



# Reverse Osmosis and Nano-filtration Innovation for Water Re-use

*5<sup>th</sup> Water Arabia Conference and Exhibition*

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**Dow Middle East Innovation Center (MEIC)**

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# Agenda

- The Water Energy-Nexus
- Dow Water and Process Solutions Mission
- Global References
- Key Takeaways





By 2030,  
the world's population will reach  
**8.3 billion**

50% more Food  
45% more Energy  
30% more Water

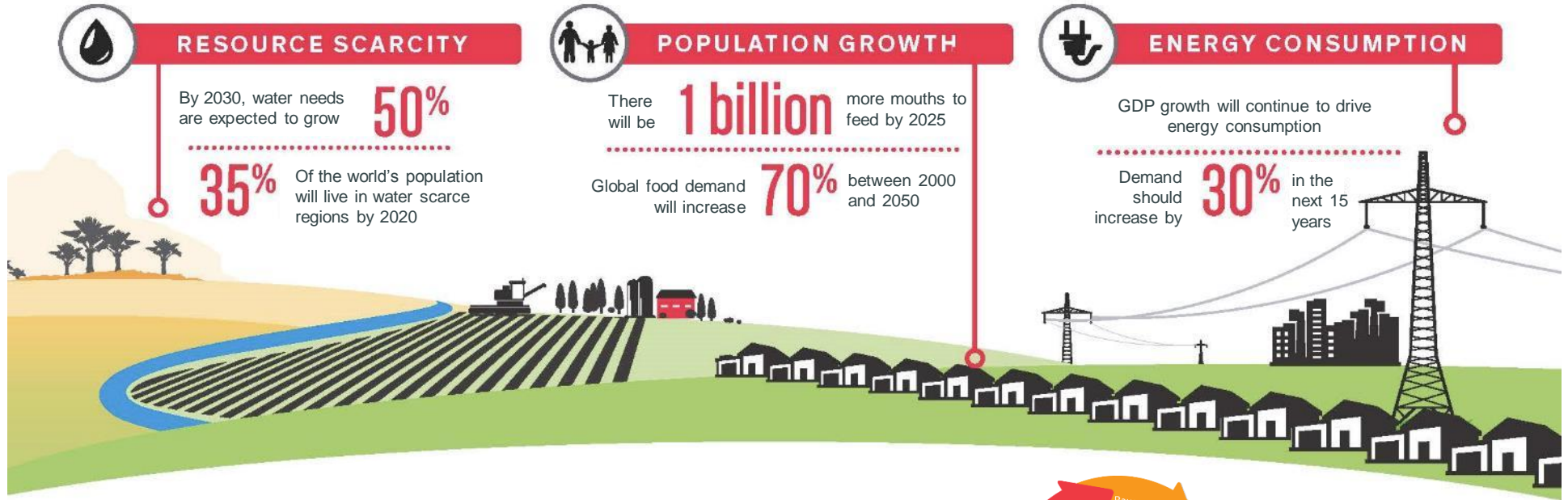
Nearly half the global population could be facing  
water scarcity – demand could outstrip supply by

