SUEZ
STRATEGIC PARTNER
FOR MEMBRANE PLANTS

ready for the resource revolution

1 | **General presentation** (*Fernando Salvador Marques*)

2 | **Membrane systems** (*João Farinha*)

3 | **Ultrafiltration WTP & WWTP** (*Luis Urrutia*)

4 | **Membrane Biological Reactor** (*Luis Urrutia*)

5 | **Electrodialysis reversal** (*Luis Urrutia*)

6 | **Reverse osmosis** (*João Farinha*)

1. GENERAL PRESENTATION

ready for the resource revolution

SUEZ at a glance

WATER TREATMENT

92 million
people supplied

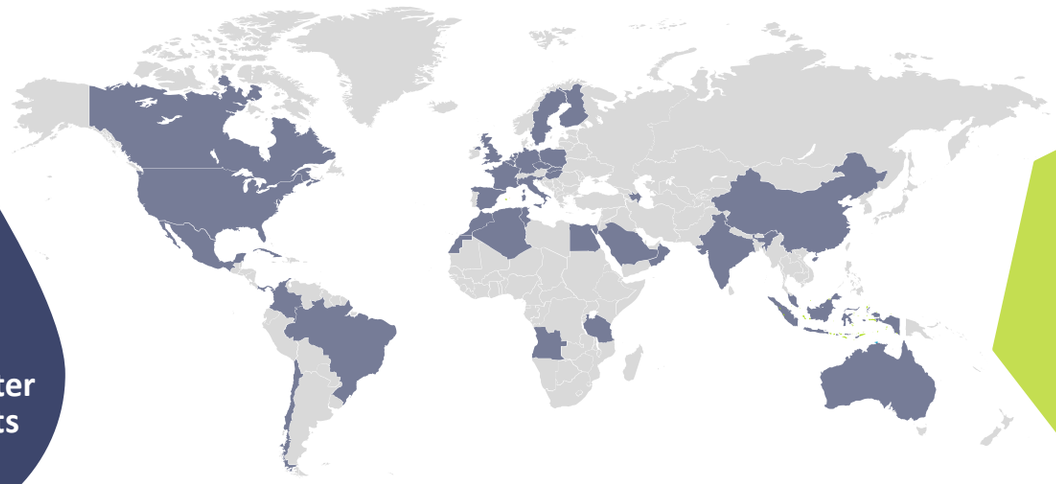
1,200 drinking water facilities

65 million
People served

2,300 wastewater treatment plants

10 million
people receiving desalinated water

>250 desalination plants



RECYCLING & RECOVERY

40 million
tons
of treated waste

57 million
people benefiting from waste collection

47
Incinerators
worldwide

5,138 GWh
produced annually from waste

14 million
tons
of valorized waste

Present in **70** countries
over **82,000** employees
€**15.1** billion turnover in 2015
€74 million invested in R&D
323,000 industrial and business customers

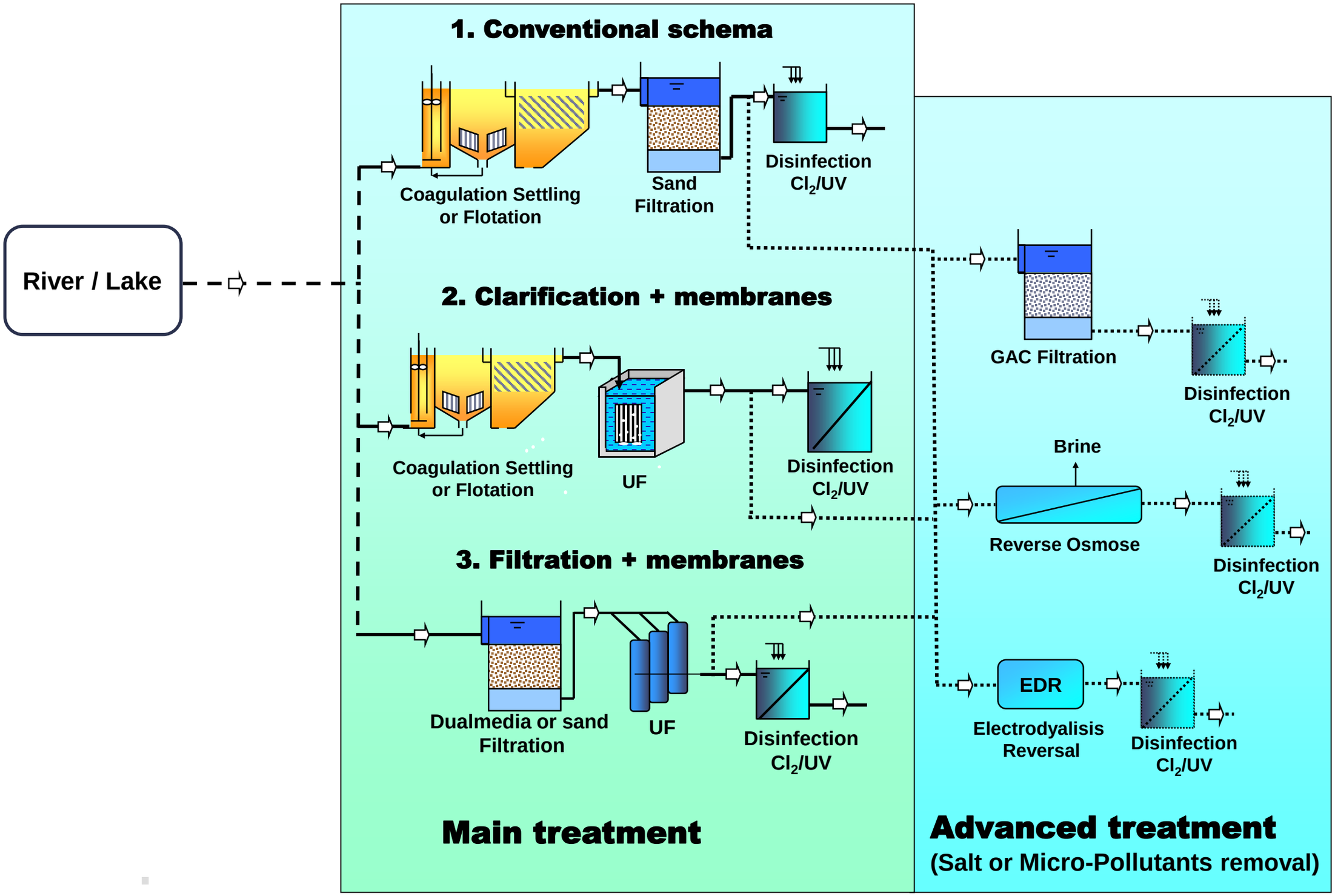
ready for the resource revolution

- SUEZ's membrane offer consists on 4 complementary areas of activity :
  - Customised design & build.
  - Operation and services solutions.
  - "Packaged" equipment and technologies.
  - Financing throught BOT contracts (from the design phase up to the Plant transfer)

- SUEZ has consolidated its world-leading position in the field, in particular thanks to:
  - Expertise as builder and operator, offering local authorities and industry competitive solutions adapted to their particular requirements
  - Mastery of pre-treatment, membrane treatment, membrane bioreactors and remineralization processes.
  - Comprehensive range of modular & standardized products to optimize design, delivery & commissioning times
  - Operating support tools to safeguard freshwater or reuse-wastewater production and continuously optimize operating costs
  - Introduction of effective energy recovery systems to reduce energy consumption
  - Solutions to preserve the Earth's flora and fauna in general, water sources and marine life (water intake and dispersion of brines).

2. MEMBRANE SYSTEMS

MEMBRANE DRINKING WATER SYSTEMS



MEMBRANE WASTEWATER REUSE SYSTEMS

Agricultural uses

Indirect drinking water uses

2.1 Conventional schema

Coagulation Settling or Flotation

Sand Filtration

Disinfection Cl_2/UV

2.2 Submerged membranes

Disinfection Cl_2/UV

2.3 Mixed schema

Sand Filtration

UF

Disinfection Cl_2/UV

Activated sludge C,N-DN

Clarification

Disinfection Cl_2/UV

1. Secondary treatment

Pre-treatment

Ultrafor® C, N-DN

2.4 Membrane Biological Reactor

2. Tertiary treatment

GAC Filtration

Disinfection Cl_2/UV

Brine

Reverse Osmose

Disinfection Cl_2/UV

EDR

Electrodyalisis Reversal

Disinfection Cl_2/UV

3. Quaternary treatment
(Salt or Micro-Pollutants removal)

Non-potable water uses

3. ULTRAFILTRATION (WTP & WWTP)

UF- Protecting Public Health with ZeeWeed Membranes

Limited and deteriorating supplies require the use of alternative water sources

Increasing regulatory standards especially regarding disinfectant by-products and waterborne pathogens

Technological innovation leading to development of low cost, high quality water treatment solutions

