Dow Water & Process Solutions

Economía circular en la reutilización de aguas para la industria. La experiencia de DOW en el complejo petroquímico de Tarragona.

Silvia Gallego
Key Account Manager Spain, Portugal & Israel.
Dow Water & Process Solutions
sgallego2@dow.com

AGENDA

1.- Introducción a Dow Water & Process Solutions

2.- Retos en la aplicación de la tecnología de membranas vs Innovación.
Aplicaciones en aguas potables & industriales.

3.- Economía circular del agua & tecnología de membranas.
Introducción al concepto de Minimal Liquid Discharge (MLD).

4.- Experiencia en reutilización en el complejo Petroquímico de Tarragona.
Proyectos DEMOWARE y REWATCH.

DW&PS at a Glance

“Purifying the Essentials of Life”

Dow technologies process 56 million liters of water every minute.

That equals more than 11 liters a day for every man, woman and child in the world.

$1B REVENUE

1700 EMPLOYEES

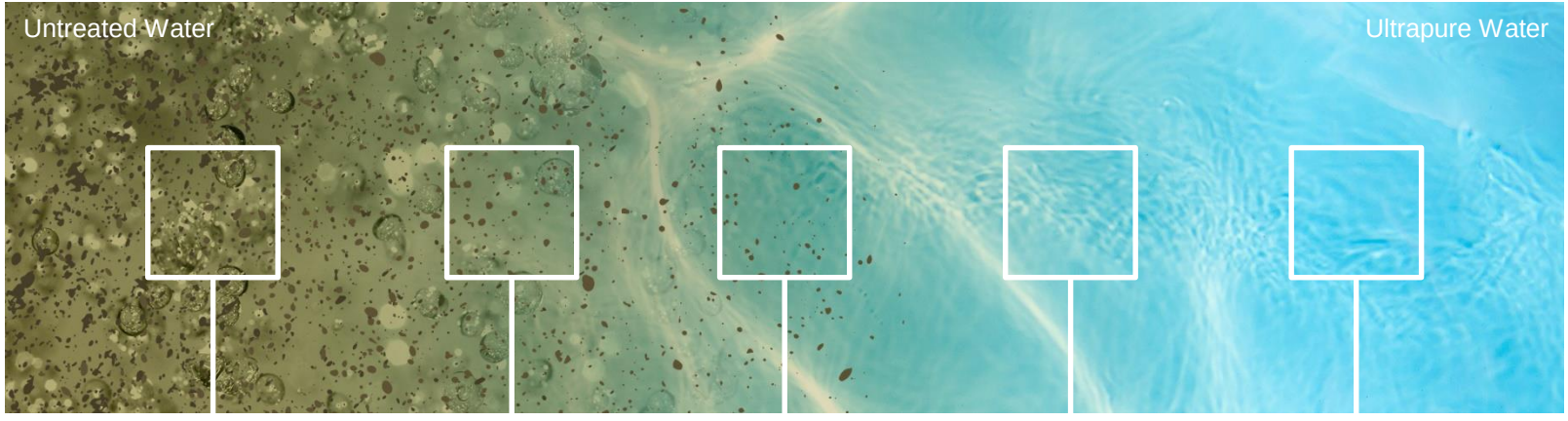
10 MANUFACTURING PLANTS

8 STATE OF THE ART **R&D CENTERS**

3 **Dow Water & Process Solutions TECHNOLOGY CENTERS** in the **EMEA** region

The Broadest Portfolio of Water Treatment Solutions

Dow Water & Process Solutions at a Glance



High-Solids Filtration

Ultrafiltration

Reverse Osmosis & Nanofiltration

ION Exchange Resins

Electrodeionization

DW&PS: Market Segments