**40%**

By 2050, manufacturing's water demands  
will increase by

**400%**

# Dow's Business is about Addressing World Challenges



**Linear economy model:** "take, make and dispose" of raw materials.

RESOURCE EXTRACTION

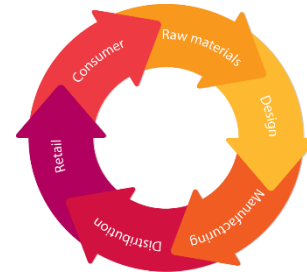
PRODUCTION

DISTRIBUTION

CONSUMPTION

WASTE

to



**Circular economy model:** "reduced, reused and reclaimed" raw materials.

# More from Every Drop: Reduce Cost, Increase Value

point-of-source

## RE-CLAIM

Source reclaimed water

on-site

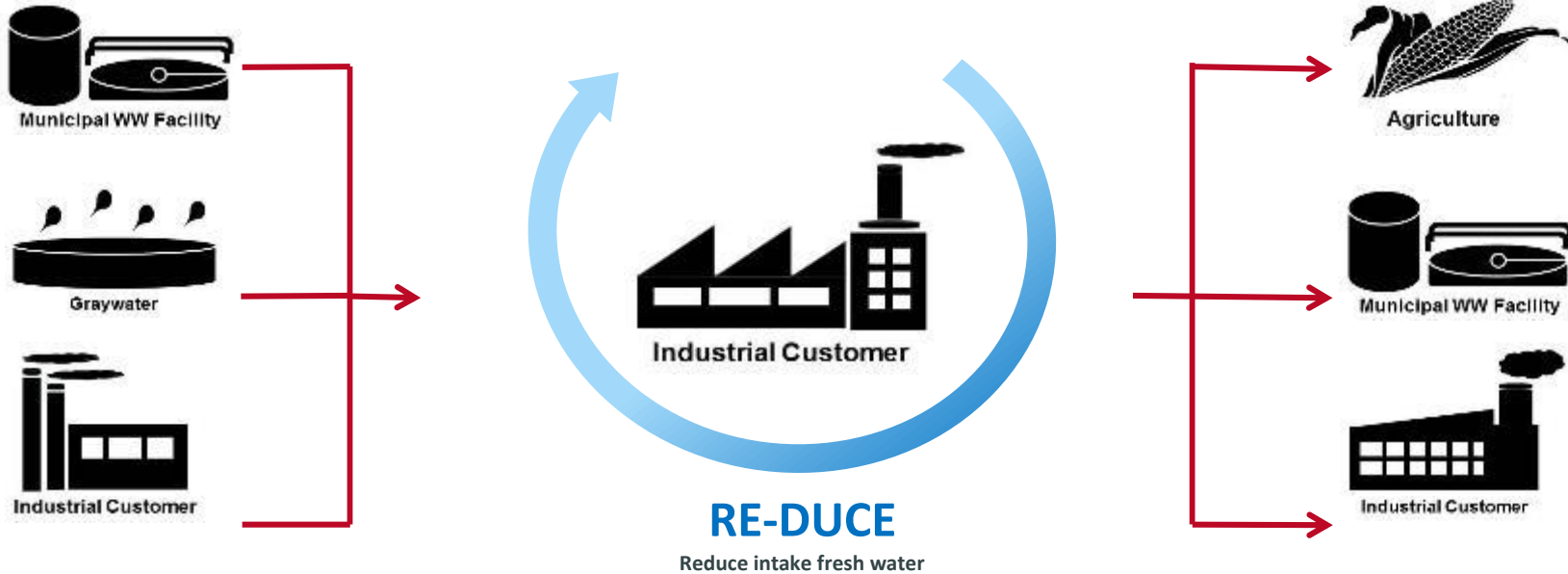
## RE-CYCLE

Increase number of cycles

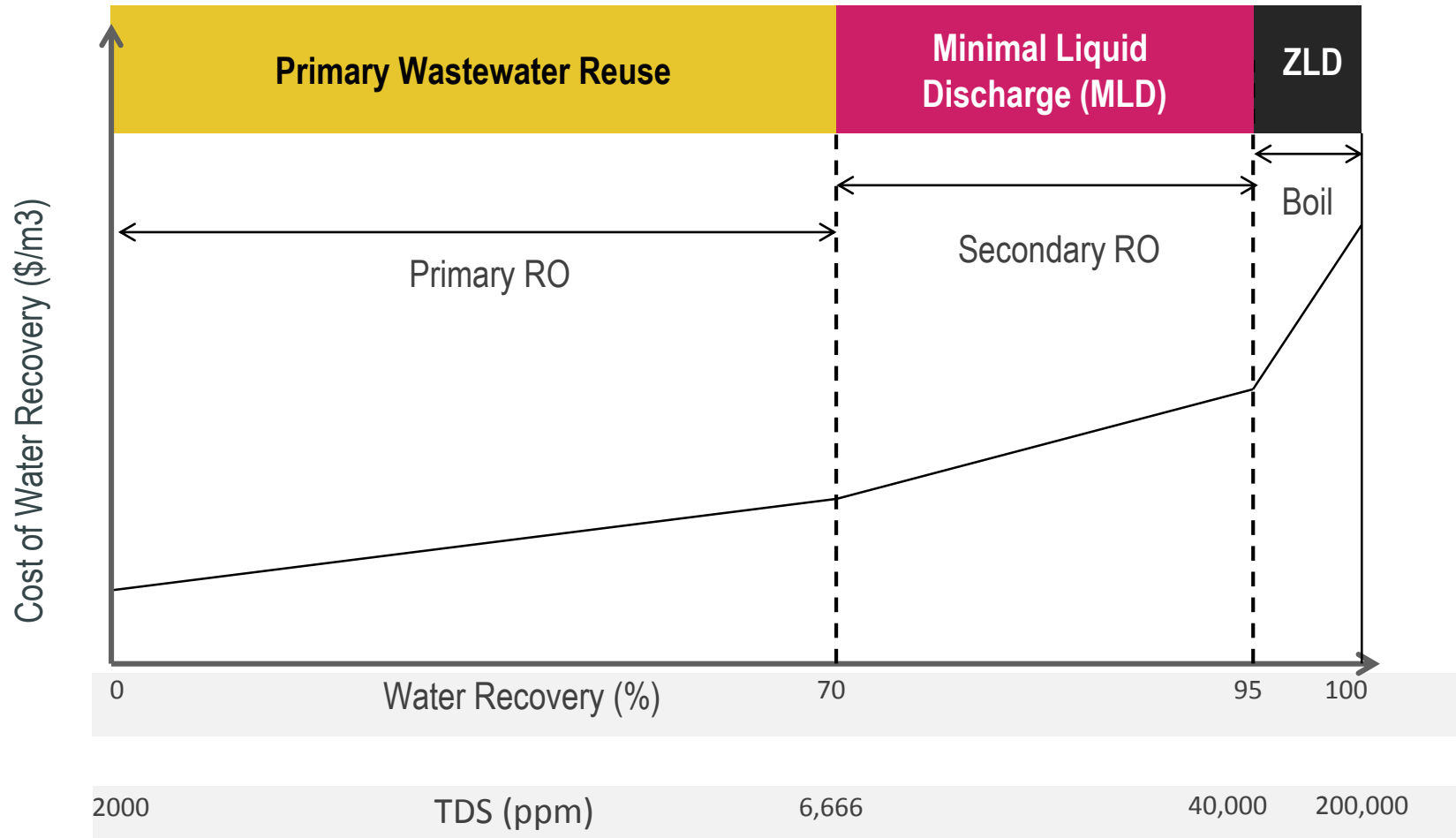
discharge

## RE-NEW

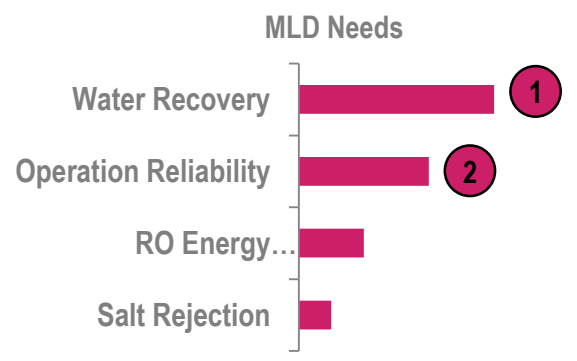
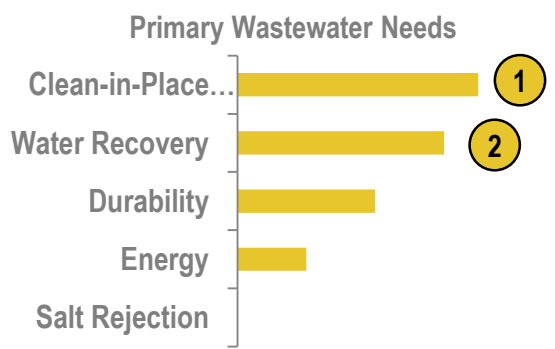
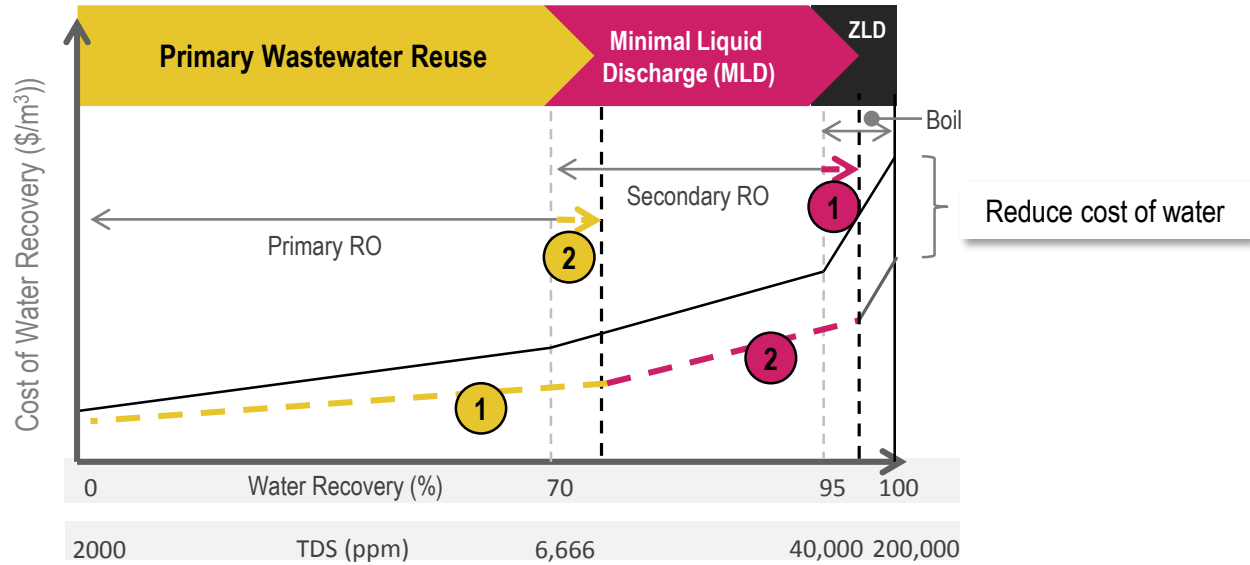
Upgrade for alternate use



