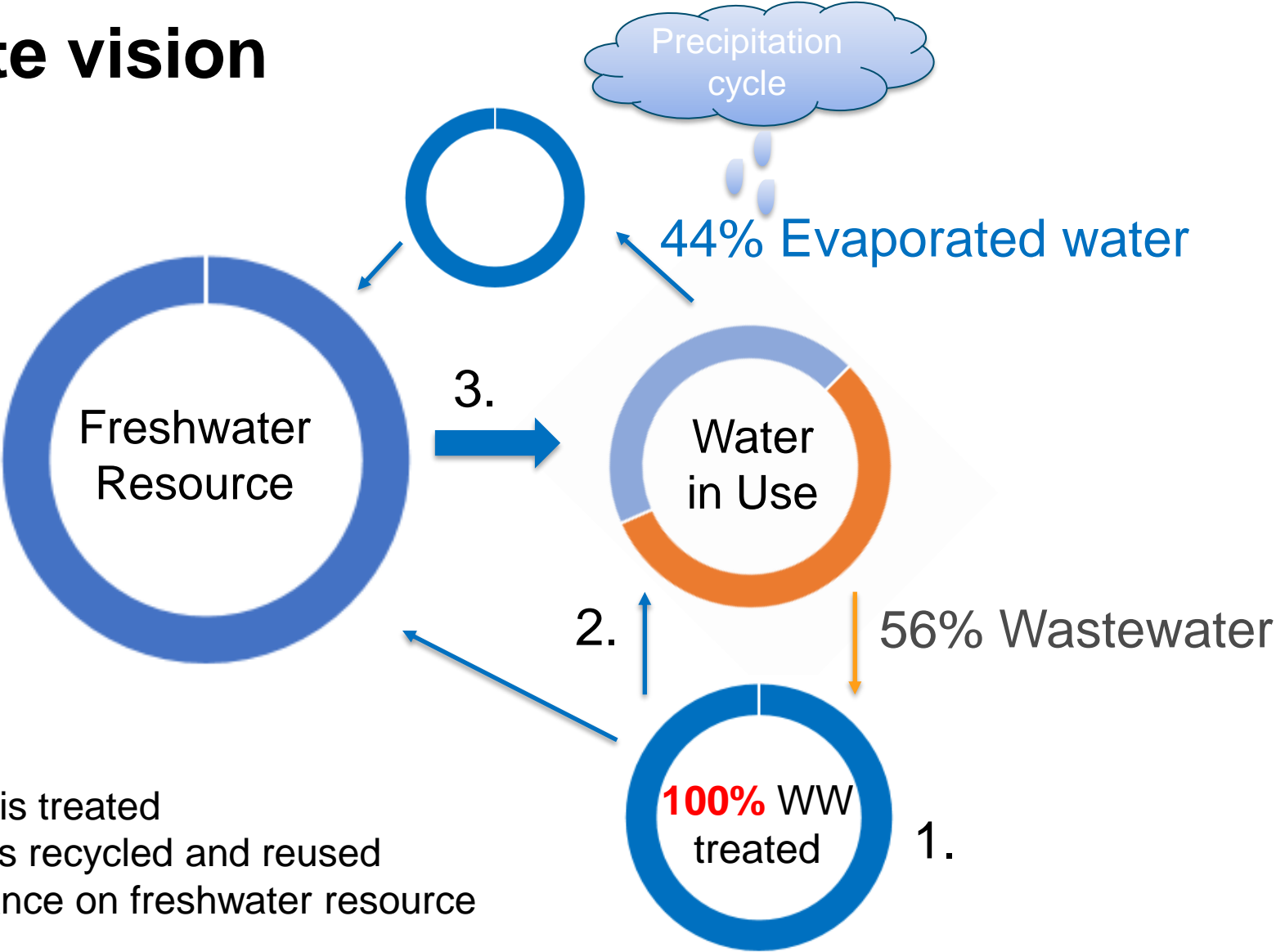
SOURCE: The United Nations World Water Development Report 2017 - Wastewater: the untapped resource