POWER GENERATION

MINING & HYDROMETALLURGY

FOOD & BEVERAGE

RESIDENTIAL

HEALTHCARE

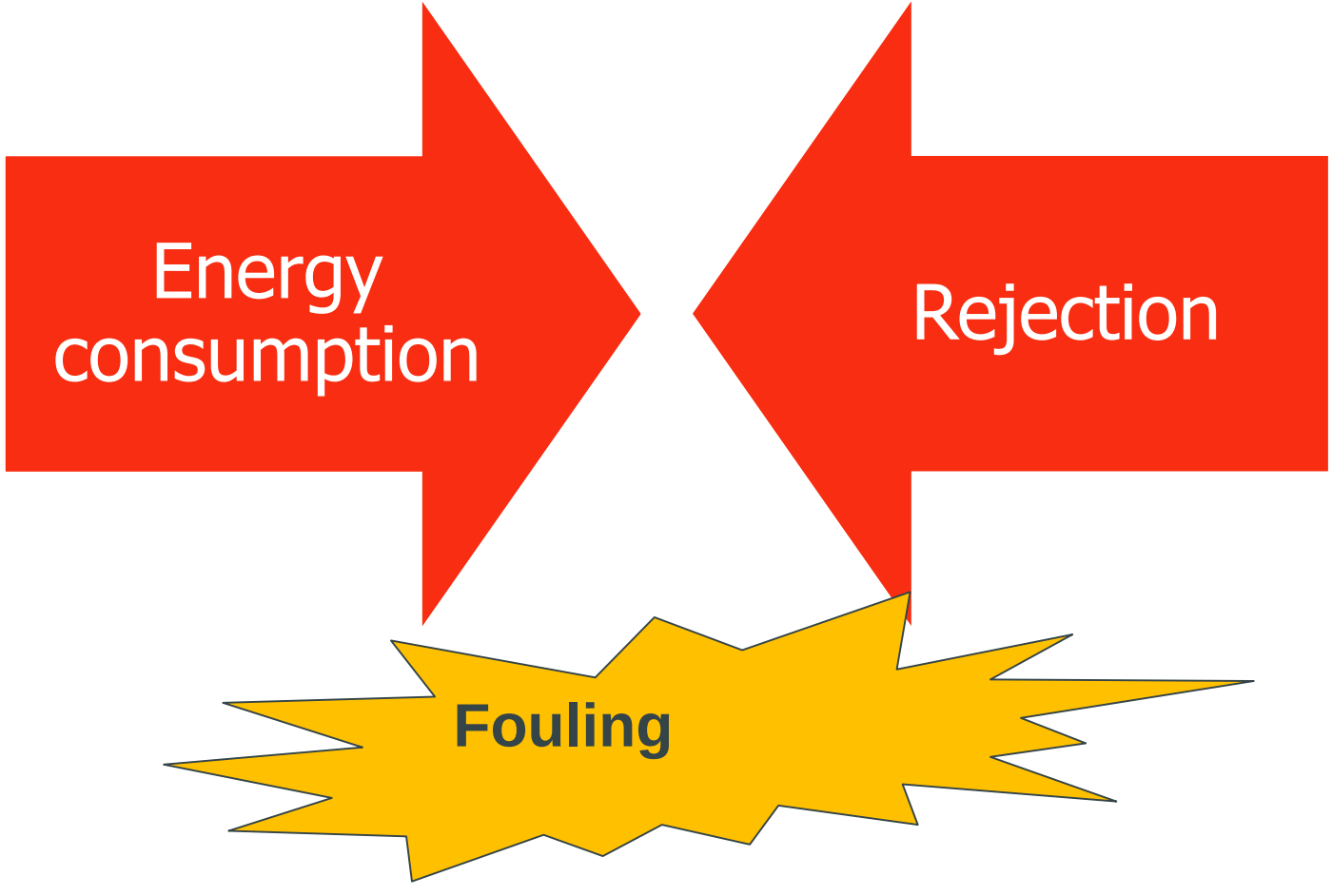
MUNICIPAL

INDUSTRIAL

BUILDINGS & INSTITUTIONS

OIL & GAS

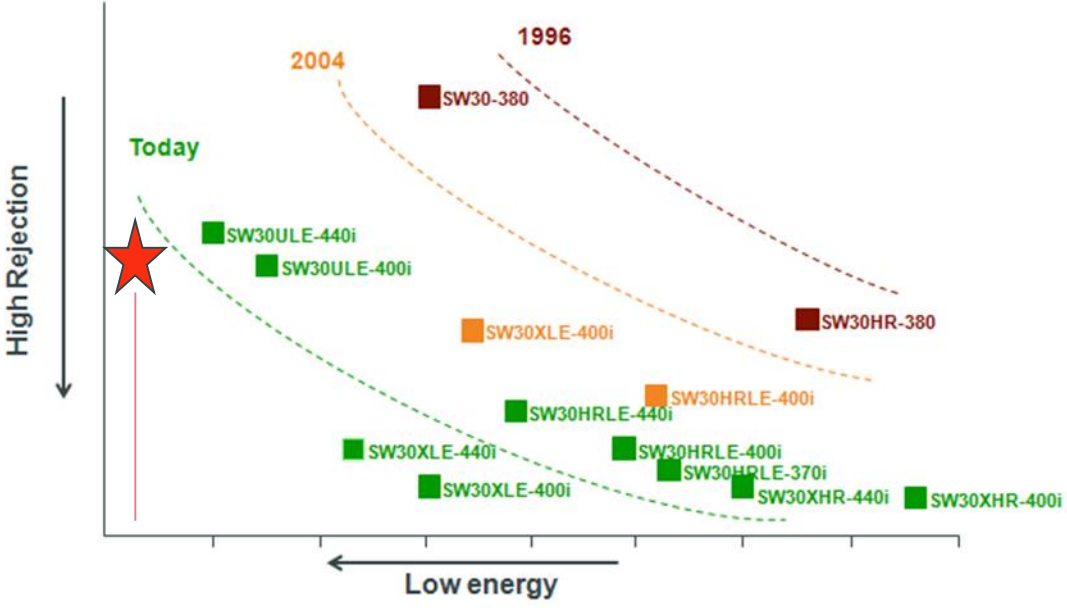
Challenges in membrane technology



SEAMAXX™ – The *lowest* energy solution

Lowest energy consumption – industry wide

17,000 gpd*: The optimized membrane chemistry minimizes pressure and energy consumption below any other existing SWRO product



Based on 41,000 mg/L TDS, 14.5 L/m^{2}h average flux and 45% recovery

Water quality you need

99.70%*: Provides reliable long term permeate quality for single, double pass and interstaged systems

Optimized module design

The combination of **28 mil feed spacer, 440ft2 active membrane surface and iLEC™** interlocking technology maximizes the productivity of your system at low differential pressure, low cleaning frequency and high cleaning efficiency."

Field Experience demonstrates real savings

Production increase of 40%
Specific energy reduction of 57%

Operation since May 2013

Original plant with SW30HR-380

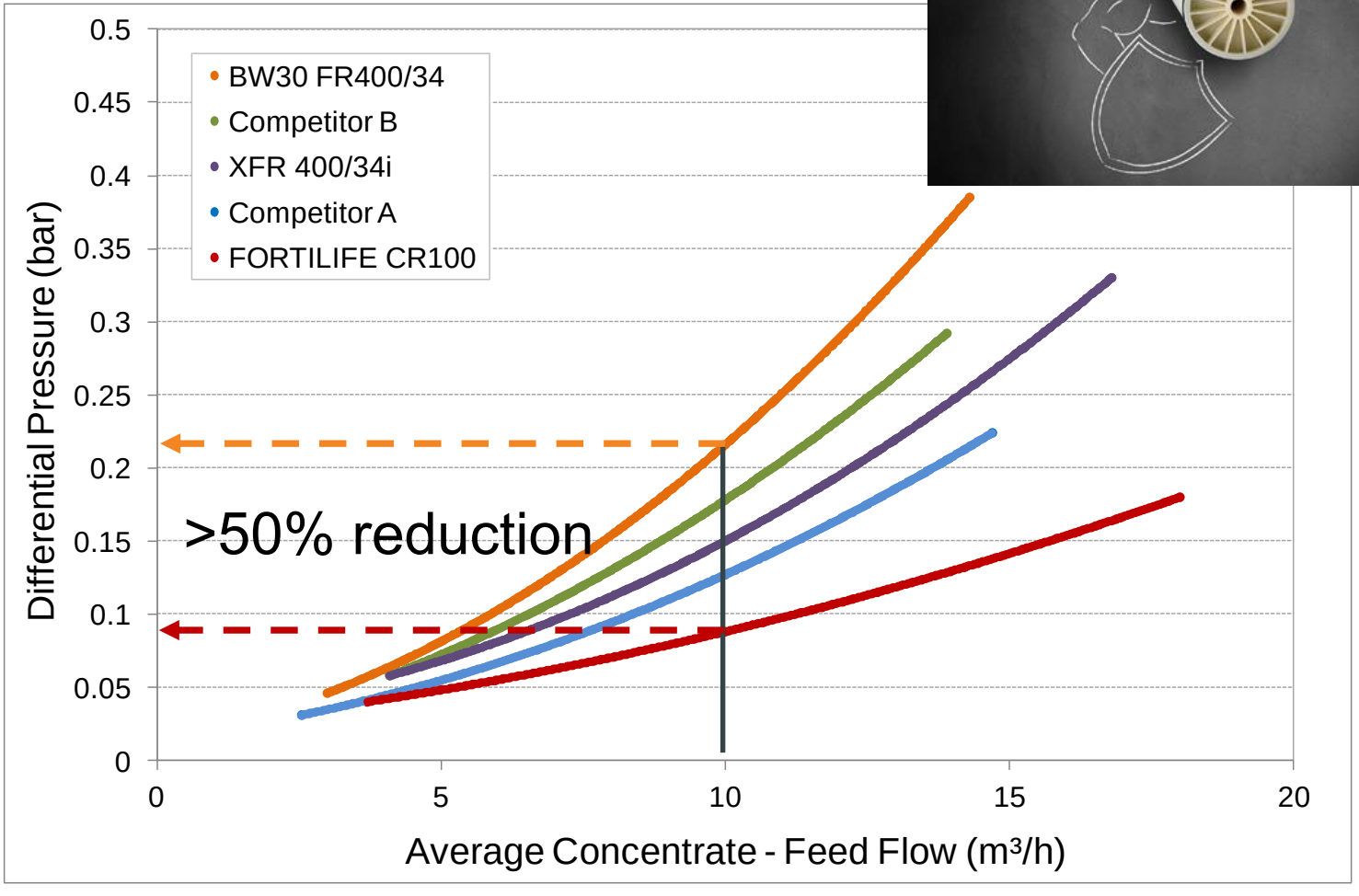
- Plant production capacity: 400 m^3/d
- Configuration: 4 pv, 7 elements each
- Nominal feed pressure: 61 bar
- Specific energy consumption: 4.9 kWh/m^3
- Product water TDS ≈ 400 ppm
- Boron < 1 ppm