# Industrial Wastewater Treatment Costs



# Industrial Wastewater Treatment Top Needs





# DOW FILMTEC™ FORTILIFE™ and UHPRO (Ultra-High Pressure) RO Elements

*Designed for a Challenge.*

*DOW FILMTEC™ FORTILIFE™ RO Elements and the support of seasoned Dow experts help industrial end users tackle the most challenging waters and applications enabling:*

- *Reliable performance*
- *Reduce water costs*
- *Achievable sustainability goals*
- *Minimal biofouling problems*
- *Minimal Liquid Discharge (MLD)*

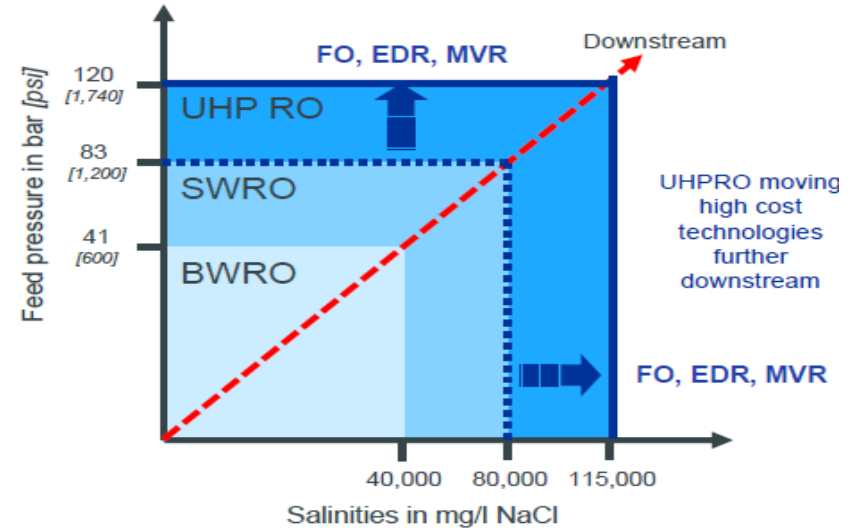
**FORTILIFE™ CR100**

**FORTILIFE™ XC70**

**FORTILIFE™ XC80**

**FORTILIFE™ XC-N**

*DOW FILMTEC™ brackish water and seawater RO elements for upstream ultra-high pressure RO*