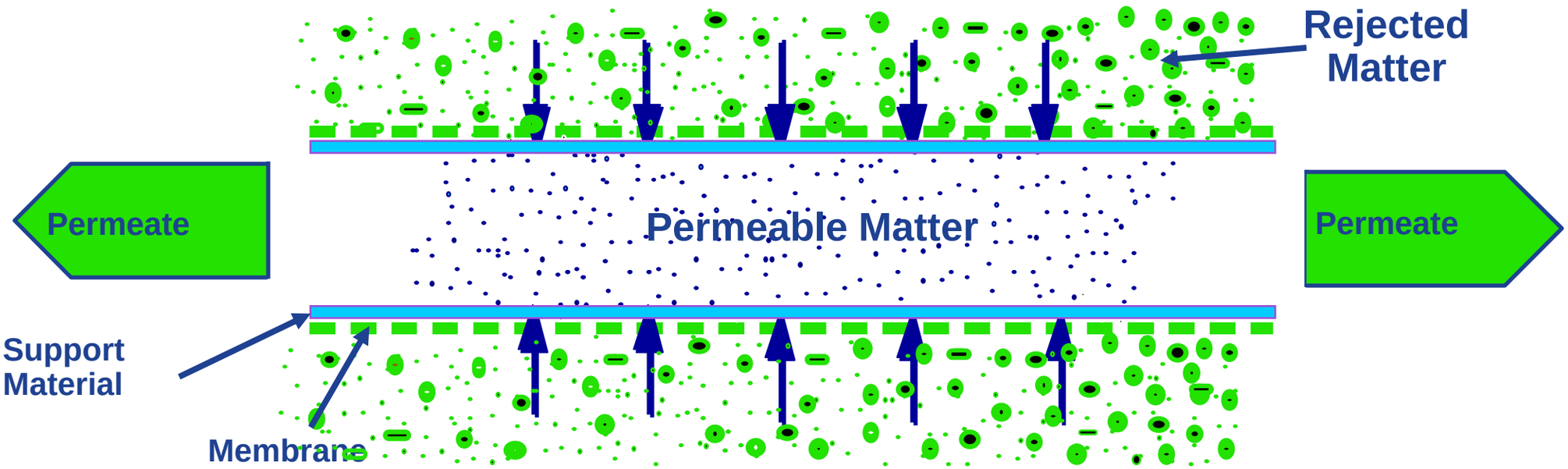
ZeeWeed Membranes offer cost effective solutions

Retrofit of old technology to protect the public from aging or underperforming systems

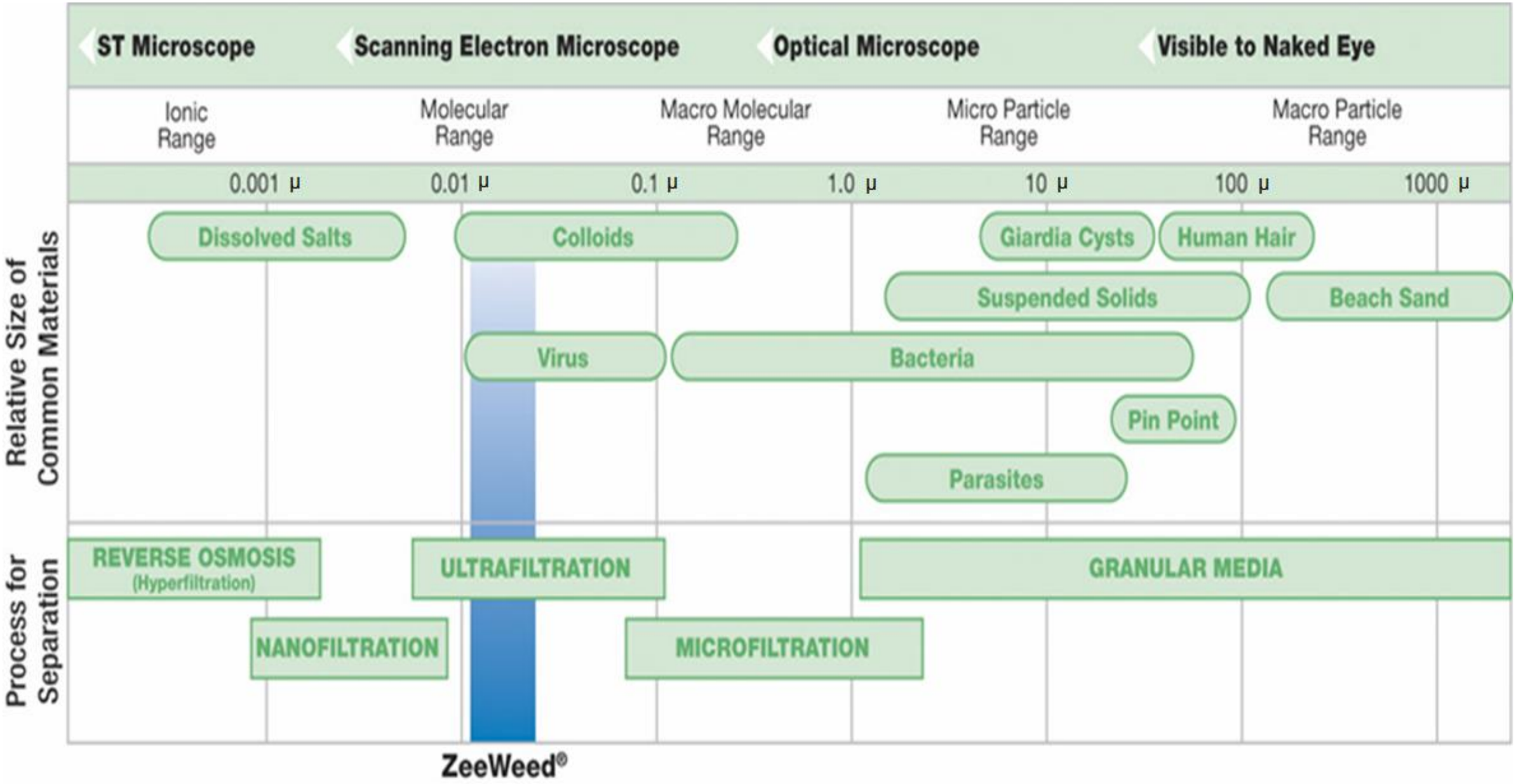
Growing demand due to population growth

What is a membrane?

Membranes are engineered thin barriers or films of material that allow certain substances to pass by a size exclusion mechanism related to the size of the pores on the membrane surface



What is a membrane?



Membrane Technology Provides the Ultimate Level of Security

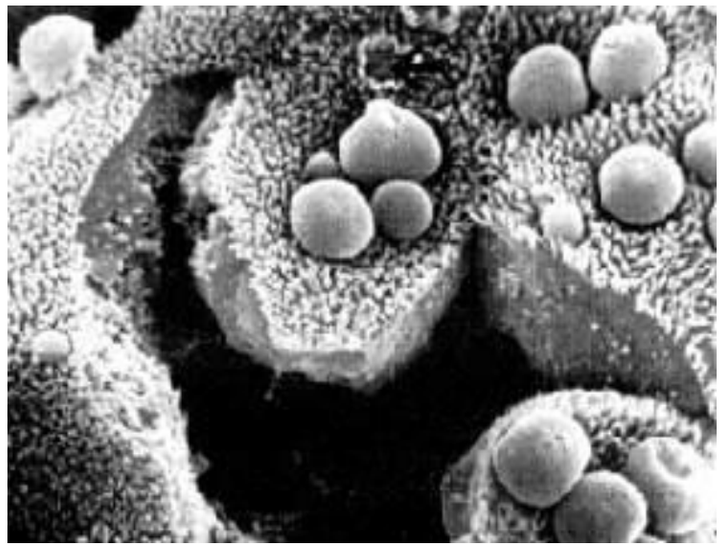
Positive barrier - Parasites are *removed* by size exclusion (>0.1 µm), not inactivation

Superior treated water quality
California Department of Health Services Testing

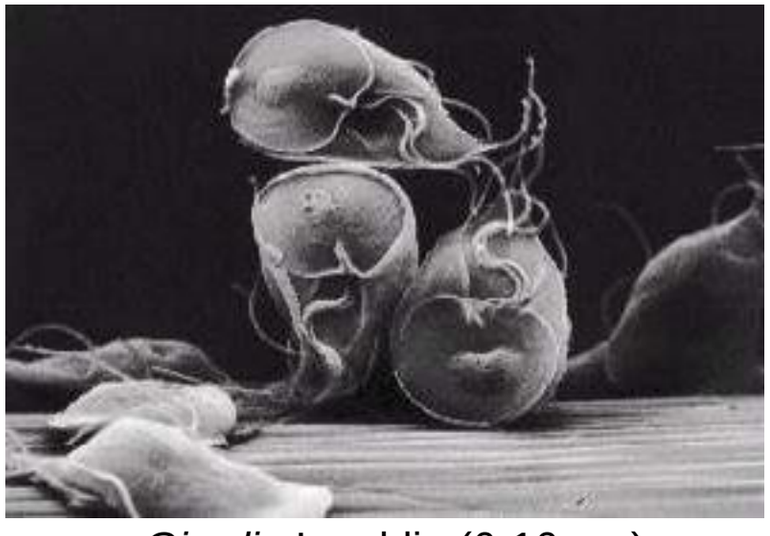
- > 9 log removal of *Giardia*
- > 9 log removal of *Cryptosporidium*
- > 2 / 3.5 log removal of *MS2* virus

Reliable, non-chemical treatment

Cost effective for small, medium and large communities



Cryptosporidium Parvum (4-7 µm)



Giardia Lamblia (6-16 µm)

ZeeWeed is the Trusted Membrane Platform

Introduced in 1993

Immersed hollow fiber membrane configuration

Outside-in mode of operation

PVDF chemistry that is resistant to chlorine, oxidants and wide pH range

Compatible with coagulants/PAC

NSF 61 Certified ultrafilter

Over 1.8 BGD* of treatment capacity makes ZeeWeed the world's most trusted and experienced immersed membrane platform!