Revamp of the installation:
-New HP Pump
- Energy Recovery
- New Membranes

Currently SW30XHR-440i + SEAMAXX

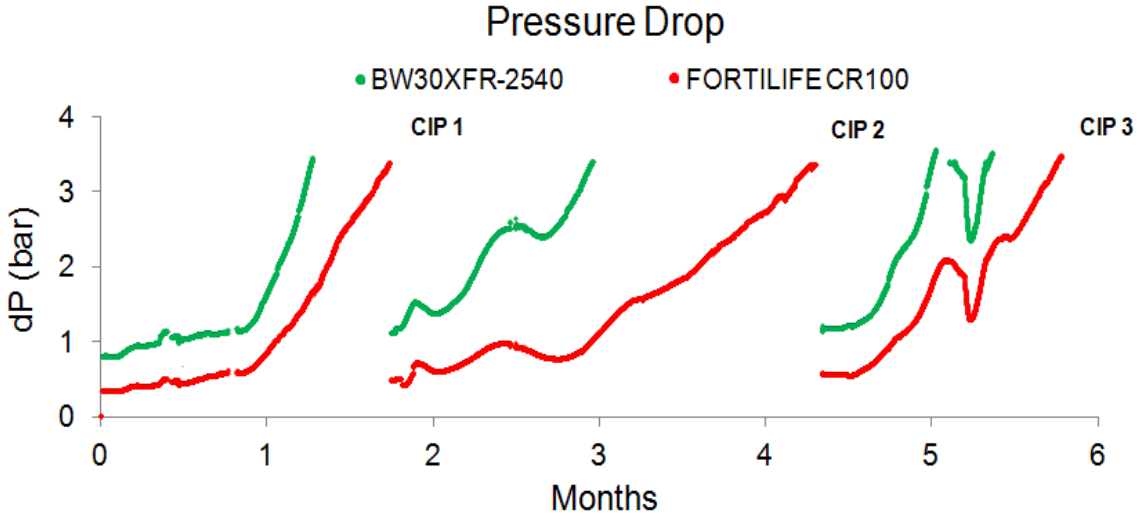
- Capacity increased to 550 m^3/d
- Same number of elements
- Feed pressure decreased to 50 bar
- Energy consumption decreased to 2.1 kWh/m^3
- Better product quality

FORTILIFE™ CR100



FORTILIFE™ CR100 Pilot Study

Side-by-side field trial of two banks of 8 2.5 inch elements operated in series with matching flux and recovery. Nutrient dosed softened tap water.



CIP #	Days cleaning delayed
1	15
2	42
3	13

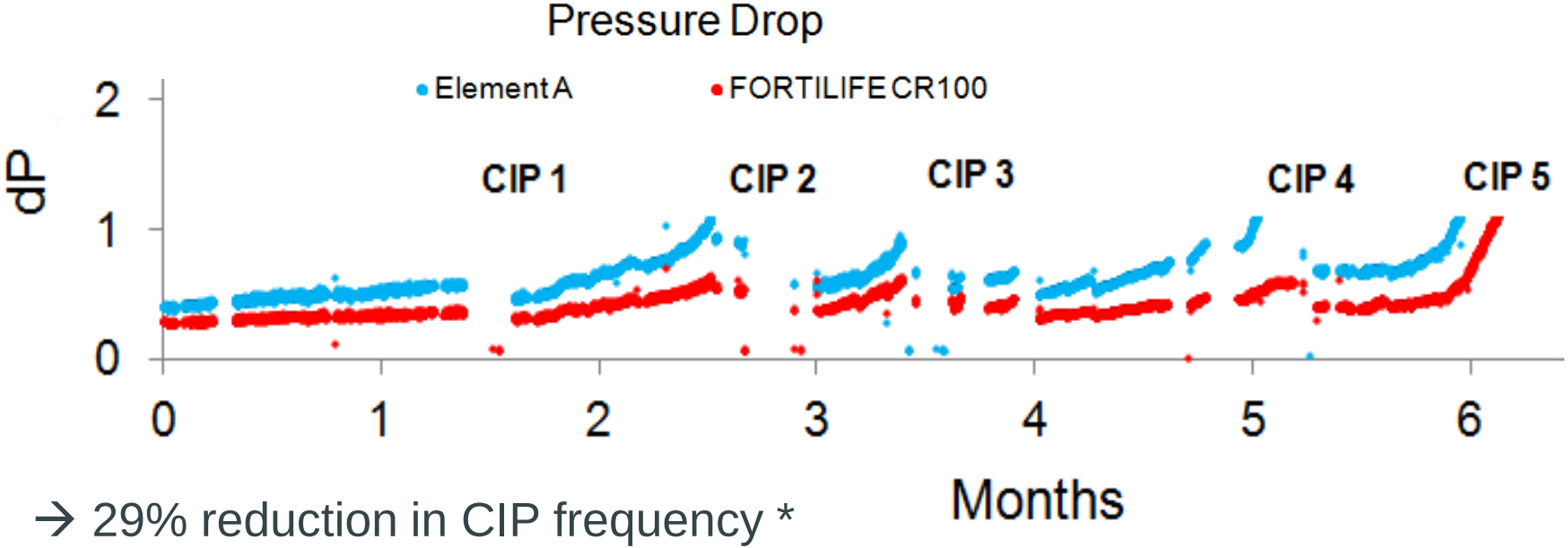
→ Average 37% CIP frequency reduction*

→ Excellent cleanability to recover DP

*This is a pilot study; we recommend to follow FILMTEC™ cleaning procedure

FORTILIFE™ CR100 Pilot Study

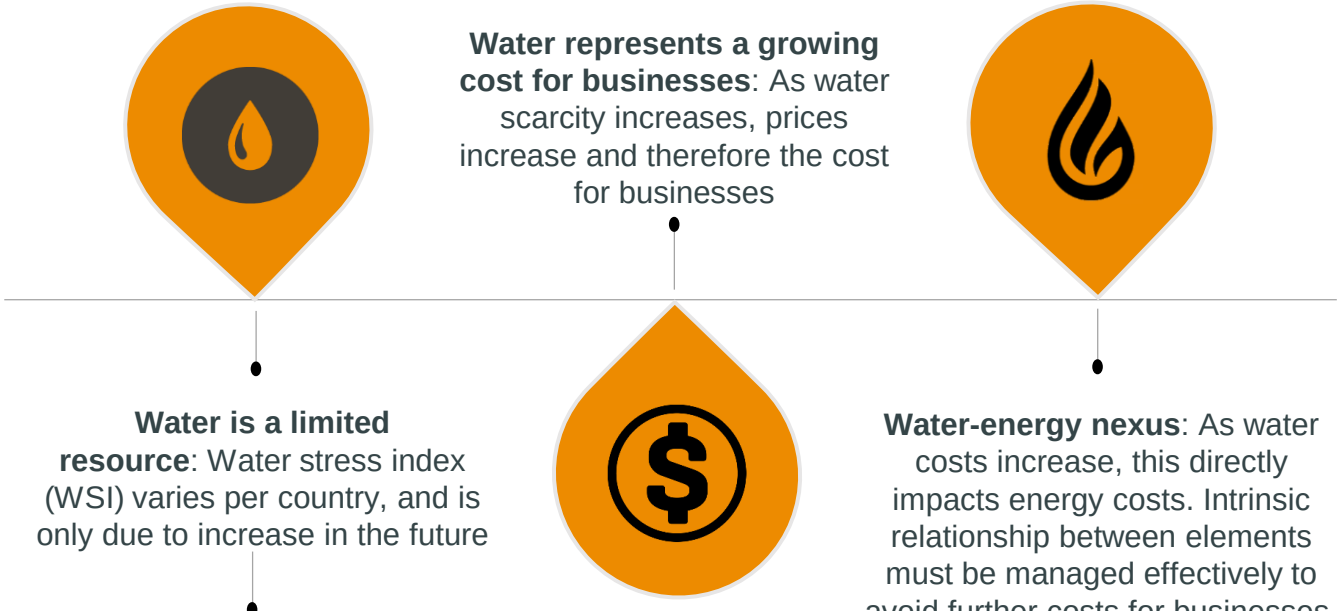
Side-by-side field trial: two banks of 6 x 4” elements in series operated with matching flux and recovery. Nutrient dosed Vilaseca Wastewater (Tarragona, Spain)