<http://unesdoc.unesco.org/images/0024/002471/247153e.pdf>

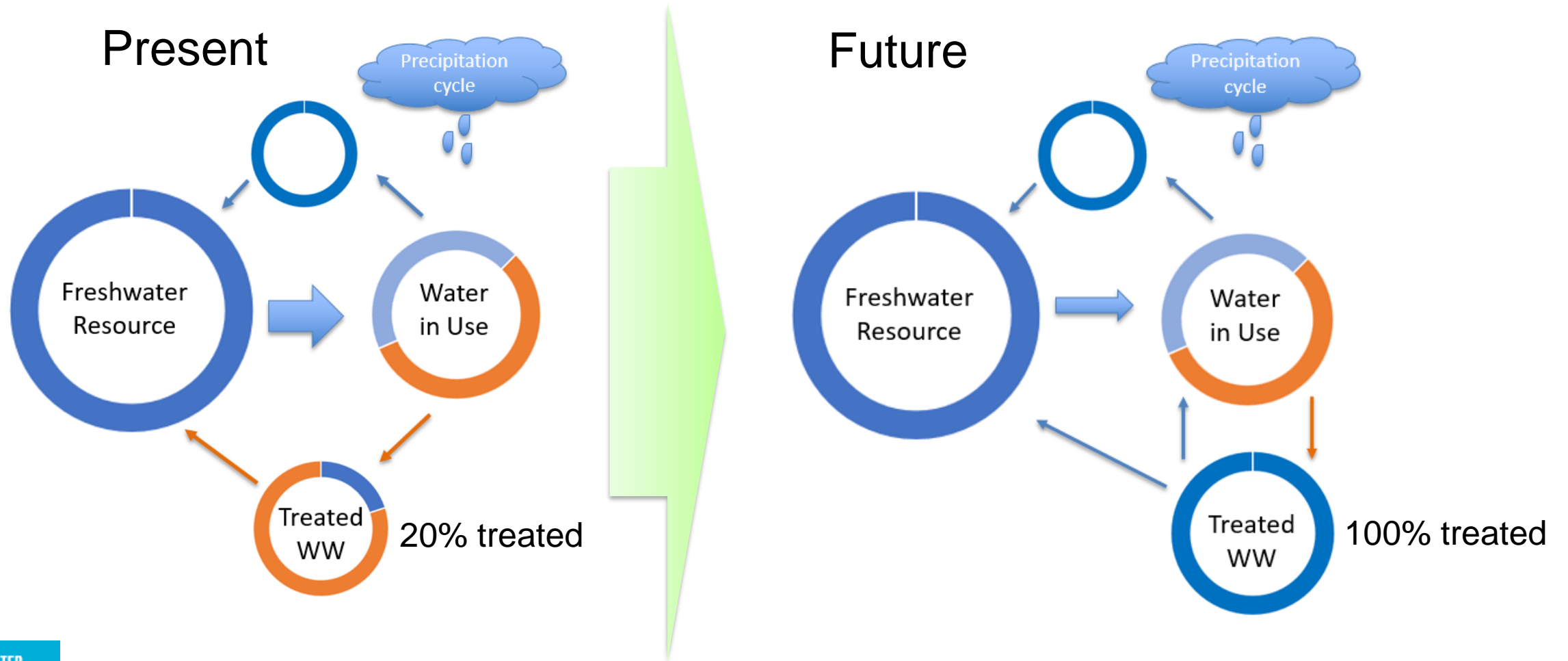
www.theworldcounts.com/stories/average-daily-water-useage



Future state vision



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



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



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, CO₂ footprint
 - High CAPEX
- Waste-salt management