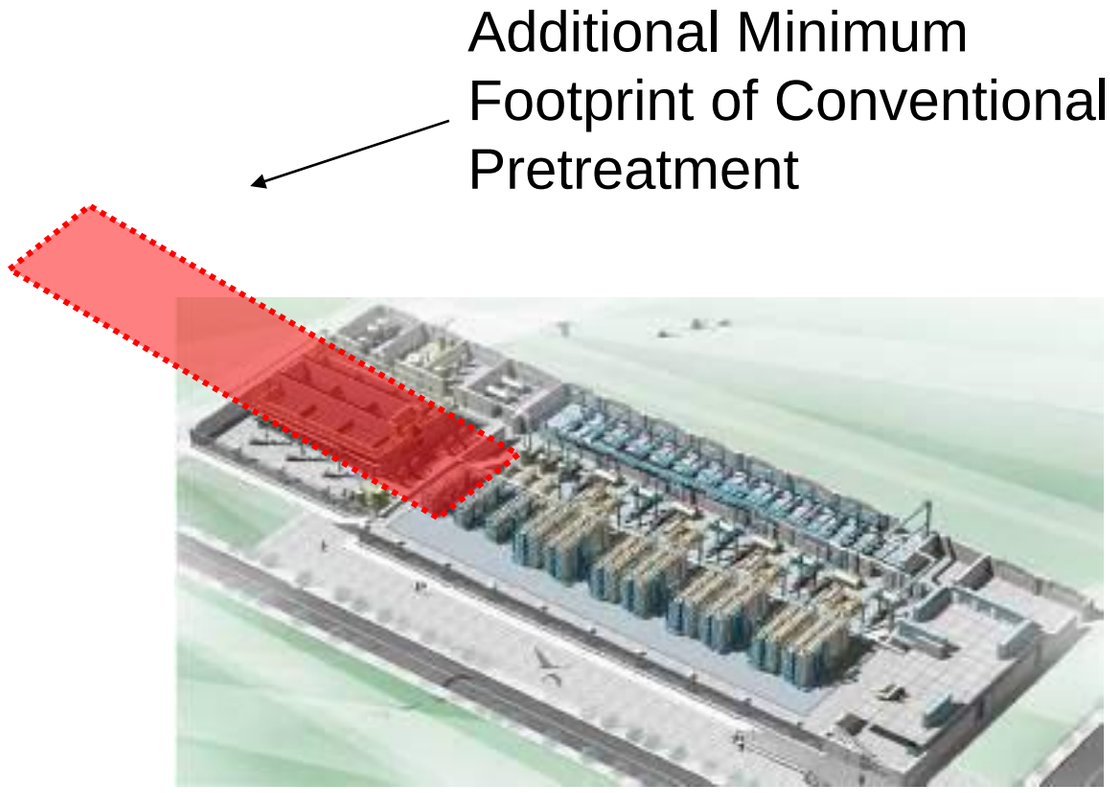
* Installed or under design as of December, 2006

Smaller Footprint

UF is uniquely suited for spatially constrained facility sites

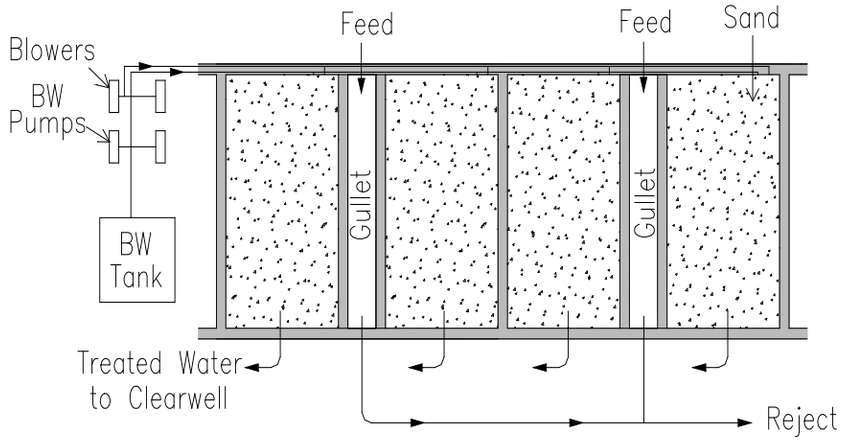
High tank intensity
Smaller flocculation zones
Elimination of clarification
Minimization of treatment chemicals

Minimization or elimination of treatment processes reduces cost



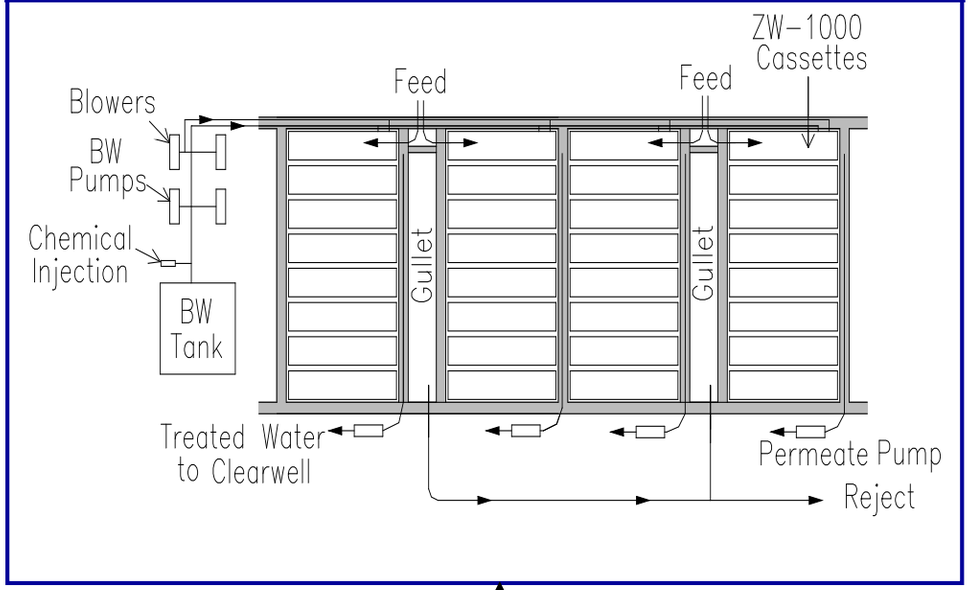
Simple, Cost Effective Media Filter Retrofits

Existing rapid sand filter



4.75 MGD (18,000 m³/d) existing plant

ZeeWeed 1000 Retrofit



17.2 MGD (65,000 m³/d) retrofit

~ 2-3x Capacity Increase in the Existing Footprint !!

Simple, Cost Effective Media Filter Retrofits

Columbine WTP, Denver, CO

28 MGD (106 MLD) Before

50 MGD (189 MLD) After

ULTRAFILTRATION TECHNOLOGY HELPS SUPPLY CLEAN DRINKING WATER IN NORTHERN PORTUGAL

The facility, based north of the city of Oporto, has a new capacity of 24 million liters per day as a result of the upgrade, providing clean drinking water to roughly 80,000 people in the Guimarães and Vizela regions.

The Santa Eufemia plant treats water from the nearby Ave River and is operated by Vimágua, the municipal authority for water management in the region. Plant upgrade work was required as a result of deteriorating water quality from the river. The plant is now one of the largest installations of SUEZ ZeeWeed 1500 modules in Europe and the Middle East.

suez

Water Technologies & Solutions
fact sheet

ZeeWeed* pressurized ultrafiltration

model ZW1500

description and use

As a pioneer of membrane technology, SUEZ leverages decades of research, development, and operational experience in developing the most advanced pressurized ultrafiltration technology in the market, ZeeWeed 1500. ZeeWeed systems are proven to consistently outperform conventional filtration technology while meeting or exceeding regulatory requirements, regardless of source water quality.

typical applications

Versatile and reliable, the pressurized ZeeWeed 1500 is ideally suited for use in numerous applications including drinking water treatment, tertiary filtration and RO pre-treatment for brackish water and seawater. Compared to granular filter media, ZeeWeed membranes produce superior water quality and are virtually unaffected by variable raw water quality - all at a cost comparable to conventional filtration technology.

General Properties

- 0.02 µm nominal pore diameter - for optimal removal of particulates, bacteria and viruses
- PVDF hollow fiber membrane - provides high mechanical strength and chemical resistance
- Outside-in filtration - provides uniform flow distribution and high solids tolerance

Storage and Handling

Modules may be stored in the original factory packaging for up to 1 year prior to installation. Modules must be stored between 5°C and 35°C (41°F to 95°F). Do not expose the membrane module to direct sunlight (UV light).