→ 29% reduction in CIP frequency *

*This is a pilot study; we recommend to follow FILMTEC™ cleaning procedure

Economic Impact of Water Management



Water represents a growing cost for businesses: As water scarcity increases, prices increase and therefore the cost for businesses

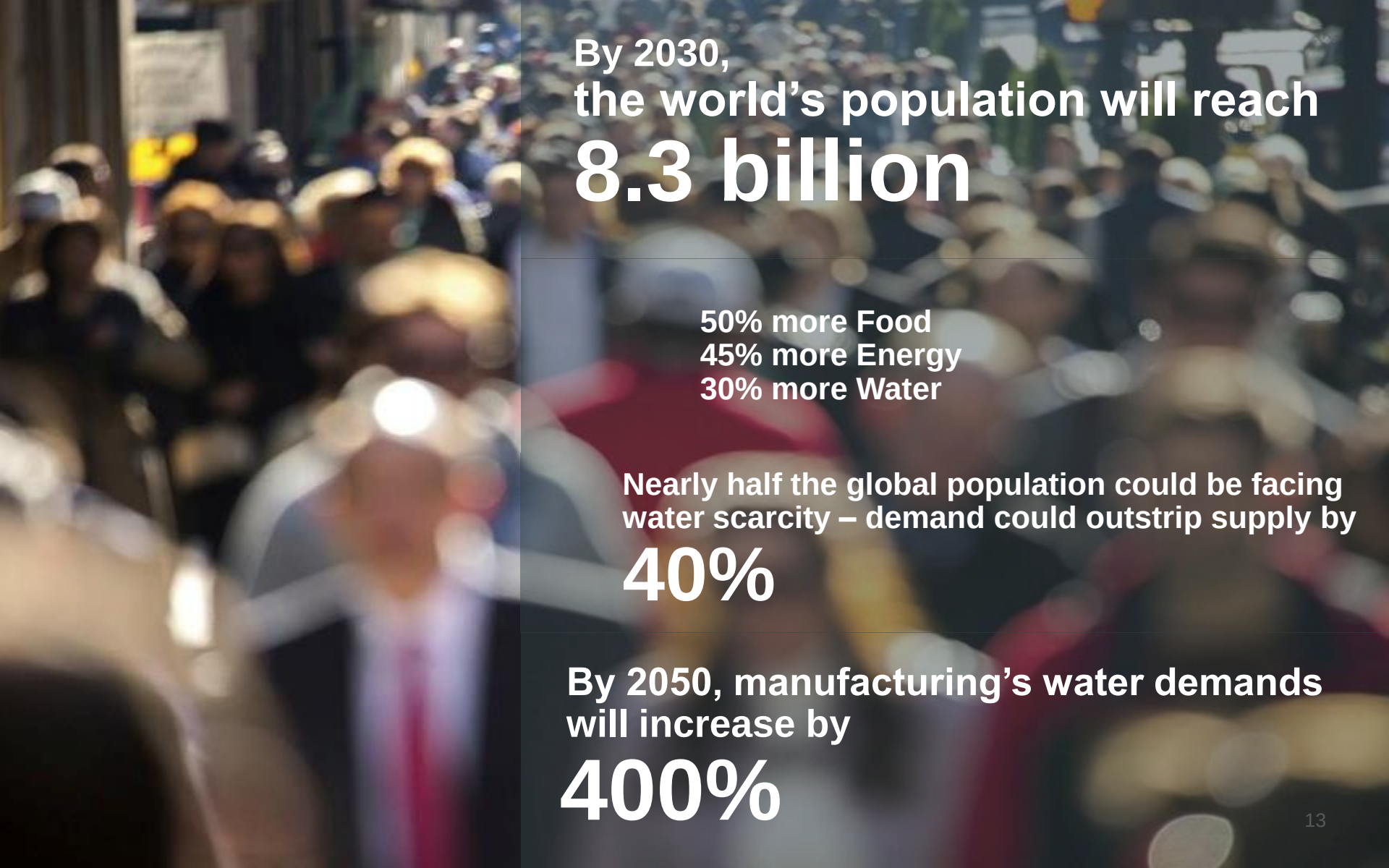
Water is a limited resource: Water stress index (WSI) varies per country, and is only due to increase in the future

Cyprus: 0.40+
Spain: 0.32+
Italy: 0.27

European average: 0.14

Water-energy nexus: As water costs increase, this directly impacts energy costs. Intrinsic relationship between elements must be managed effectively to avoid further costs for businesses.

Improved water management can have a significant impact on all sectors, industries and, therefore, whole economies



By 2030,
the world's population will reach

8.3 billion

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

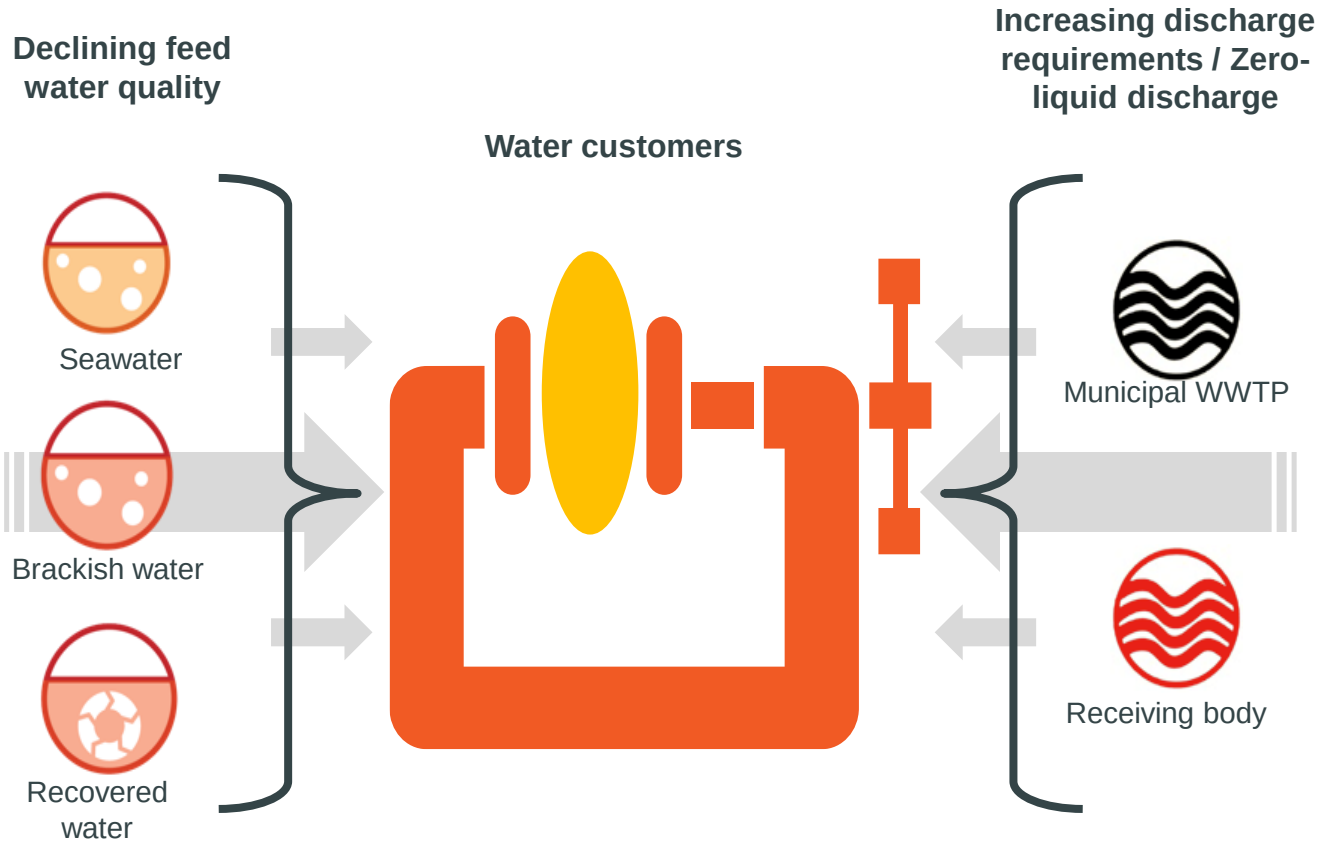
Nearly half the global population could be facing water scarcity – demand could outstrip supply by