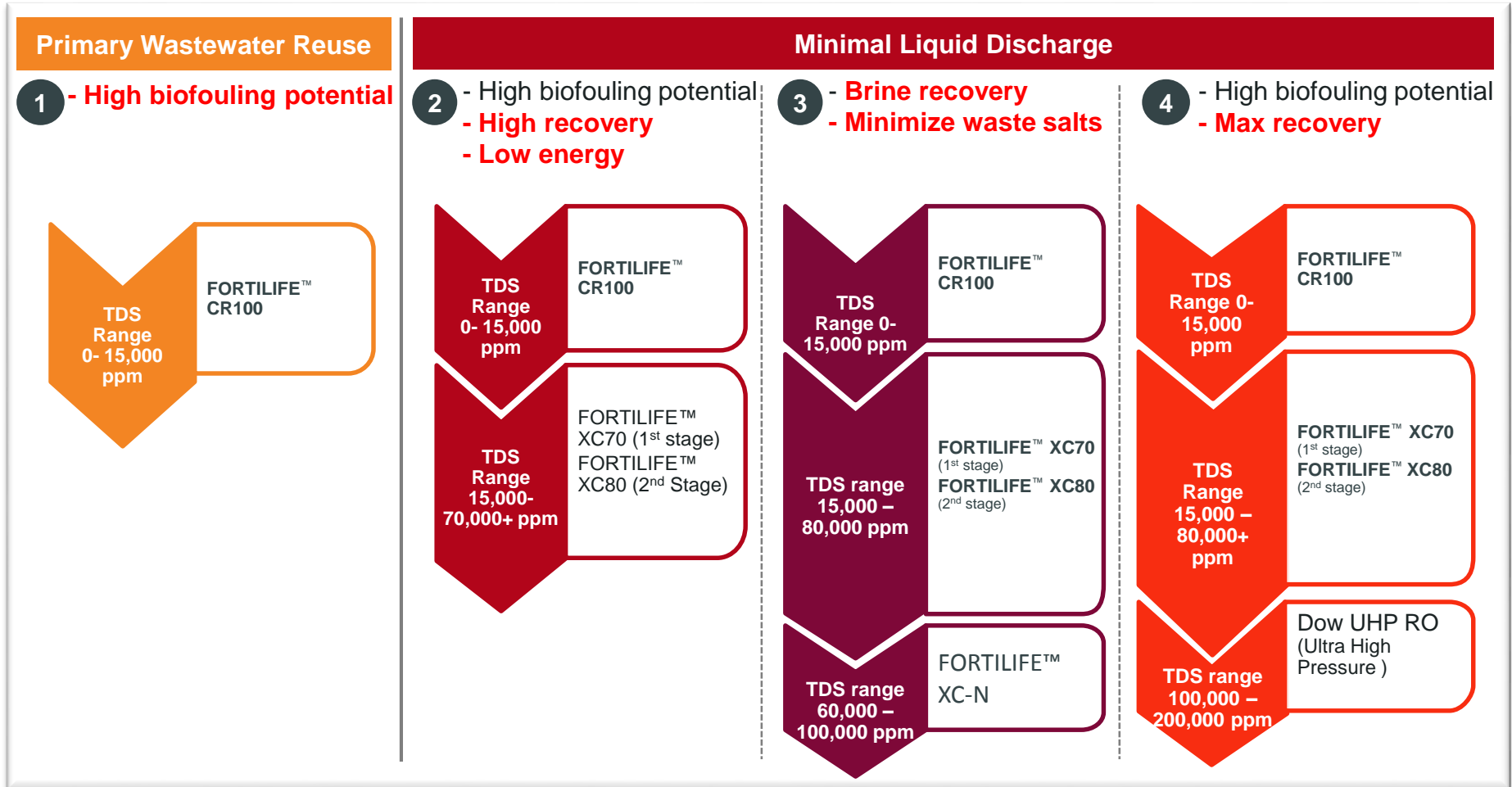


FO: forward osmosis  
EDR: Electro Dialysis Reverse  
MVR: Mechanical Recompression