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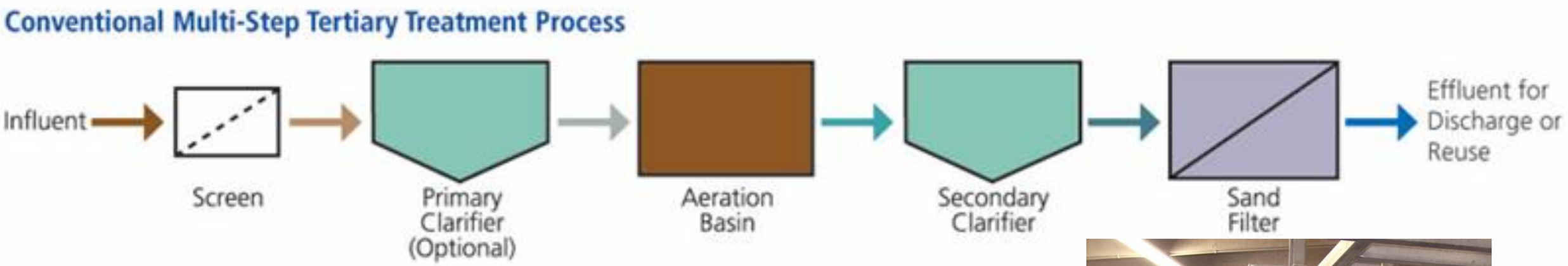
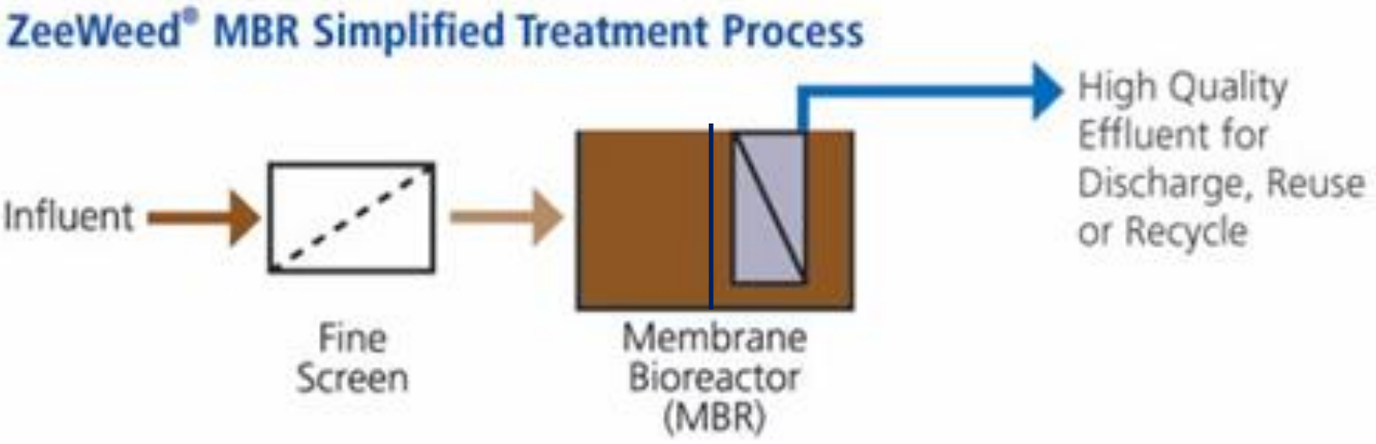
Largest DW Installations use ZeeWeed

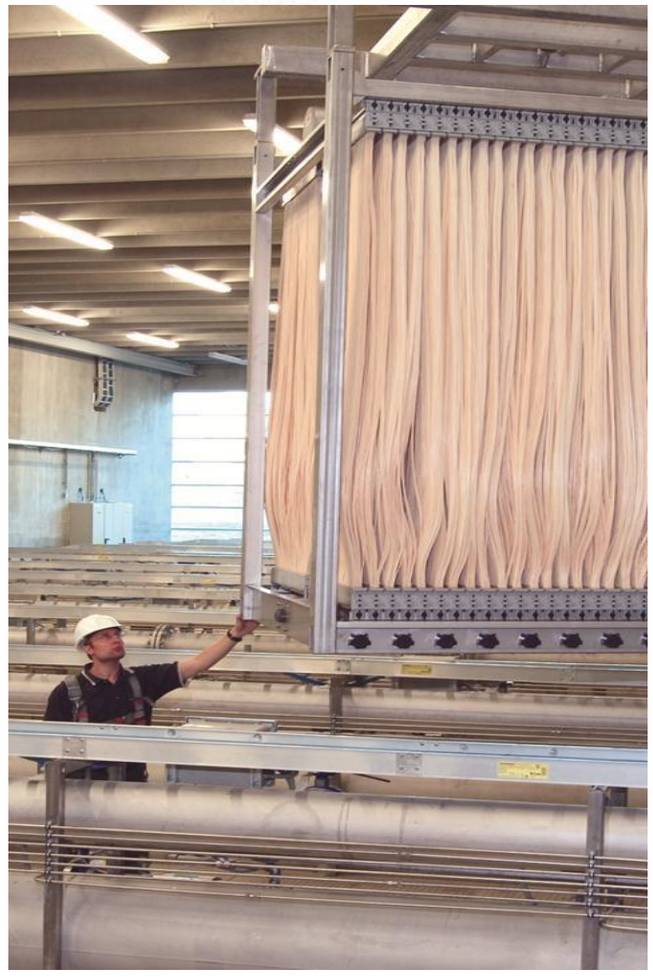
Twin Oaks, CA, USA		100 mgd
Lakeview, ON, Canada	95 mgd	
Fridley, MN, USA – P		90 mgd
Moscow, Russia - A		73 mgd
Chestnut Avenue, Singapore		72 mgd
Columbia Hts, MN, USA - N		70 mgd
Racine, WI, USA		50 mgd
Thornton, CO, USA		50 mgd
CCK, Singapore		48 mgd
Clay Lane, UK - N		42.8 mgd
Kamloops, BC, Canada	42.3 mgd	
Forest Park, PA, USA – USF		40 mgd
Roetgen, Germany - N	38 mgd	
Escombreras, Spain		37 mgd
San Joaquin, CA, USA	36 mgd	
Modesto, CA – USF		36 mgd
Olivenhain, CA, USA		34 mgd
Coliban, Bendigo, AU – USF		33 mgd
Sweetwater, CA		30 mgd
Scottsdale, AZ		30 mgd
Thunder Bay Bare Point	30 mgd	