40%

By 2050, manufacturing's water demands will increase by

400%

The New Normal: Water Users Squeezed



Membranes in the circular economy of water

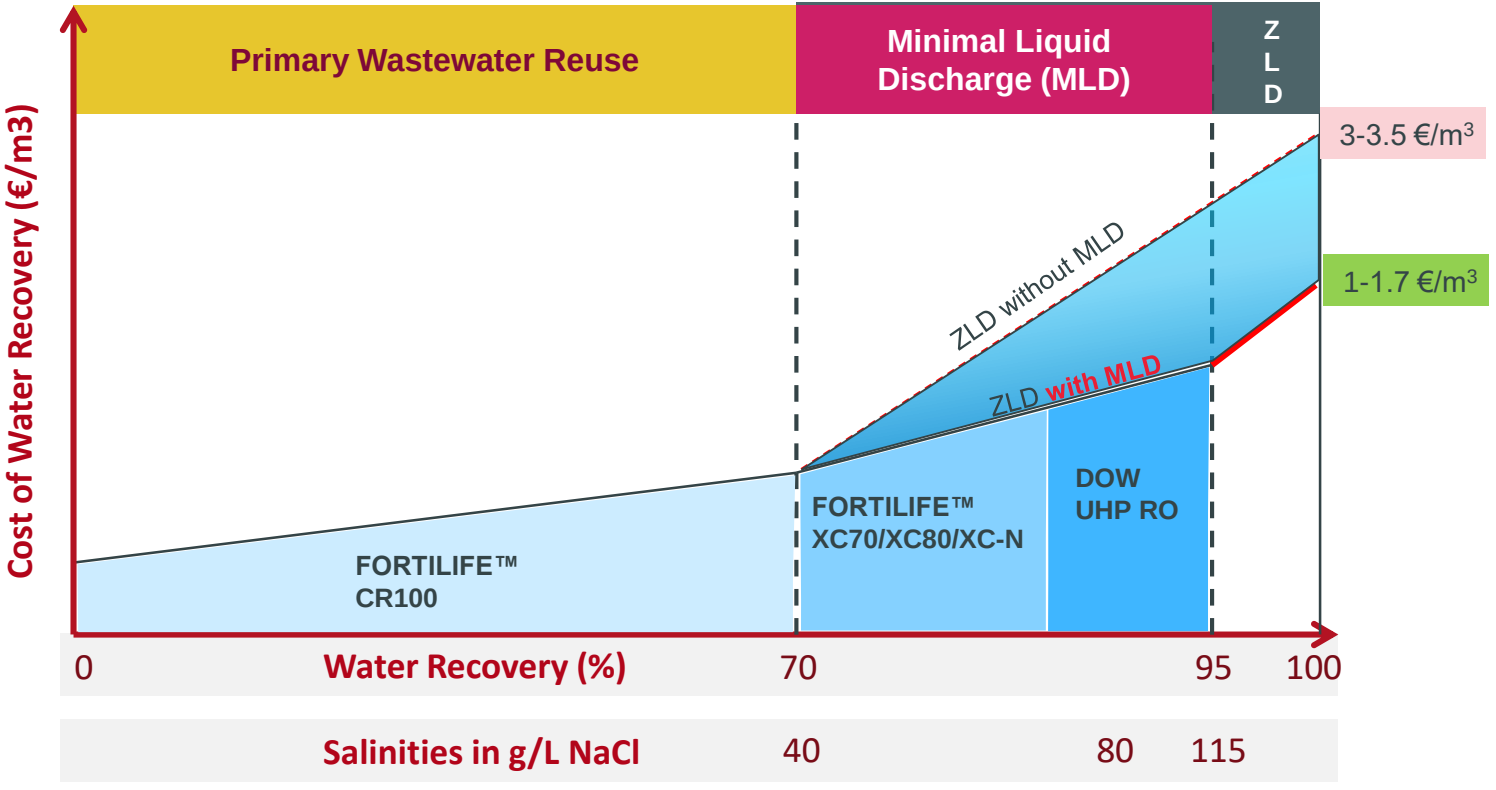
Water Supply
(Potable/Utility Water)

Minimal Liquid Discharge (MLD)

Primary Water Reuse

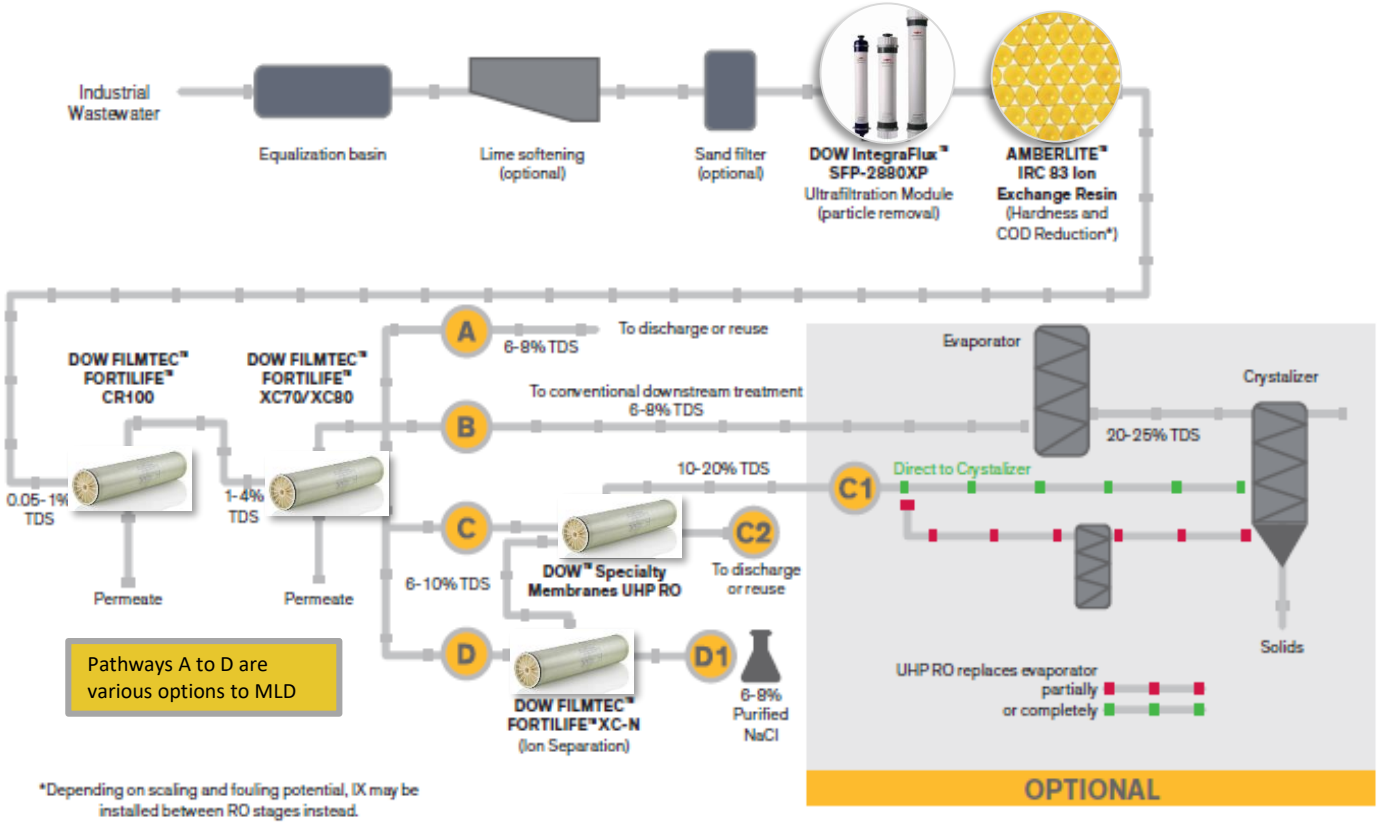
MLD reduces the cost of recovering the last 30% of Water by 60%