Wastewater **Treatment** → Wastewater **Refinery**

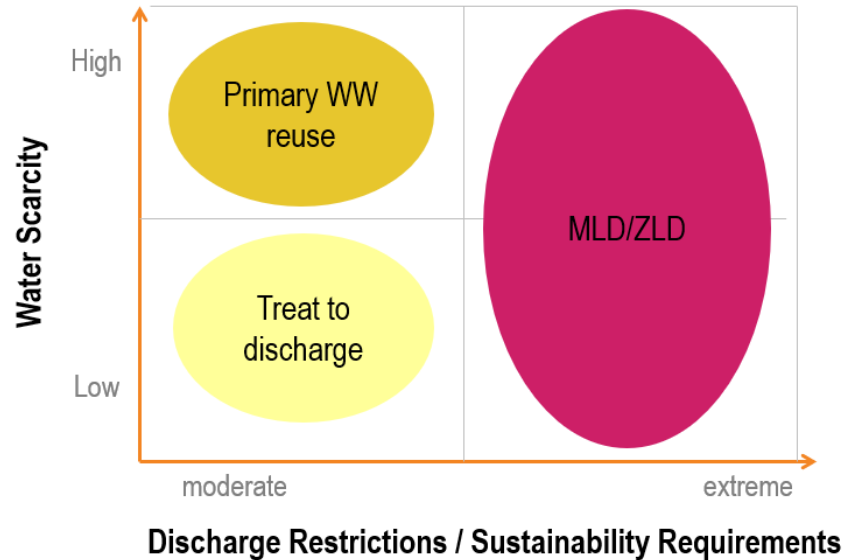
“...**water treatment** is primarily about **taking things out of water**, whereas **water refining** is about **separating impaired water sources into their different fractions** and **finding a value** for each of them.”

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



Regulation Driven → Value Driven

Wastewater Treatment – regulation driven






Wastewater Refinery – value driven


Income	Expenses
<ul style="list-style-type: none">• Refined water• Refined salts• Refined organics• Biogases	<ul style="list-style-type: none">• Equipment• Energy• Raw Materials<ul style="list-style-type: none">• 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 ₂ SO ₄	NaCl, Na ₂ SO ₄ (50:50)	NaCl

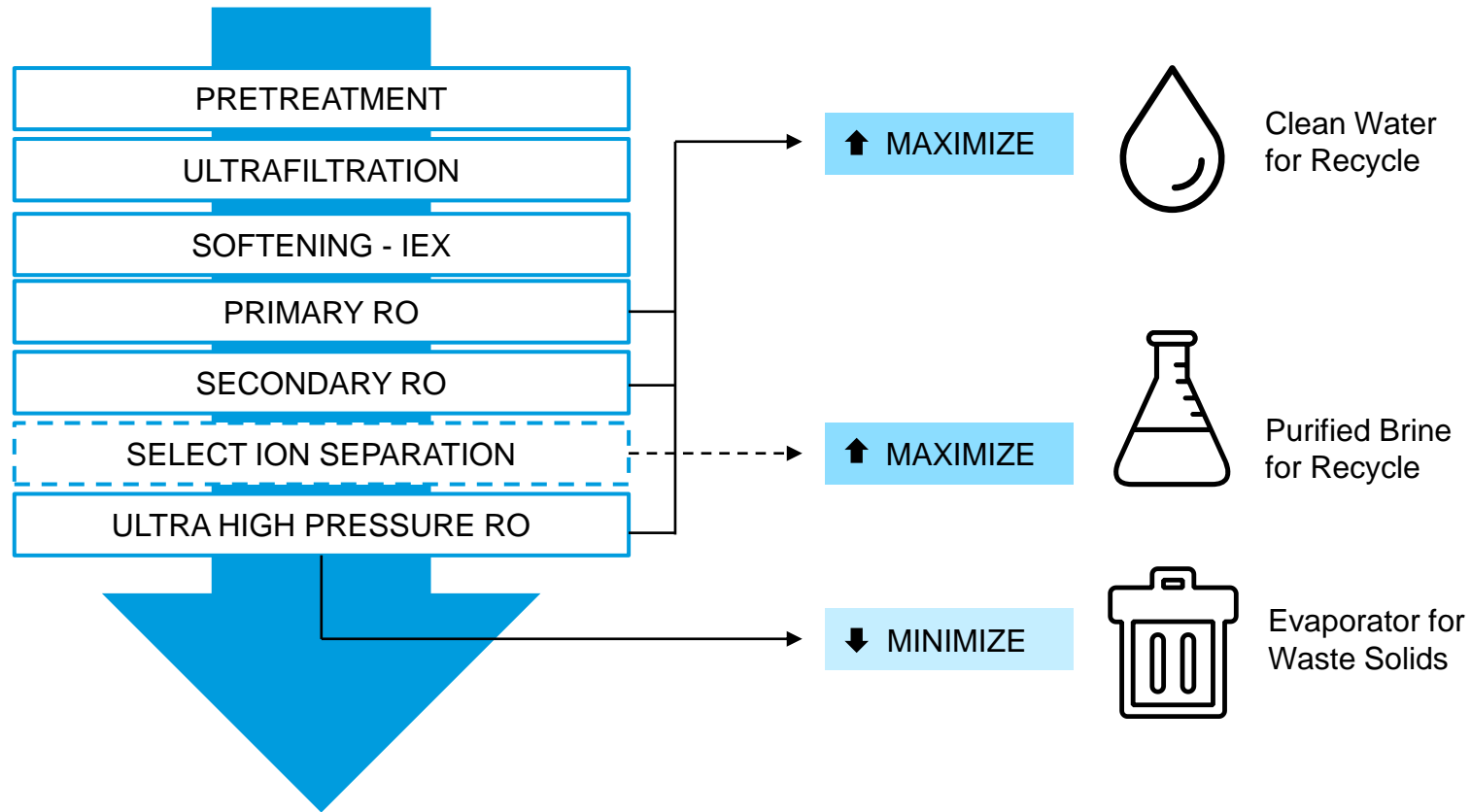
 = large dump truck with 12,700 kg capacity