4. MBR (WWTP)

MBR. Membrane Biological Reactor

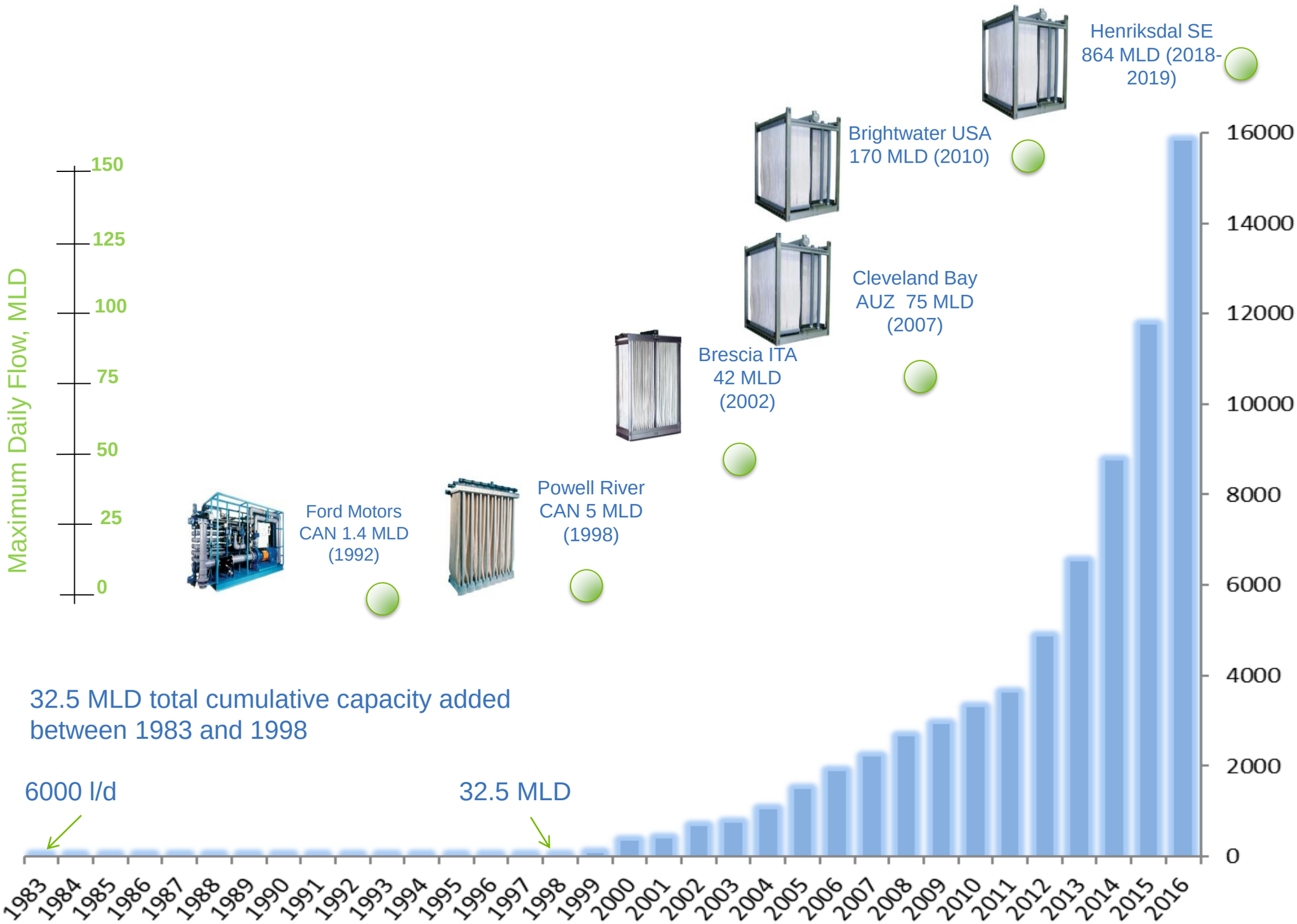






* **UF barrirer instead settling process, this guarantee output quality water.**

MBR Installations

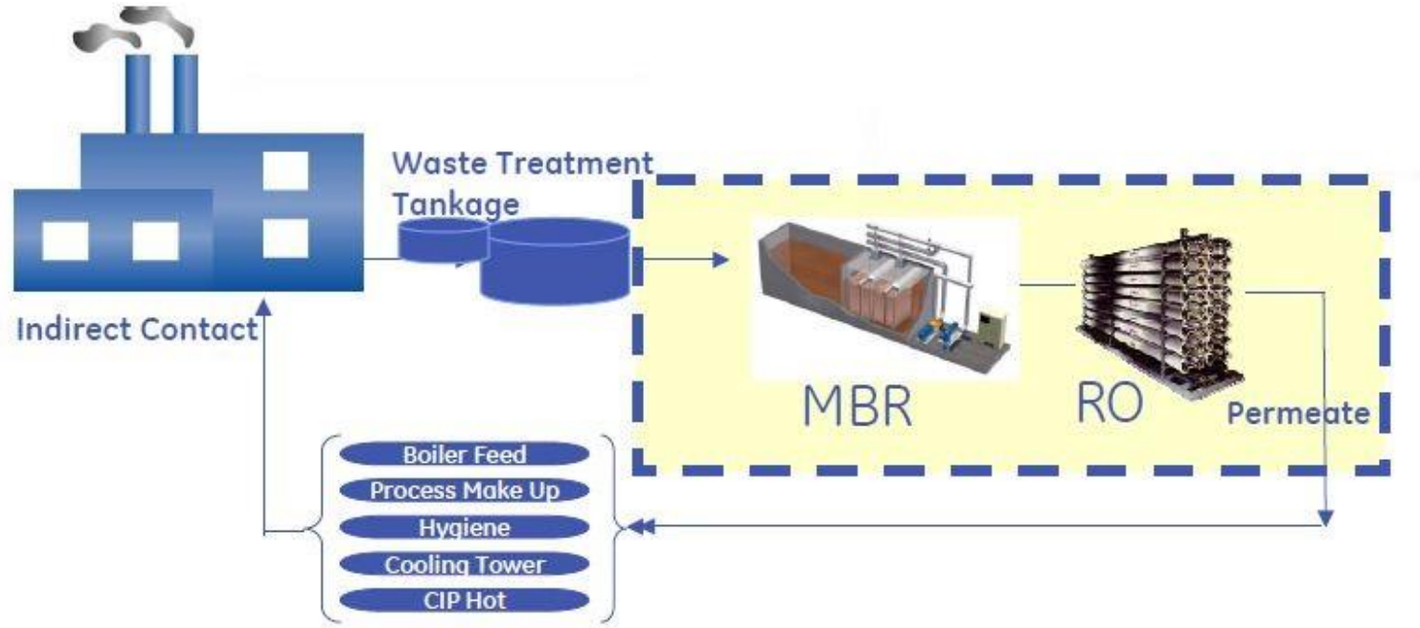


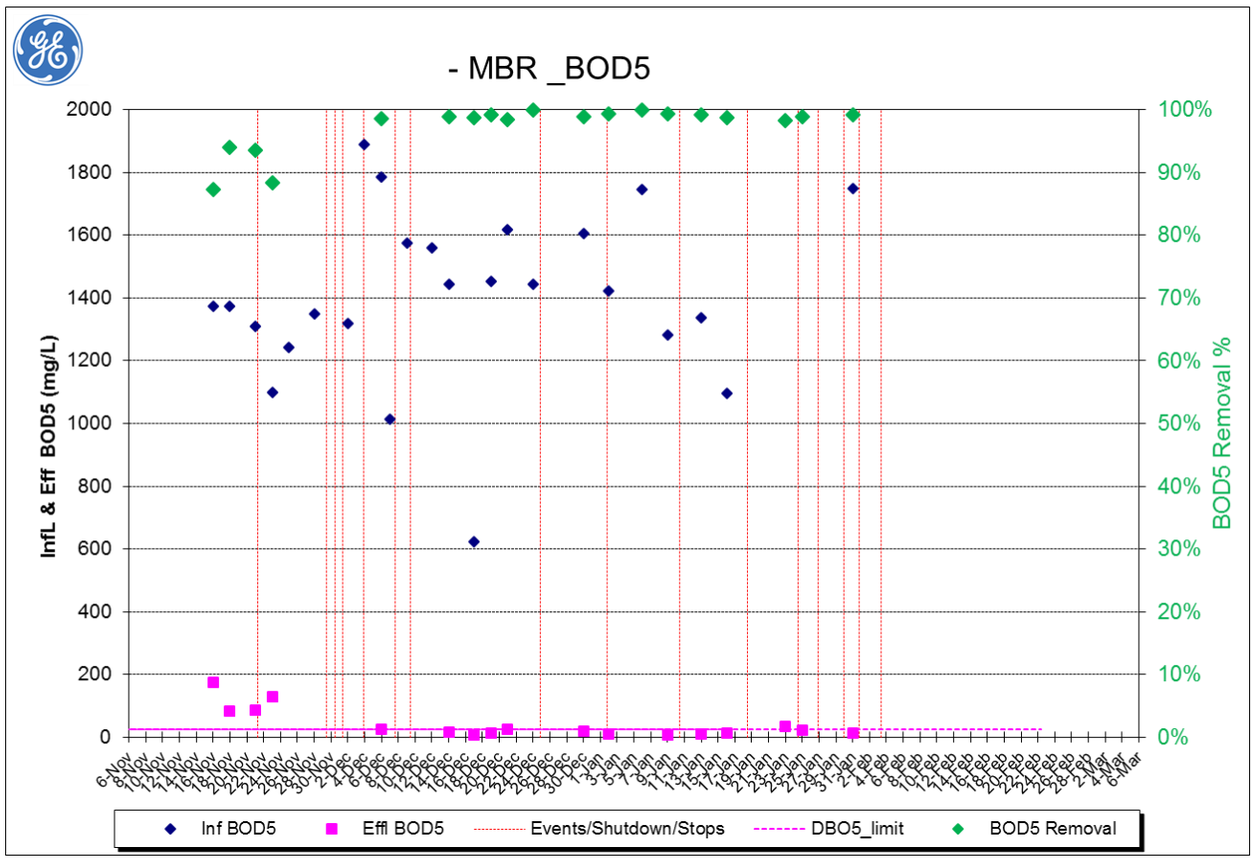
Benefetis

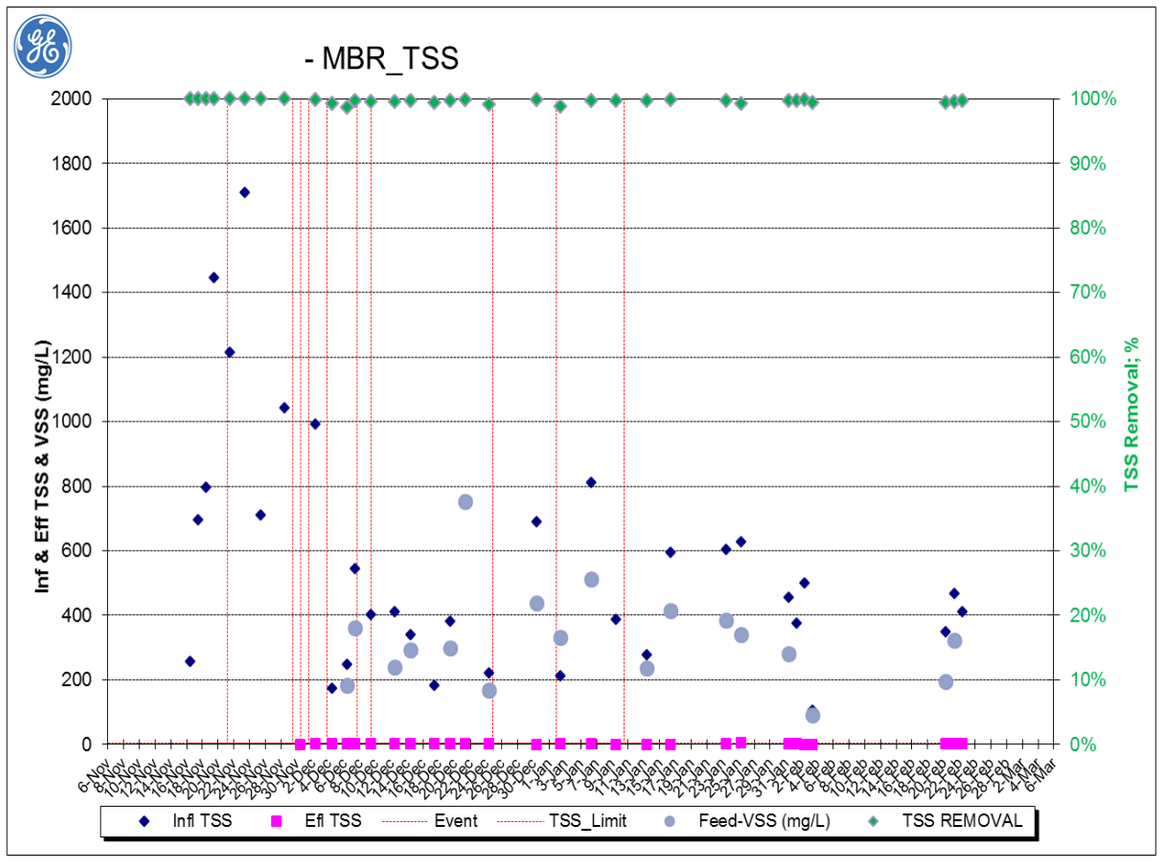
- Allways 100% quality. Physical barrier. BAT/MTD in current BREF
- It does not affect by "bulking" phenomena, filamentous, etc..
- Increase WWTP capacity in small area
- Remove settler that can be used for other process
- **Perfect biological process control**, solids can not go out.
- Modulas and flexible design. Revamping projects.