Dow Water & Process Solutions



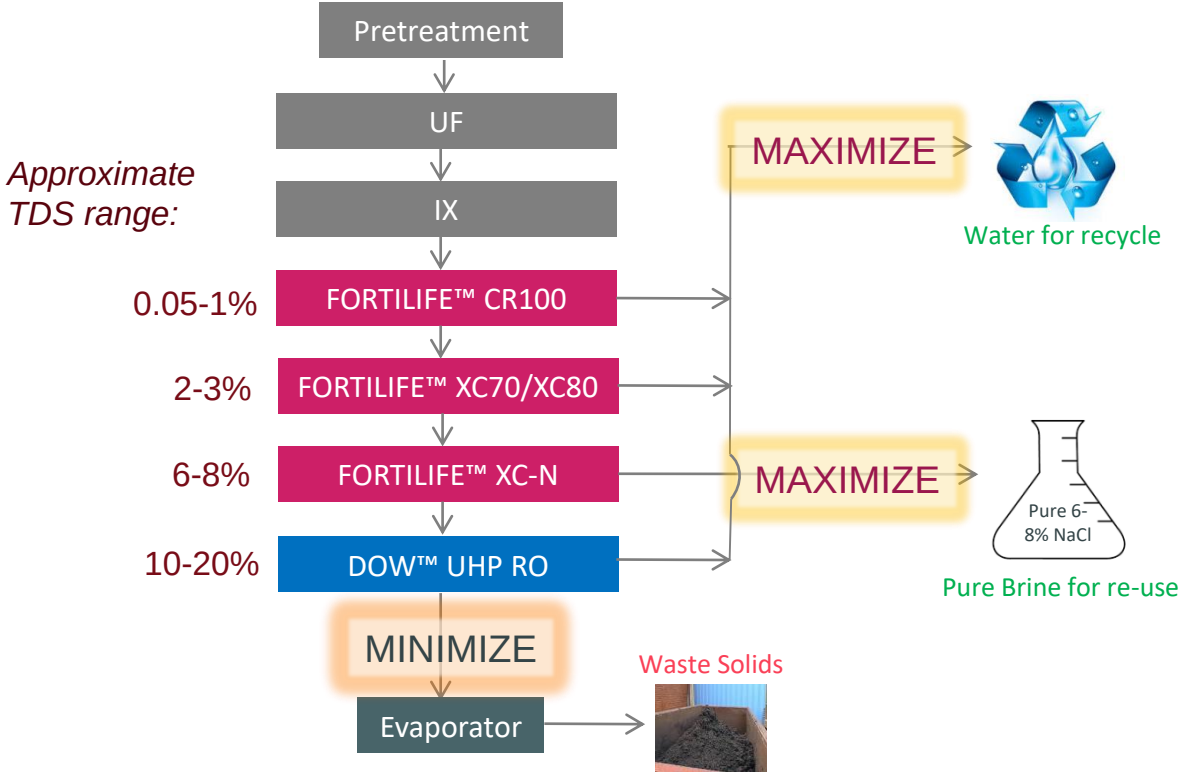
Bond, R.G. and Veerapaneni, S. Journal AWWA, 2008, 100 (9), 76-89.

Dow Solutions for Industrial Water Reuse – Minimal Liquid Discharge



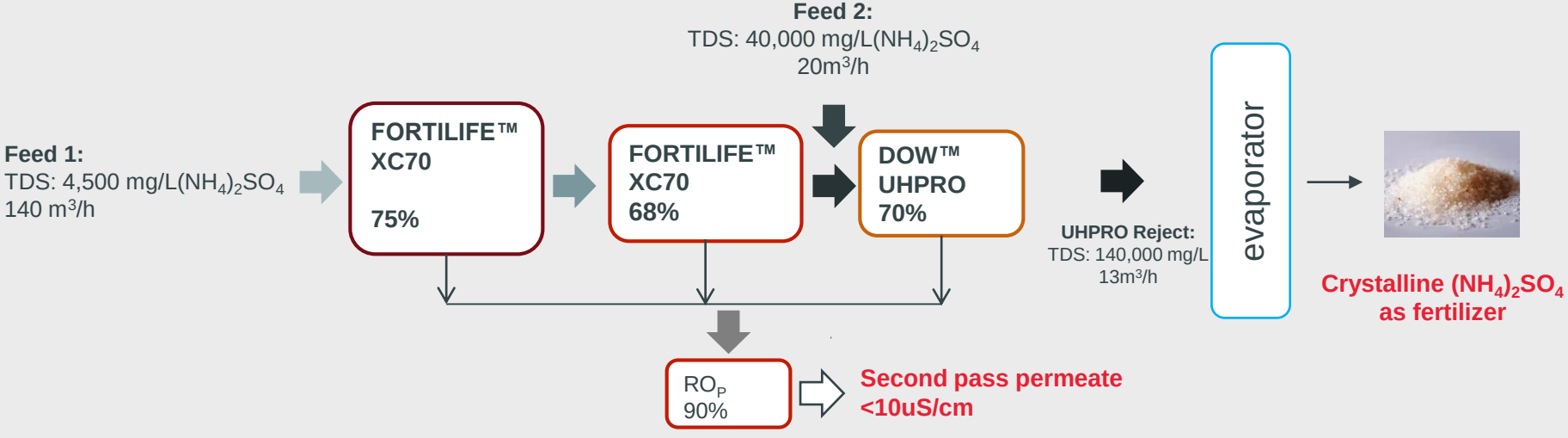
Maximize water for recycle and enable the recovery of by products

Challenging water recovery: general schematic



FORTILIFE™ and DOW™ UHPRO enable circular water management

$(NH_4)_2SO_4$ Recovery from Industrial WW



DW&PS Global Water Technology Center, Tarragona

Availability of real water sources to generate real solutions

3

Real Water Sources

4

Technologies

To support

10

Applications

Ebro River Pre-treated Surface Water

Mediterranean Sea

Waste Water Camp Tarragona WWTP

TEQUATIC ™ PLUS filter

DOW Ultrafiltration modules

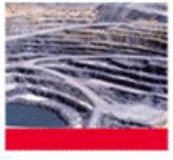
DOW FILMTEC™ elements

DOW Ion Exchange resin

CHEMICAL PETROCHEMICAL

FOOD & BEVERAGE

POWER GENERATION



MINING & HYDROMETALLURGY

OIL FIELD WATER

INDUSTRIAL WATER

HEALTHCARE

MUNICIPAL & DESALINATION

RESIDENTIAL & COMMERCIAL

WASTE WATER & REUSE

Best in Class Installations

40 test units / 150 separation component test positions / 10,000 m^3/d – 2.6 MM

Oil Field & Desalination Platform (UF + RO)