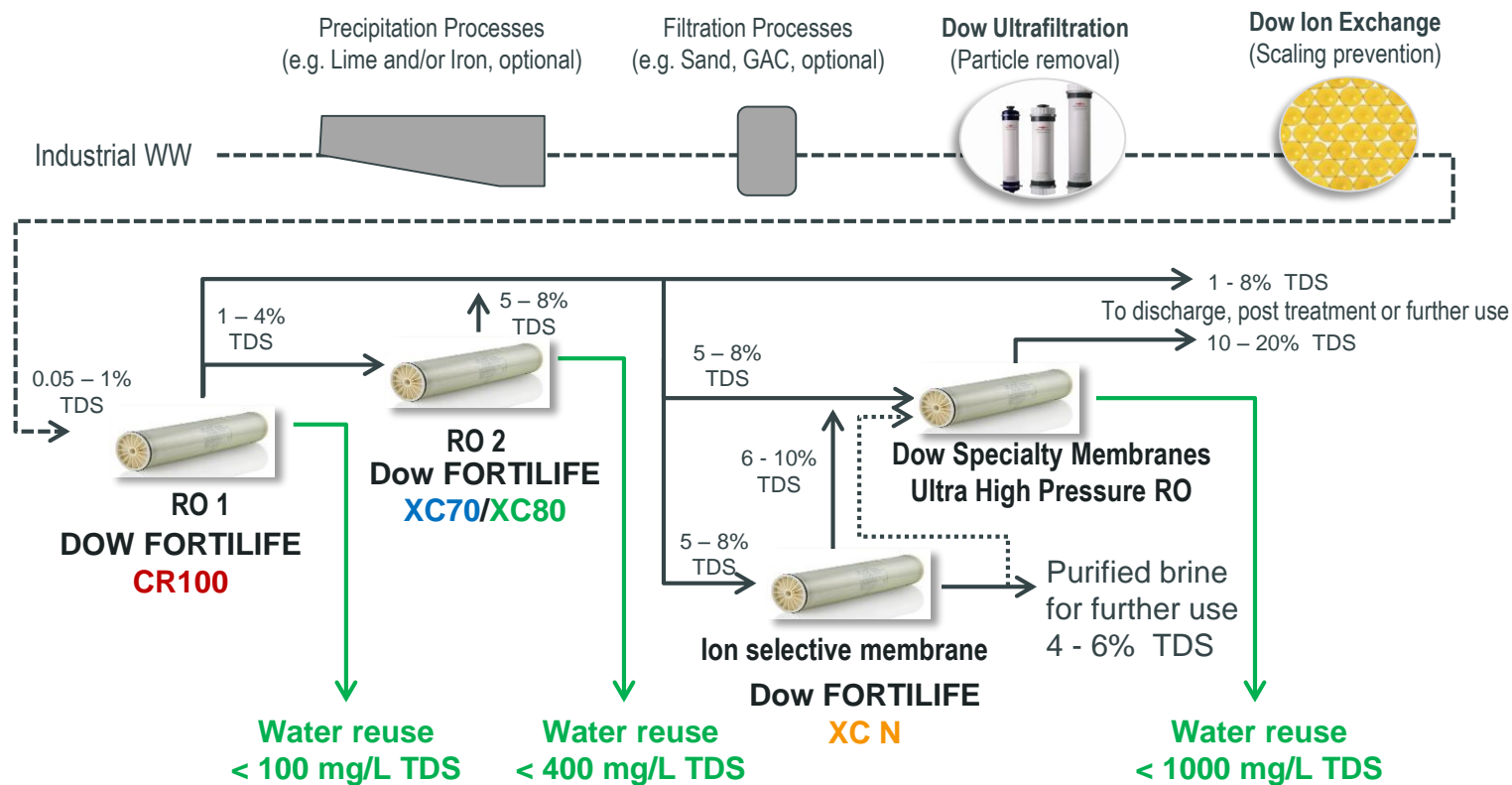


# — Global References

# Wastewater Treatment Design Recommendations



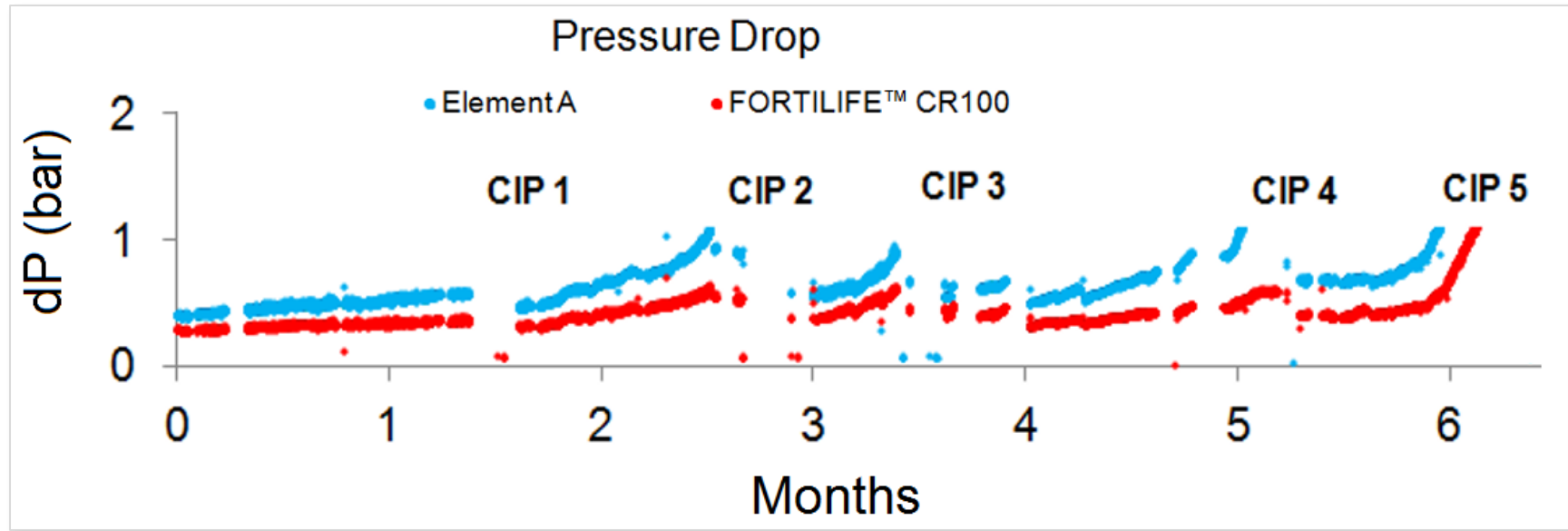
# Dow Solutions for Industrial Water Reuse – Minimal Liquid Discharge



## Municipal Wastewater: FORTILIFE™ CR100

Evaluation of two banks of 6 x 4" elements in series operated with matching flux and recovery.

RO Feed: TDS = 1700 mg/L; TOC = 5.9 mg/L; ATP = 46 ng/L; Nitrate = 24.9 mg/L; Phosphate = 0.4 mg/L



→ 29% reduction in CIP frequency

# Industrial Wastewater: FORTILIFE™ XC70 Brine Concentration

To improve system reliability **Competitor SWRO** elements in **RO3** were replaced with **FORTILIFE™ XC70**

Pretreatment: Feed TDS: 4500 ppm NaCl

Lime +  $\text{Fe}_2\text{SO}_4$  Coagulation- Biological Treatment – C/F – Clarifier– Sand Filter– UF

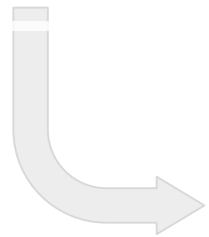
**RO3 Feed:**

Feed TDS: ~31,000 ppm

Feed COD: 800 ppm

Total Hardness: 800 ppm

pH: 7.1



Combined permeate <300 ppm

**CIP practice with SWRO installed:**

- Daily Caustic Cleaning at the end of the day. (15 mins)
- Short CIP with Caustic followed by Acid after every 3 days (60 mins)
- Long CIP with EDTA + STPP+ Caustic followed by acid after every 10 days. (120-150 mins).

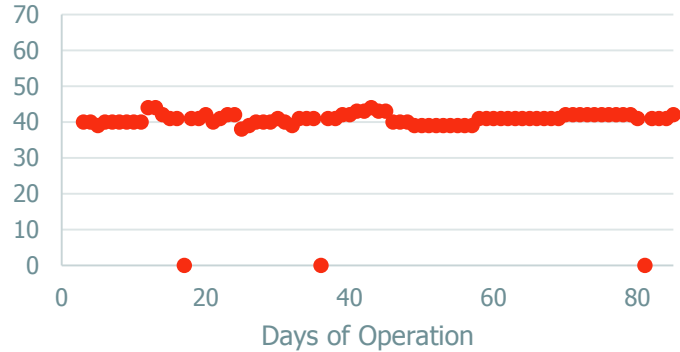
Steam Pan  
Evaporator



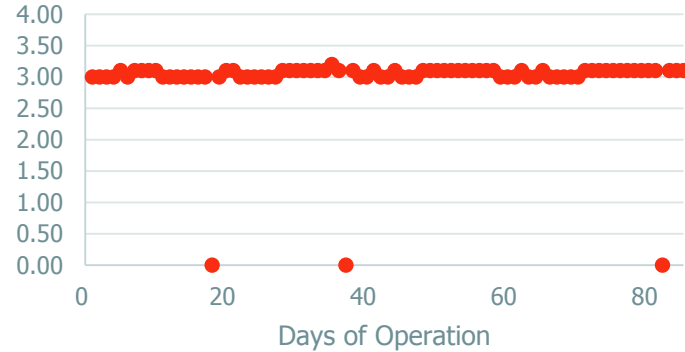
# Industrial Wastewater: FORTILIFE™ XC70 Brine Concentration

first 100 days of operation providing improved system reliability

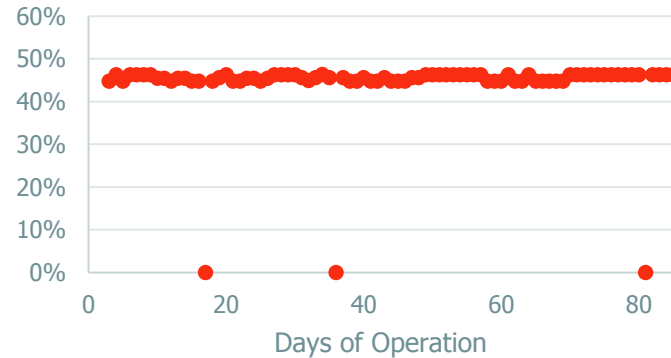
Feed Pressure (bar)



Raw Permeate flow (m3/h)