Reuse

- Cooling towers
- Process
- Boilers feed
- Feed a RO,EDR, IX…







press release

Moscow, January 24, 2018

Bashneft and SUEZ Put into Operation a Complex of Biological Treatment Facilities with the World's Largest Industrial Membrane Bioreactor and Electrodialysis Reversal Units

- ***Bashneft-Ufaneftekhim Biological Treatment Plant Will Treat up to 84 Million Liters of Wastewater per Day Using SUEZ Industrial Wastewater Treatment Technology***
- ***Equipment Being Serviced and Maintained by SUEZ as Part of a 15-Year Agreement***
- ***SUEZ Remote Monitoring and Diagnostic Solutions Will Help Maximize Performance and Lower Operating Costs***

Today, Bashneft-Ufaneftekhim refinery, a Rosneft-affiliated company, inaugurated its biological treatment plant, Bashneft key nature protection facility, which secured its spot as the world's largest industrial facility using membrane bioreactor (MBR) and electrodialysis reversal (EDR) technologies. The facilities, located in the Russian city of Ufa, will treat up to 84 million liters of wastewater per day, which makes them unprecedented for industrial wastewater treatment, employing the most advanced technologies and enabling water reuse.

SUEZ supplied its ZeeWeed* MBR membranes, EDR and reverse osmosis (RO) equipment to the Bashneft-Ufaneftekhim biological treatment plant and will provide services as part of a 15-year long-term service contract to ensure reliable operation of equipment and an uninterrupted guaranteed replacement of membranes.

LARGEST MBR Europe

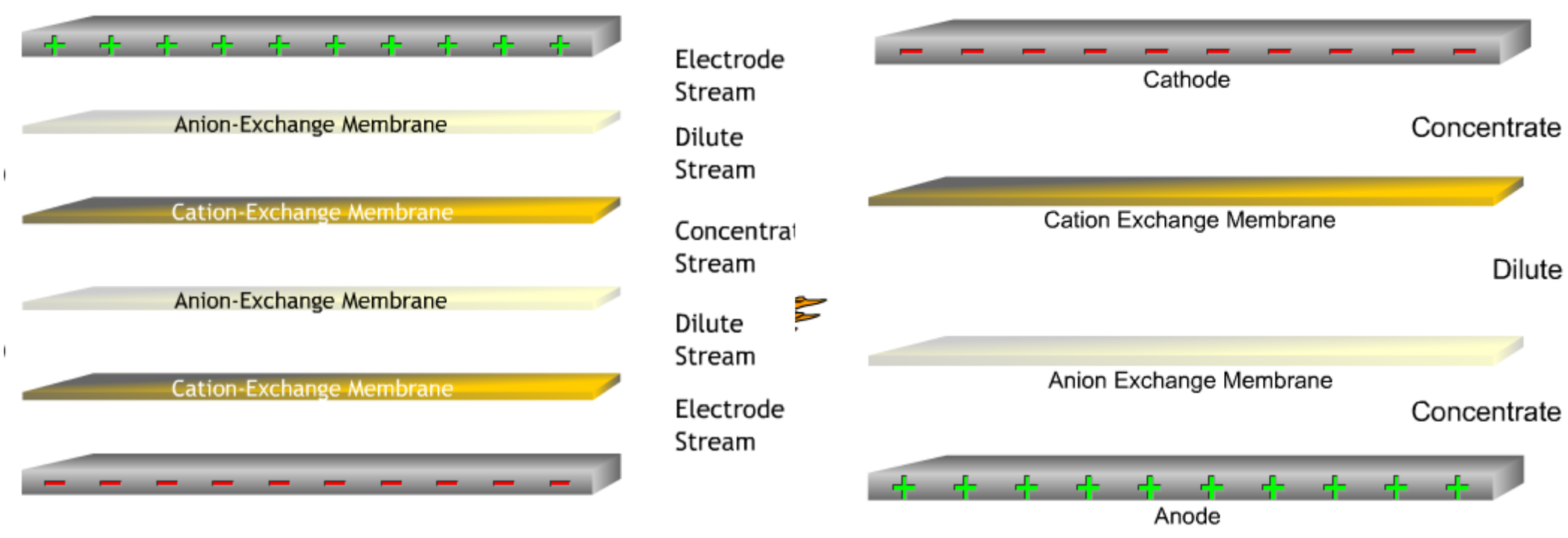
Installations	Location	Technology Provider	(Expected) date of commissioning	PDF (MLD)	ADF (MLD)
Henriksdal, Sweden	nr Stockholm, Sweden	SUEZ	Stage 1: mid 2019 Stage 2: 2021 Stage 3: 2023 Stage 4: 2026	864	536
Seine Aval	Acheres, France	SUEZ	2016	357	224
Brussels Sud	Brussels, Belgium	SUEZ	2017	190	86
Carré de Reunion	Versailles region, France	Koch Membrane Systems	2015	144	42
Assago	Milan, Italy	SUEZ	2016	125	55
Aquaviva	Cannes, France	SUEZ	2013	108	60
La Moree	France	SUEZ	2013		61
Sabadell	Spain	Kubota	2009	55	
San Pedro del Pinatar	Spain	SUEZ	2007	48	
Porta Maghera	Italy	SUEZ	2005	47	
Nordkanal	Kaarst, Germany	SUEZ	2004	45	
Brescia	Italy	SUEZ	2002		43
Gava	Spain	SUEZ	2010		33

PDF: Peak daily flow
ADF: Average daily flow, Megalitres per day
SUEZ: SUEZ Water Technologies & Solutions (formerly GE Water & Process Technologies)

5. ELECTRODIALYSIS REVERSAL (WTP & WWTP)

EDR is the most robust and highest recovery wastewater desalination technology.

- 10+ year membrane life
- High turbidities
- Chlorine tolerance
- Silica tolerance, high recovery > 90%



Typical Applications

Drinking Water

Reduction of total dissolved solids

Removal of **nitrate**, fluoride, arsenic, perchlorate, radium, Uranium, Selenium

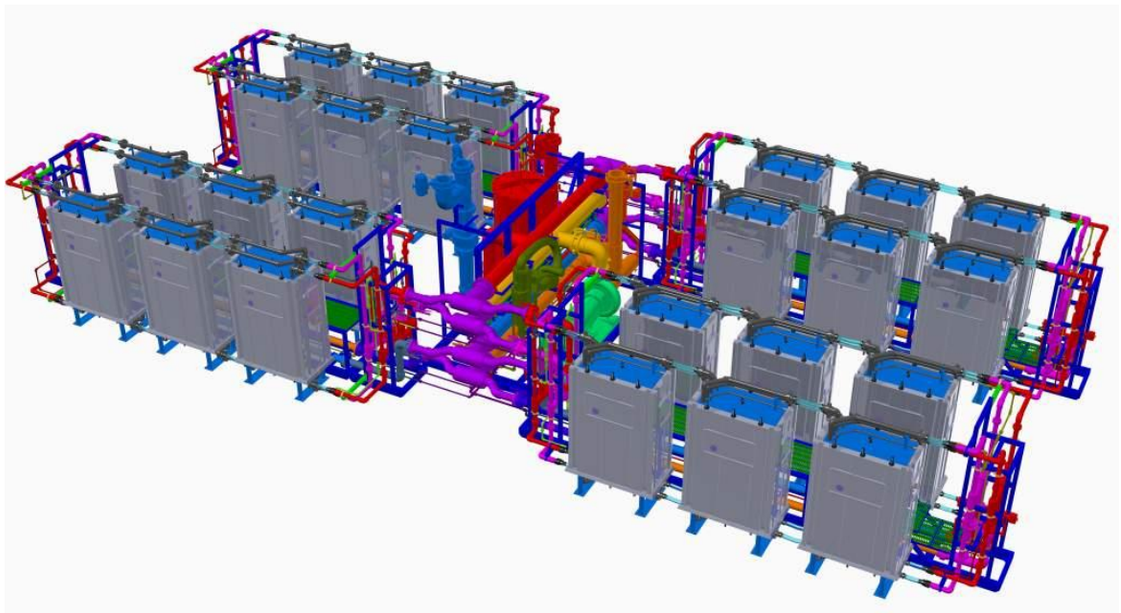
High silica feed water applications

Municipal Wastewater for Irrigation

Reduction of TDS

Alleviates fresh water use

TOC Tolerance



Industrial Process Water

- Reduce TDS prior to ion exchange
- Recovery of RO reject
- High silica loading (up to 140 ppm)