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



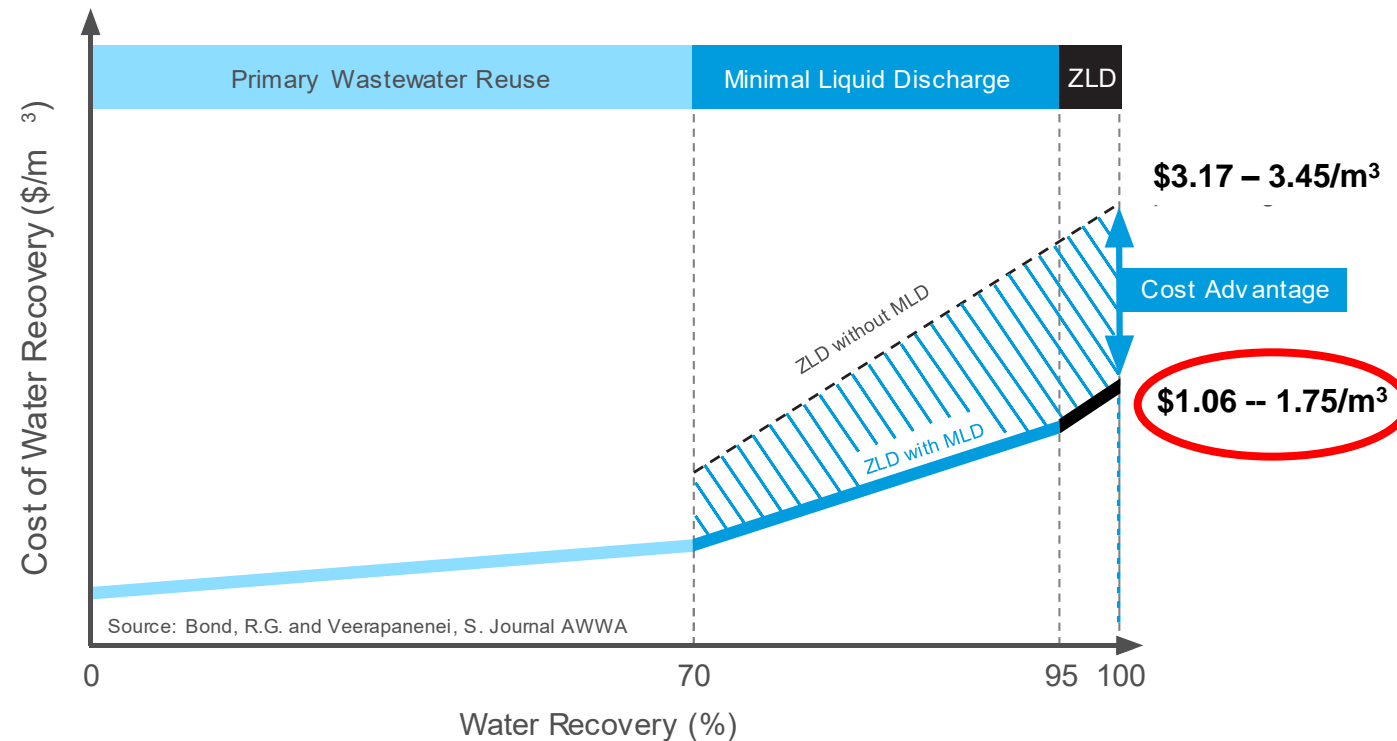
Minimal Liquid Discharge (MLD)