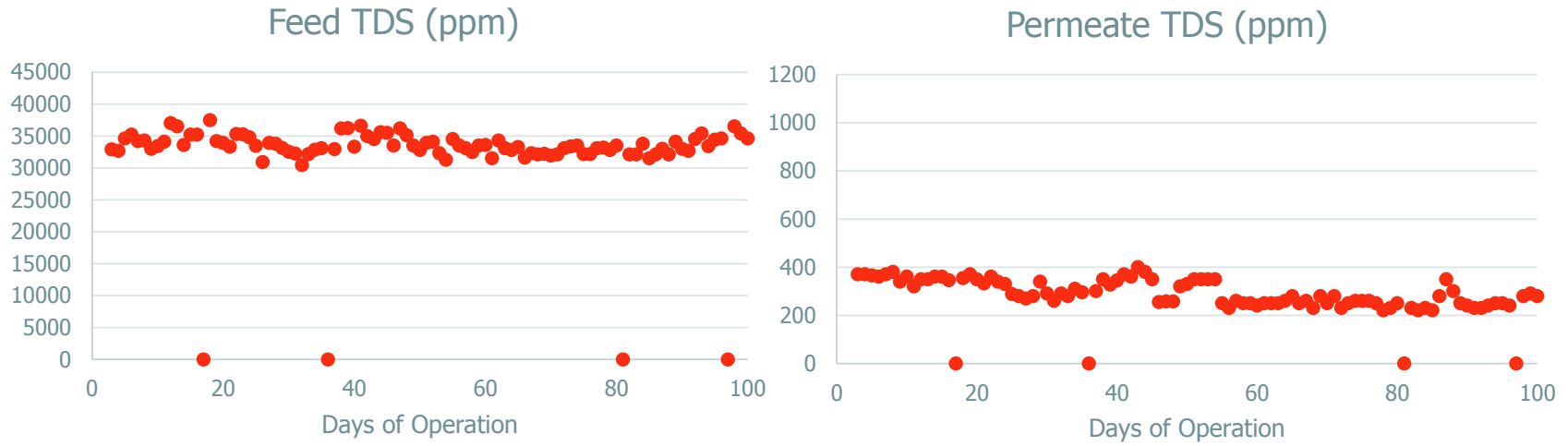
Recovery (%)



## CIP practice with FORTILIFE™ XC70:

- one CIP after 90 days of operation

# Industrial Wastewater: FORTILIFE™ XC70 Separation Performance



**XC70 provides excellent stable permeate quality**



# Guodian Hanchuan Power Plant in Asia

## Salt Separation and Brine Concentration followed by ZLD

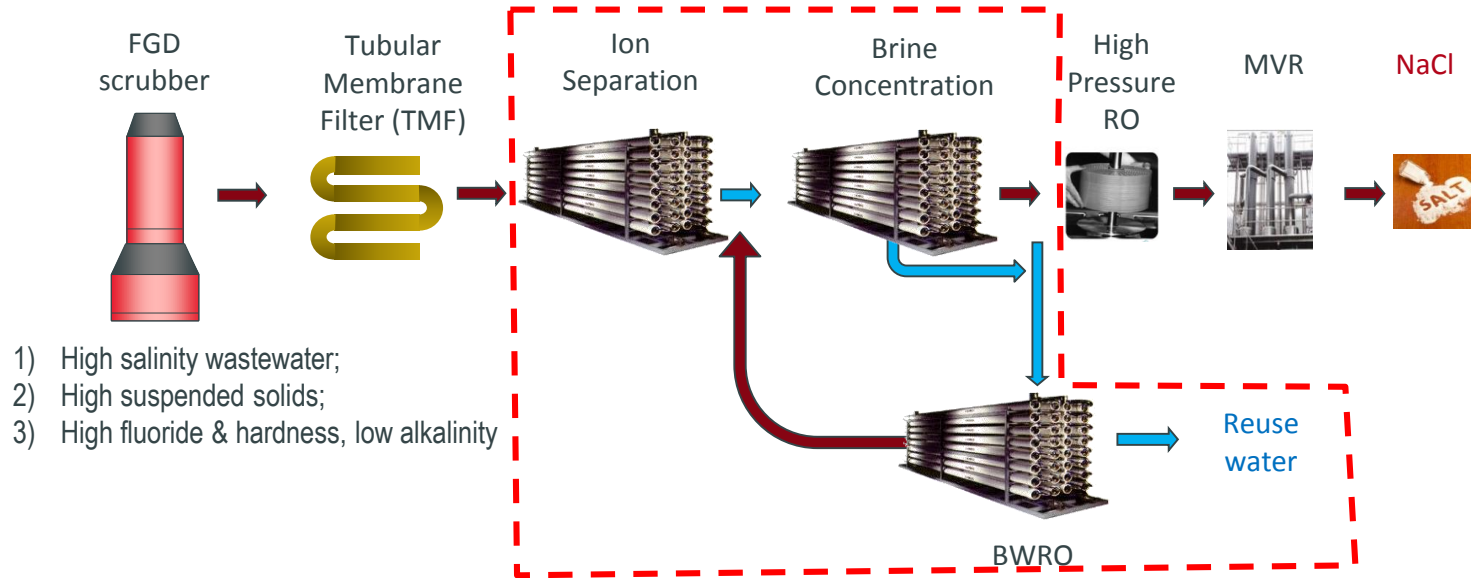
- This power plant is in one of the five largest national power groups in Asia.
- It is chosen as the pioneer power end user to establish Fuel Gas Desulfurization (FGD) wastewater Zero Liquid Discharge (ZLD) technology.
- Six months of close cooperation between DOW and a local Original Equipment Manufacturer (OEM) – NJ Lucency succeeded in piloting a new process while validating the performance of the FORTILIFE XCN and XC80 products.

*Process and photo by courtesy of EPC (Engineering Procurement Construction) contractor: Beijing Lucency Environmental Tech Co, Nanjing Branch*



# Guodian Hanchuan Power Plant in Asia

## Salt Separation and Brine Concentration followed by ZLD



Unit	Product Type	Elements Amount (pcs)
Ion Separation	FORTILIFE™ XC-N	80
Brine concentration	FORTILIFE™ XC80	78
BWRO	BW30-400	36

Process and photo by courtesy of EPC (Engineering Procurement Construction) contractor: Beijing Lucency Environmental Tech Co, Nanjing Branch