Exploration Produced Water

- Concentration of salt, reduce disposal volume

Wastewater

Removes salts from wastewater

1. Effective on all charged constituents:

Sodium, Nitrate, Small TOC

2. Advantages of EDR:

Higher turbidity/solids allowance

Reduction in required pretreatment

Can manually clean membranes

Maintain Chlorine residual to prevent biogrowth

Removes salt to drinking water limits

1. Effective on all charged constituents:

Arsenic, Radium, Perchlorate, Fluoride, Nitrate

2. Advantages of EDR:

Multiple well sources with varying quality

Inconsistent demand, start/stops

High recovery

Reduced operating costs (chemicals, labor)

typical operating parameters

Water Recovery	Up to 94%
Salt Removal	50 to 95%
Silica Removal	none
Temperature	40 to 100ºF (4 to 38ºC)
Input Voltage	480VAC/3/60Hz

feed water guidelines

Typical Feed TDS	100 to 3,000 ppm (mg/l)
Maximum Feed TDS	6,000 ppm (mg/l)
Silica (Reactive)	unlimited
pH	2 to 10
Turbidity	5 NTU
Free Chlorine (continuous)	0.5 ppm (mg/l)
TOC	< 60 ppm (mg/l)
COD	< 200 ppm (mg/l) as O2
Iron	< 0.3 ppm (mg/l)
Manganese, Aluminum	< 0.1 ppm (mg/l)
H2S	< 0.1 ppm (mg/l)

Allowable Intermittent Levels:

Turbidity	10 NTU
Free Chlorine	30 mg/l

ESTIMATED OPERATION COST

Company	
User	R Lewis
WATSYS Run Date	Thursday, June 25, 2015
Number of Lines	2
EDR System	2020-2L-2S with 2 Line(s) 2 Stage(s)
Anion Membrane	AR204
Cation Membrane	CR67
Spacer	Mark IV-2

Blended Product	130	m3/hr	
EDR Product	72,0	m3/hr	
Dilute In	74,4	m3/hr	
Dilute Flow Losses	0,9	m3/hr	
Dilute Out	73,5	m3/hr	
Off-Spec Product	1,5	m3/hr	2% OSP
Feed Pump	78,7	m3/hr	
Concentrate Pump	67,0	m3/hr	
Electrode Waste	0,6	m3/hr	
Concentrate Makeup Flow	3,7	m3/hr	
Net System Feed into EDR	78,7	m3/hr	
Total System Waste	6,7	m3/hr	8% Waste w/o Bypass 5% Waste w/ Bypass
Concentrate Blowdown	6,7	m3/hr	
System Feed w/ Bypass	136,7	m3/hr	
Bypass Feed to Product	58,0	m3/hr	
Minimum Velocity	11,49	cm/s	
First Stage Inlet Pressure	3,06	bar	
Last Stage Outlet Pressure	0,69	bar	
Temperature	18	C	
Pumping Power	0,41	kWh/m3	
DC Power	0,25	kWh/m3	
Total Power	0,66	kWh/m3	
Total DC KVA	21,05	KVA	
Feed Pump Power	24,41	hp	
Concentrate Pump Power	15,06	hp	

		Raw Feed	Blended Product	Conc. BD	Waste	EDR Product
Calcium	mg/l	90,0	49,6	874,9	874,9	17,09
Magnesium	mg/l	29,0	16,4	273,2	273,2	6,31
Sodium	mg/l	116,9	70,4	1019,5	1019,5	33,01
Potassium	mg/l	0,0	0,0	0,0	0,0	0,00
Strontium	mg/l	0,0	0,0	0,0	0,0	0,00
Barium	mg/l	0,0	0,0	0,0	0,0	0,00
Ammonia	mg/l	0,0	0,0	0,0	0,0	0,00
Bicarbonate	mg/l	253,0	156,7	2106,2	2106,2	79,01
Sulphate	mg/l	69,4	37,3	694,0	694,0	11,38
Chloride	mg/l	176,5	98,1	1711,5	1703,8	34,90
Fluoride	mg/l	0,2	0,1	1,4	1,4	0,04
Nitrate	mg/l	85,6	48,3	811,1	811,1	18,20
Total PO4	mg/l	0,0	0,0	0,0	0,0	0,00
HPO4	mg/l	0,0	0,0	0,0	0,0	0,00
H2PO4	mg/l	0,0	0,0	0,0	0,0	0,00
Silica	mgl	0,0	0,0	0,0	0,0	0,00
CO2	mgl	13,09	13,09	36,02	36,02	13,09
Carbonate	mgl	0,35	0,13	8,73	8,73	0,03
Total Hardness	CaCO3	343,8	191,4	3306,4	3306,4	68,58
TDS	mg/l	820,9	477,1	7500,5	7492,8	199,98
Conductivity	uS/cm	1222,3	733,6	9090,1	9073,8	317,86
pH		7,54	7,33	8,02	8,02	7,03
WATSYS % Saturation						
CaSO4		4,0	2,1	40,5	40,5	0,60
BaSO4		0,0	0,0	0,0	0,0	0,00
SrSO4		0,0	0,0	0,0	0,0	0,00
CaF2		15,9	0,0	143,9	143,9	0,00
CaHPO4		0,0	0,0	0,0	0,0	0,00
Ca3(PO4)2		0,0	0,0	0,0	0,0	0,00
Langelier Index (LI)		0,16	-0,49	2,50	2,48	-1,50
Stiff-Davis Index (SDI)		-0,04	-0,70	2,12	2,12	-1,75
SAR		2,74	2,21	7,70	7,70	1,7318
Flow Rate	m3/hr	78,7	130,0	6,7	6,7	72,0

ESTIMATED OPERATION COST

Feed:MBR
PERMEATE

WATSYS Run Date

Number of Lines	6	
EDR System	2020-6L-3S with 6 Line(s) 3 Stage(s)	
Anion Membrane	AR204	
Cation Membrane	CR67	
Spacer	Mark IV-2	
EDR Product	4000,0 m3/day	
Dilute In	4296,4 m3/day	
Dilute Flow Losses	129,8 m3/day	
Dilute Out	4166,7 m3/day	
Off-Spec Product	166,7 m3/day	4% OSP
Feed Pump	4705,9 m3/day	
Concentrate Pump	3866,8 m3/day	
Electrode Waste	37,6 m3/day	
Concentrate Makeup Flow	371,8 m3/day	
Net System Feed into EDR	4705,9 m3/day	
Total System Waste	705,9 m3/day	15% Waste w/o Bypass
Concentrate Blowdown	501,6 m3/day	
System Feed w/ Bypass	4705,9 m3/day	
Bypass Feed to Product	0,0 m3/day	
Minimum Velocity	9,07 cm/s	
First Stage Inlet Pressure	2,81 bar	
Last Stage Outlet Pressure	0,69 bar	
Temperature	15 C	
Pumping Power	0,4 kWh/m3	
DC Power	0,67 kWh/m3	
Total Power	1,07 kWh/m3	
Total DC KVA	136,46 KVA	
Feed Pump Power	53,42 hp	
Concentrate Pump Power	35,55 hp	

		Raw Feed	Product	Conc. BD	Waste
Calcium	mg/l	38,8	3,1	310,8	241,4
Magnesium	mg/l	39,8	3,7	314,8	244,6
Sodium	mg/l	510,9	69,4	3874,0	3012,9
Potassium	mg/l	38,6	3,9	302,4	235,0
Strontium	mg/l	0,0	0,0	0,0	0,0
Barium	mg/l	0,0	0,0	0,0	0,0
Ammonia	mg/l	0,0	0,0	0,0	0,0
Bicarbonate	mg/l	336,0	79,7	2294,2	1788,3
Sulphate	mg/l	154,3	11,9	1237,2	961,1
Chloride	mg/l	665,8	67,9	5215,7	4053,7
Fluoride	mg/l	0,0	0,0	0,0	0,0
Nitrate	mg/l	56,8	6,2	441,5	343,1
Total PO4	mg/l	0,0	0,0	0,0	0,0
HPO4	mg/l	0,0	0,0	0,0	0,0
H2PO4	mg/l	0,0	0,0	0,0	0,0
Silica	mgl	20,0	20,0	20,0	20,0
CO2	mgl	12,68	12,68	21,87	24,21
Carbonate	mgl	0,62	0,03	16,70	9,17
Total Hardness	CaCO3	260,4	22,6	2069,6	1608
TDS	mg/l	1861,5	265,8	14027,1	10909,2
Conductivity	uS/cm	2993,9	420,3	19407,5	15455,7
pH		7,70	7,08	8,30	8,15
WATSYS % Saturation					
CaSO4		2,6	0,2	21,5	16,7
BaSO4		0,0	0,0	0,0	0,0
SrSO4		0,0	0,0	0,0	0,0
CaF2		0,0	0,0	0,0	0,0
CaHPO4		0,0	0,0	0,0	0,0
Ca3(PO4)2		0,0	0,0	0,0	0,0
Langelier Index (LI)		-0,01	-2,27	2,29	1,92
Stiff-Davis Index (SDI)		-0,21	-2,52	1,73	1,47
SAR		13,76	6,34	37,00	32,65
Flow Rate	m3/day	4705,9	4000,0	501,6	705,9

aguas de valencia chooses SUEZ's EDR technology for the gandia water system

Figure 1: Falconera Water Treatment Plant

challenge

Gandia is a city that is 60 km (37.3 miles) south of Valencia along the coast in southern Spain. The city has around 80,000 people during the winter and the population swells to 250,000 during the summer with tourists and vacationers from Madrid who own in Gandia.