Industrial Water Platform (UF + RO + IER)

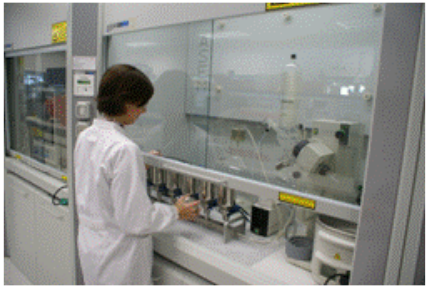
Water Reuse Platform
(UF +RO)

Oil Field containerized unit
(UF + NF)

Seawater containerized unit
(UF + RO)

Analytical Center

50 different techniques for water, membrane, fibers and solid deposits

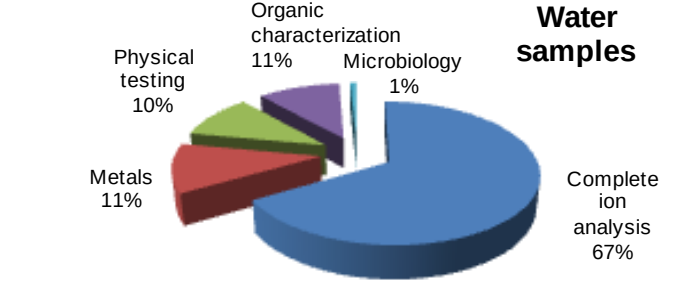


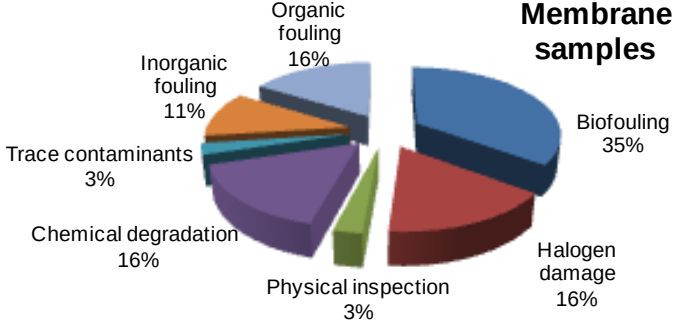
Water analysis

- Inorganic: Ion chromatography, Induced coupled plasma optical emission spectrometry, titration, electroanalytical techniques
- Organic and Microbial: Gas chromatography – mass spectrometry (GC-MS), Total organic carbon (TOC), Chemical Oxygen demand, Biological oxygen demand, Spectrophotometry, Luminometer for ATP and Bactiquant
- Physical: Total dissolved and suspended solids, turbidity

Membrane and deposit analysis

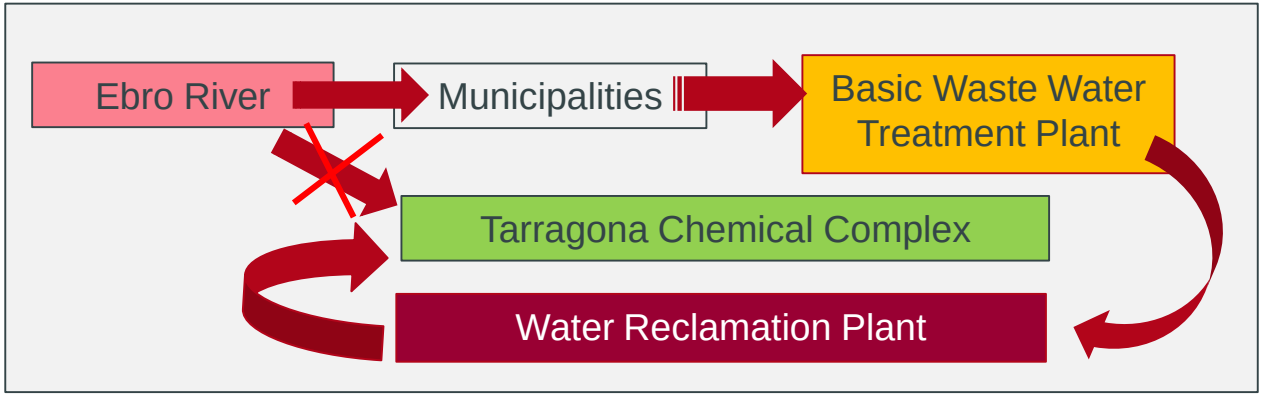
- Inorganic: X-ray fluorescence (XRF)
- Organic: Fourier transform infrared (FTIR), TOC, Polysaccharides, Proteins, Gas chromatography-mass spectrometry
- Microbial: Luminometer for ATP, microscope evaluation
- Halogen detection



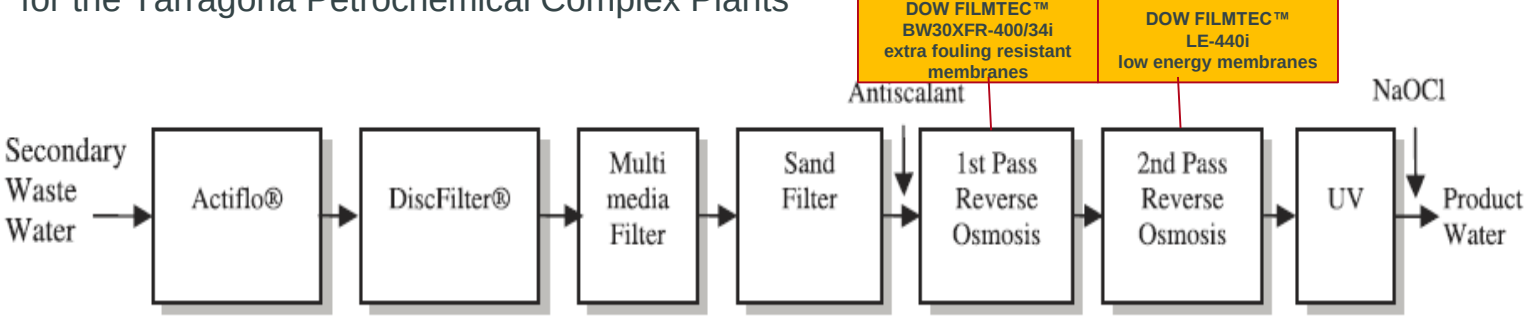


Reduced ~25 % fresh water intake; reduced ~50% water discharge

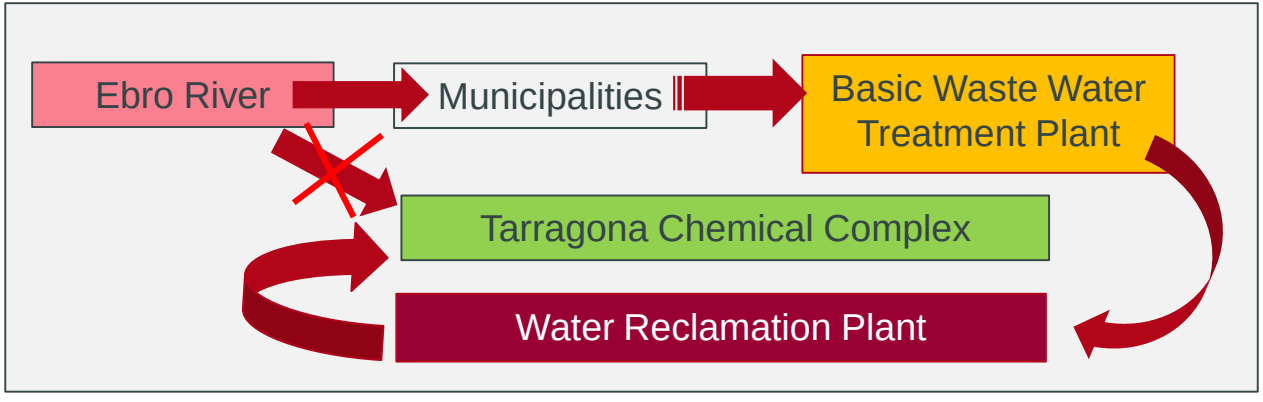
Dow in Tarragona, Spain



- Reclamation Plant designed for 19,000 m^3/d of permeate water from Tarragona and Vila-seca Wastewater Treatment Plant. (Phase 1)
- Owned by ACA (Water Catalan Agency) and operated by Veolia and AITASA
- Reused water is blended with Ebro River water in order to provide make-up cooling water for the Tarragona Petrochemical Complex Plants