# Guodian Hanchuan Power Plant in Asia

## Salt Separation and Brine Concentration followed by ZLD

*Raw FGD wastewater composition*

Item	Value	Unit	Item	Value	Unit
TDS	25000	mg/L	NH <sub>3</sub> -N	56.18	mg/L
Conductivity	28050	μS/cm	K <sup>+</sup>	124.2	mg/L
pH	6.5	--	Na <sup>+</sup>	10687	mg/L
Turbidity	60.8	NTU	Mg <sup>2+</sup>	7586	mg/L
SS	80	mg/L	Ca <sup>2+</sup>	2893	mg/L
COD	140	mg/L	F <sup>-</sup>	65	mg/L
TOC	9.6	mg/L	Cl <sup>-</sup>	7000	mg/L
Alkalinity	12	mg/L CaCO <sub>3</sub>	SO <sub>4</sub> <sup>2-</sup>	5325	mg/L

### *Wastewater challenges:*

- 1) High salinity wastewater;
- 2) High suspended solids;
- 3) High fluoride & hardness, low alkalinity;

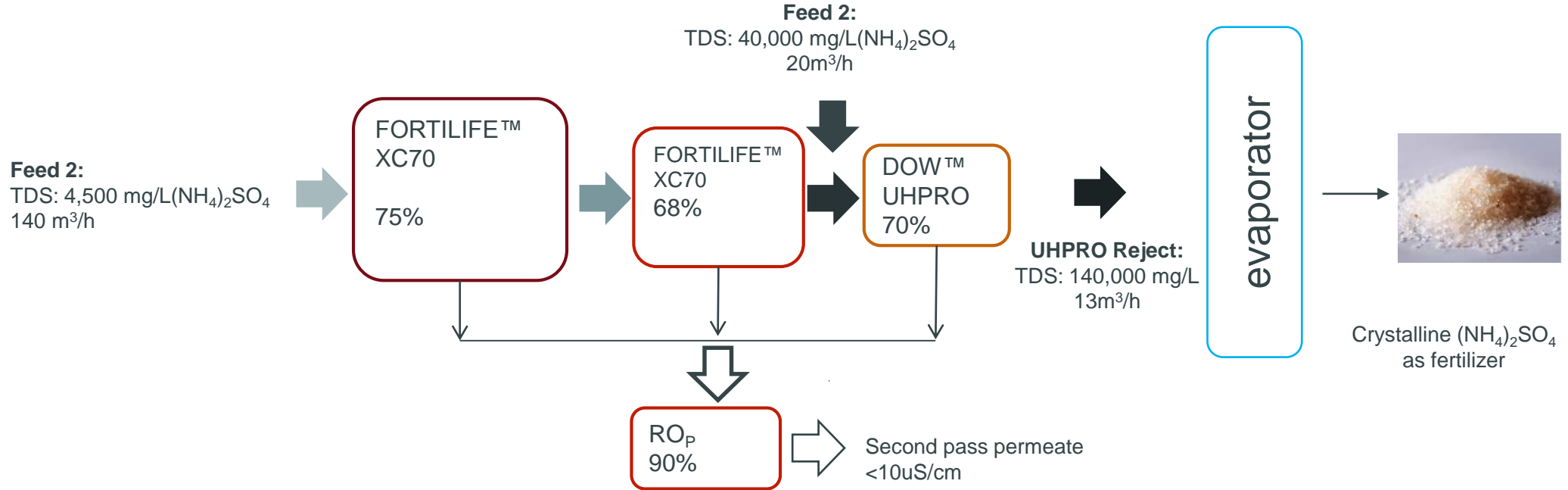
*Piloting time and cleaning frequency*

System	Piloting time / days	Cleaning	Notes
TMF	100	1	Recovered after cleaning
NF	60	0	No normalized flow & dP change
RO	60	0	No normalized flow & dP change
DTRO	30	0	No normalized flow & dP change

**Low fouling, reliable performance**

*Cited from Sunup presentation, Tsingdao CDA conference, 2016*

# $(\text{NH}_4)_2\text{SO}_4$ Recovery from Industrial WW: DOW™ Specialty Membranes ultra-high pressure RO



## Key Takeaways

- DOW FILMTEC™ FORTILIFE™ family are designed with the challenges of MLD in mind to provide the best membrane options for achieving reliable high water recovery at low energy.
- DOW FILMTEC™ FORTILIFE™ CR100 offers 30–50% less cleanings
- This is observed in three waters and fouling resistant elements



### THE NEXT BIG THING IN REVERSE OSMOSIS...

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**Reduce “Clean-in-place”  
Frequency by 30% ~ 50%**

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**Increase Water Recovery**

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**For Improved Water Availability  
Reliable Operations  
Low Cost Water**