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 Na₂SO₄ = \$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 ₂ SO ₄	NaCl, Na ₂ SO ₄ (50:50)	NaCl
Circular value:	Recovered: \$/m³	Recovered: \$/m³	Recovered: \$/m³
	Fresh water \$0.56-1.00	Fresh water \$0.25	Fresh water \$0.25
	NaCl (dye bath) \$0.50	IG NaCl \$0.21	IG NaCl \$0.90
		IG Na ₂ SO ₄ \$0.31	
	Total Value: \$1.06-1.50/m³	Total Value: \$0.77/m³	Total Value: \$1.15/m³

Net cost*: \$ 0.25-0.69/m³

\$ 0.98/m³

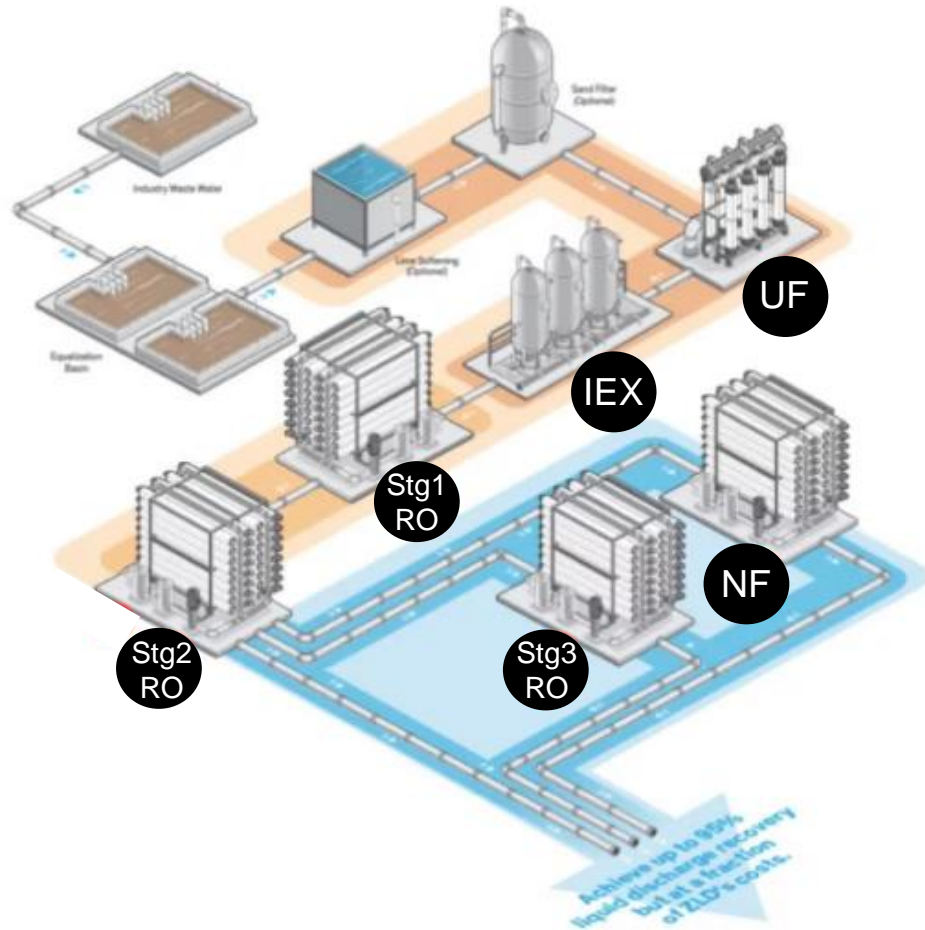
\$ 0.60/m³



*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





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