Creating Value, Tarragona & Chemical Complex



1983 — Ebro River National Park

1989 — Transfer System from Ebro River to Tarragona

1993 — Wastewater Treat. Plant (1)

1995 — Wastewater Treat. Plant (2)

2012 — El Camp de Tarragona Water Reclamation plant

2013 — Ebro Delta – UNESCO biosphere reserve

DOW Tarragona starts consuming recycled Water

2016 — 40% of DOW's water consumption is recycled water

Reduced ~25 % fresh water intake; reduced ~50% water discharge

Dow in Tarragona, Spain

Circular Economy Solutions for a Scarce fresh water region

Save 1.5 Mm^3/yr of fresh water
Reduce discharge by 49%
Chemicals needed: 23% less

Breakthrough Consortium to tackle the problem

- Objective: reclaimed water for Cooling towers make-up; proof feasibility, long-term sustainability

- Dow Ibérica
- Dow Water & Process Solutions
- Aitasa and Veolia as reclamation plant operators
- Nalco, supplier of the chemical envelope for CT

Awards

environmental LEADER
Environmental & Energy Management News

Global AWARDS 2016 Finalist
IChemE

IDA

50 TECHNOLOGY CENTERS
A Tradition of Excellence • 1965-2015
Dow

EMEAI #Dow2025 Award

Innovation ***DEMO***nstration for a Competitive and Innovative European ***WA***ter ***RE***use Sector FP7-ENV-2013-WATER-INNO-DEMO Call with the Grant Agreement no 619040 · Coordinator: CTM

Reduced fresh water intake. Wastewater reuse
Dow in Tarragona, Spain

What? Decrease the environmental impact of the petrochemical industry

How? Implementation of an on-site innovative wastewater recycling scheme to increase water efficiency in a petrochemical industry

Where? Petrochemical complex of DCI in Tarragona

Who? Fundació CTM Centre Tecnològic, DOW Chemical Ibérica, Veolia Water Technologies, KWR Water, and Water Supply and Sanitation Technology Platform WssTP

When? September 2016 – December 2019

Why? Decrease freshwater consumption by the petrochemical/industrial sector

Aerial view of the North petrochemical complex in Tarragona

*Demonstration of an innovative and versatile **RE**cycling scheme for increasing the **WAT**er efficiency in the petro**CH**emical industry*
LIFE15-ENV_ES_000480 · Coordinator: CTM

Reduced fresh water intake. Wastewater reuse

Dow in Tarragona, Spain

Water influents

Steam production (11%)

Cooling tower make-up (89%)

Petrochemical industry DOW North complex

Wastewater effluents

Process water (11%)

(water involved within the process and in contact with the different chemicals)

Oily water (18%)

(water collected in the trench system)

Intermediate Water (71%)

(cooling tower blowdown and instruments and pumps cooling)

Annual water in**: 5.3 hm³/year**

Annual wastewater out: **1.9 hm³/year**

*Demonstration of an innovative and versatile **RE**cycling scheme for increasing the **WAT**er efficiency in the petro**CH**emical industry*

LIFE15-ENV_ES_000480 · Coordinator: CTM

REWATCH

Reduced fresh water intake. Wastewater reuse

Dow in Tarragona, Spain

Stream wastewater quality			Feed water quality specifications	
Parameter	**Mixture**		**Boiler**	**Cooling tower makeup**
TOC (mg/L)	350		<0.2	<15
COD (mg/L)	250			<20
BOD_5 (mg/L)	60			
Turbidity (NTU)	9			
TSS (mg/L)	11	**Wastewater treatment train**		<5
TDS (mg/L)	2700			
Phosphate (mg/L)	1.5			
Conductivity (µS/cm)	3500	**Validate the technical, environmental and economic feasibility**	4-6	<2000
Silica (mg/l)	7		<0.005	
Iron (mg/l)	0.5		<0.005	
Copper (mg/l)	n.a.		<0.001	
Calcium (mg/l)	350			<350
Sulphates (mg/l)	1200			<300
Recalcitrant and/or toxic compounds (BTEX, phenols, cresols, glycols, PAH, sulfides, etc.)	-			

LIFE15-ENV_ES_000480 · Coordinator: CTM

*Demonstration of an innovative and versatile **RE**cycling scheme for increasing the **WAT**er efficiency in the petro**CH**emical industry*

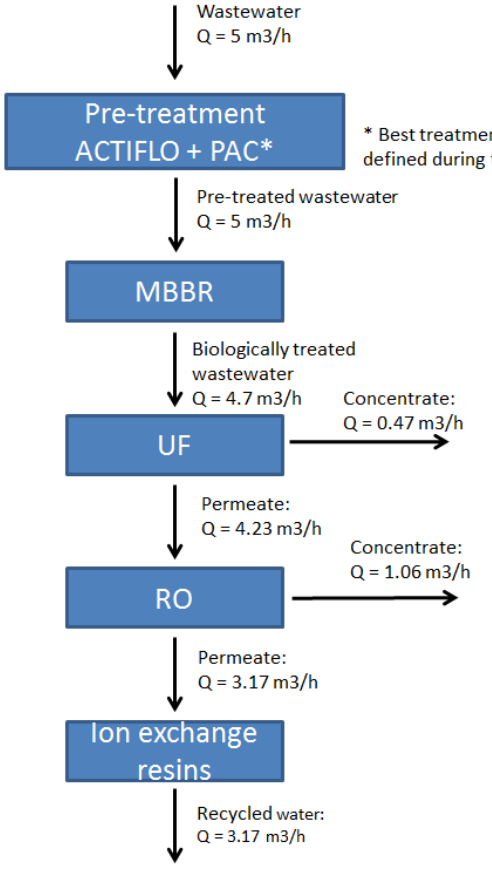
LIFE15-ENV_ES_000480 · Coordinator: CTM

DOW

REWATCH

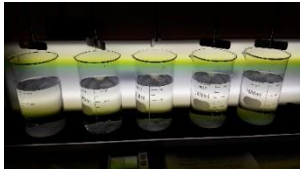
Reduced fresh water intake. Wastewater reuse

Dow in Tarragona, Spain



* Best treatment step to use PAC will be defined during the project execution

Pre-treatment ACTIFLO®



Moving bed biofilm reactor (AnoxKaldnes® MBBR)

Ultrafiltration

Reverse Osmosis

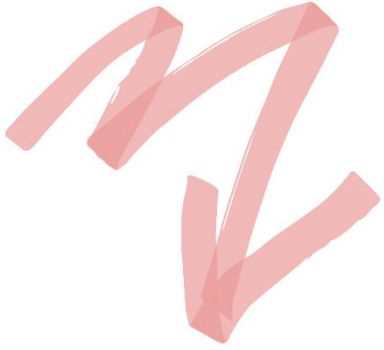
Ion Exchange Resins

DOW

Water

Drives

Economies



Water

Means

Business

Thank You.
Let's *discuss*.