Thank You.  
Let's *discuss.*

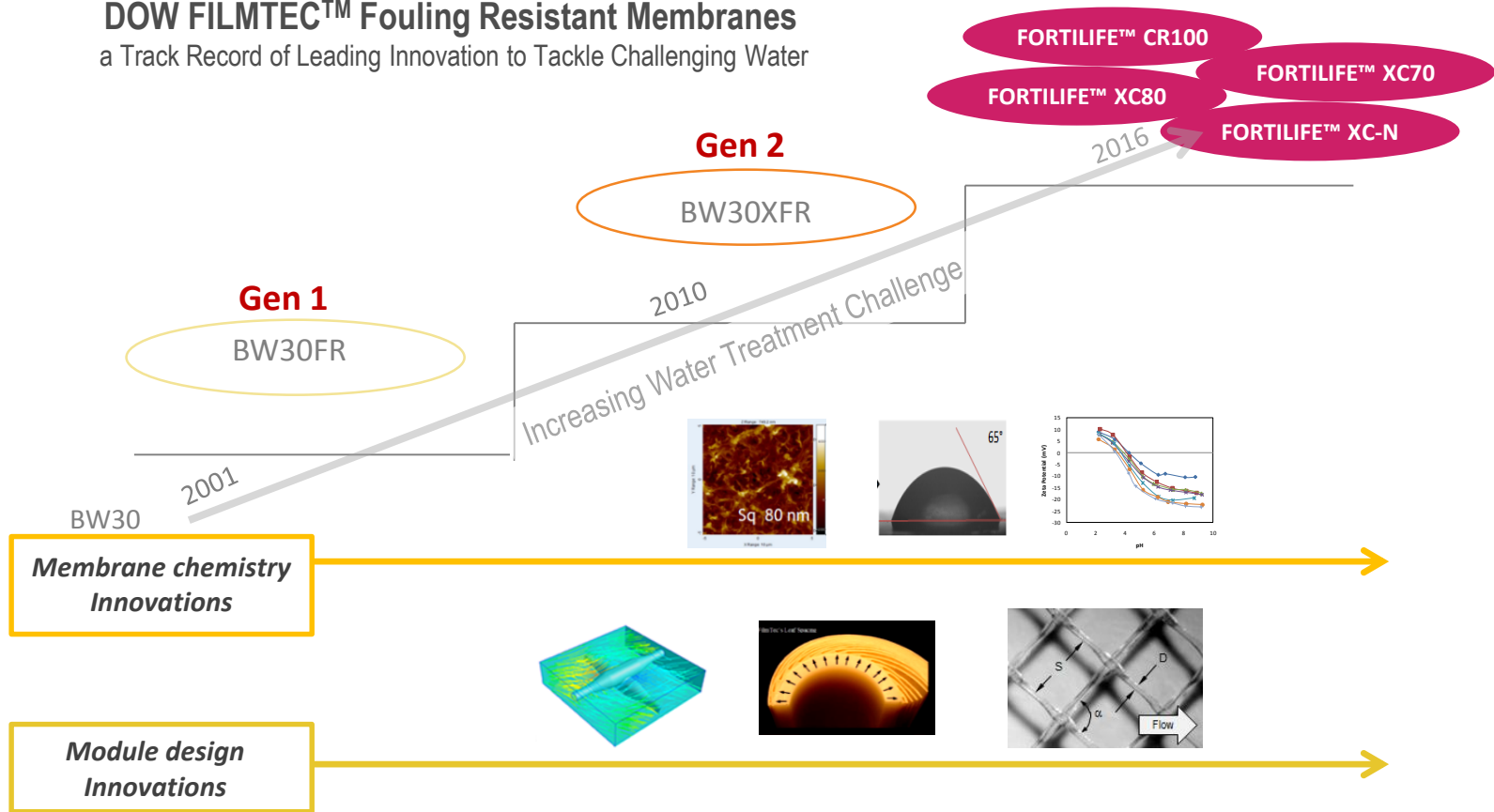


# DOW FILMTEC™ FORTILIFE™ Product Line

Membranes to stand up to today's water challenges.



**DOW FILMTEC™ Fouling Resistant Membranes**  
a Track Record of Leading Innovation to Tackle Challenging Water





**— Back up slides**

## Partnering to Address Waste Water Challenges

Bringing it all together takes partnership

- Innovation: Global and Regional
- External Partnerships: Global and Regional
  - Chemistry/Science/Components Engineering
  - Systems Engineering
  - End users : wide range of applications from Industrial, Institutional to Municipal
  - Regional Water Knowledge and Engagement

# DOW™ UHPRO (Ultra-High Pressure) reducing total treatment



## DOW™ Specialty Membranes ultra-high pressure RO (XUS1808-series)

max operation pressure: 120 bar / 1740 psi  
(@ max 30°C); 83 bar @ 45C

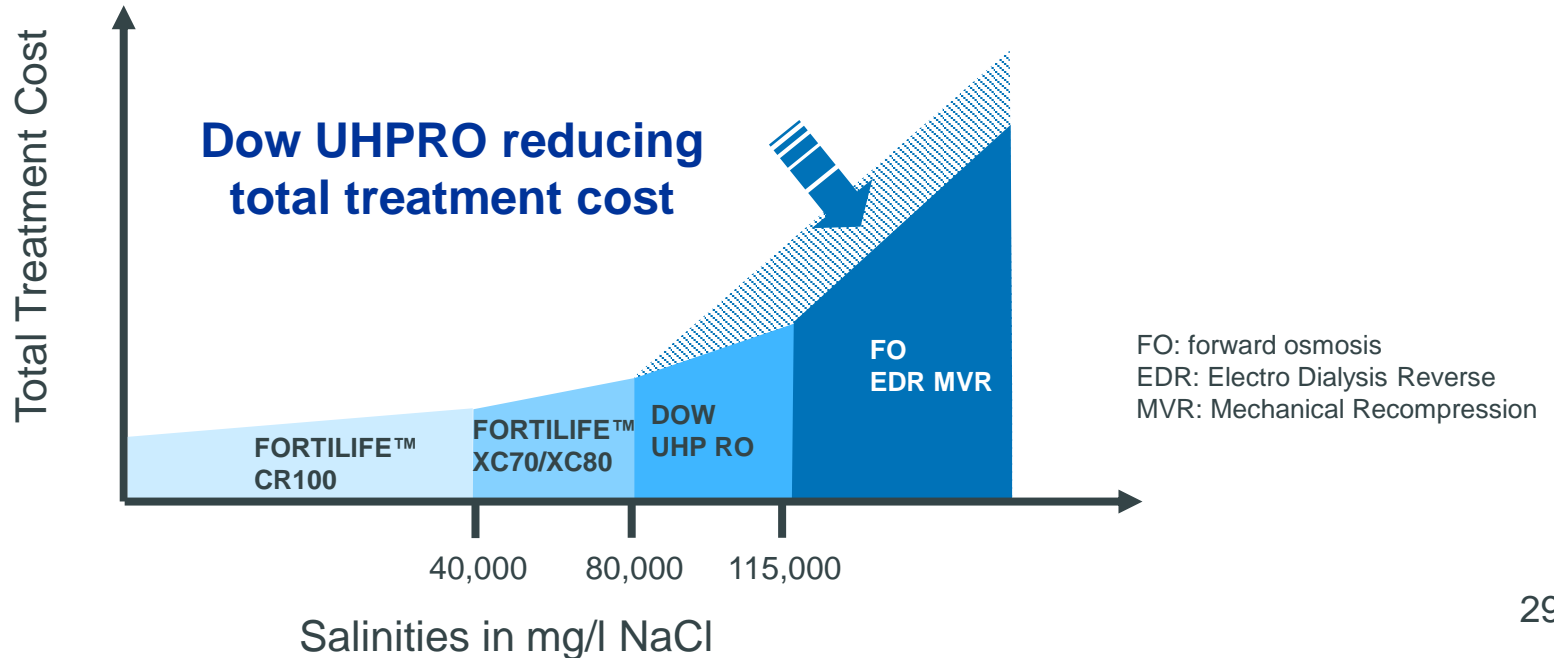
Membrane area (8"): 285 sqft / 27m<sup>2</sup>

34 mil feed spacer

Distinctive element construction including polysulfone permeate water tube  
High pressure DOW FILMTEC™ SW30 flat sheet

Available in 8040, 4040 and 2540 design

Fits into standard size pressure vessels with 120 bar specification



# Challenging water recovery: general schematic