The nitrate levels for the wells that feed the city were too high to meet new regulations (<50 ppm) that were coming in to effect, so the city started to explore possible solutions. They tested different technologies and ultimately settled on Electrodialysis Reversal (EDR) from SUEZ. EDR technology reduces the nitrate levels while operating at high water efficiency at a good long-term operating cost. The goal for this system was to supply water with less than 25 ppm of nitrate.

The high recovery from SUEZ EDR systems was key to avoid the construction of new wells.

solution

Aguas de Valencia, the Concessionaire of Gandia Water Distribution System, and the City Council of Gandia have carried out the construction of these facilities, that they also operate, They worked together with SUEZ to design and install two EDR plants that are identical but located about 5 km (3.1 miles) apart from each other.

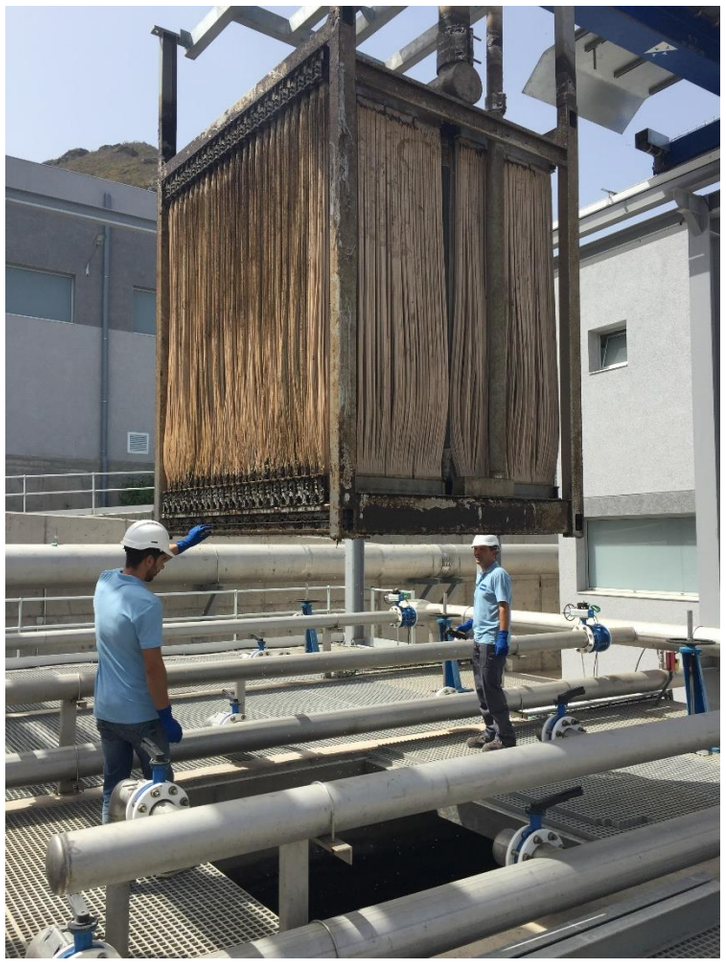
The solution provided through Aguas de Valencia and SUEZ moved swiftly. The buildings were constructed in six months and the system was up and operating 1-2 months later. The first site is Ull de Bou and the second site is Falconera.

results

Each site has four (4) trains of EDR systems operating (40 stacks/site) and produces 16,000 m^3/day (1468 gpm) of drinking water and operates at 90% recovery.

Figure 2: Installed EDR Systems

MBR + EDR (irrigation reuse) . Valleguerra Plant Canary Islands)



MBR : 30.000 m3/d

EDR: 4000 m3/d to irrigation

MBR + EDR (irrigation reuse) . Valleguerra Plant -Canary Islands

https://www.youtube.com/watch?v=IGIgUH0GB6w

6. REVERSE OSMOSIS (Sea Water Desalination)

Reverse Osmosis Desalination in Suez

- Nearly 50 years of experience (first reference in 1969 in Houat Island, France) :
  - SUEZ has successfully developed and integrated complementary technologies to make this a sustainable solution
  - SUEZ has built more than 255 desalination plants all over the world

- SUEZ Treatment Infrastructures has two Production Centers acting as “Excellence Centers” for the Desalination Market with plenty of experts on this field. These PCs are based in France (Rueil) & Spain (Bilbao)

1.5
million cubic meters of desalinated water produced by a plant operated by SUEZ

3.5
million cubic metres of desalinated water produced per day by a degremont® plant

10
million people supplied

a pioneer in desalination by reverse osmosis,
SUEZ has built 255 degremont® plants in all four corners of the world

Global Water Awards* recognition from our peers

2007
Desalination plant of the year
Perth (Kwinana), Australia
Desalination plant of the year
(highly commended)
Wadi Zarqa Ma'in, Jordan

2010
Desalination company of the year
Desalination plant of the year
Barcelone-Llobregat, Spain
Desalination project of the year
Victorian desalination plant,
Melbourne, Australia
Energy and Water, plant of the year
Barka II, Oman

2012
Water company of the year
(distinction)
Desalination plant of the year
(highly commended)
Al Dur, Bahrain

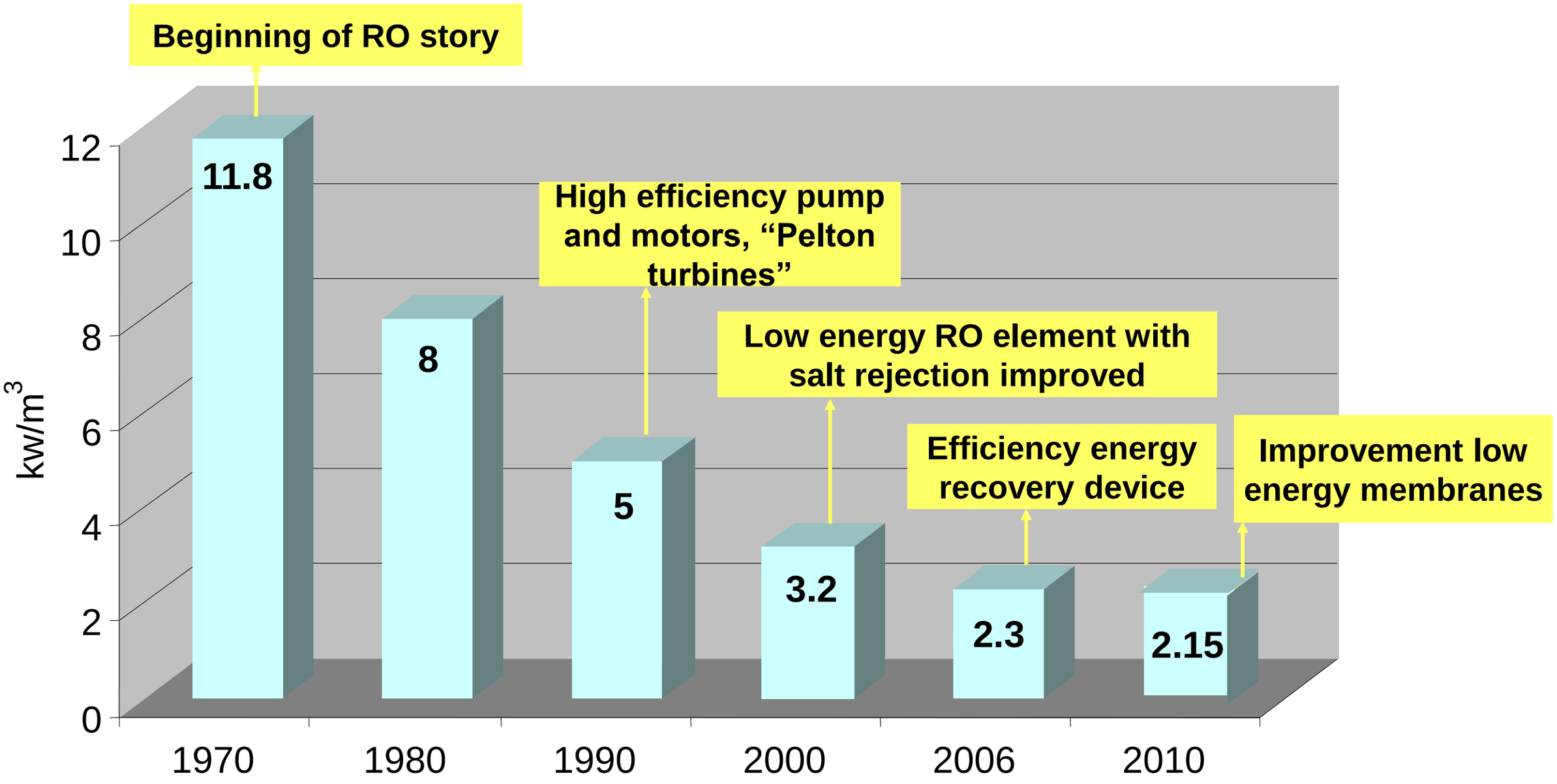
2013
Desalination company of the year
(distinction)
Desalination plant of the year
Victorian desalination plant,
Melbourne, Australia

2014
Desalination Deal of the year
Victorian Desalination Project
refinancing, Australia
Water Project of the year
Riyadh water supply enhancement
programme, Saudi Arabia

2015
Desalination company of the year
(distinction)

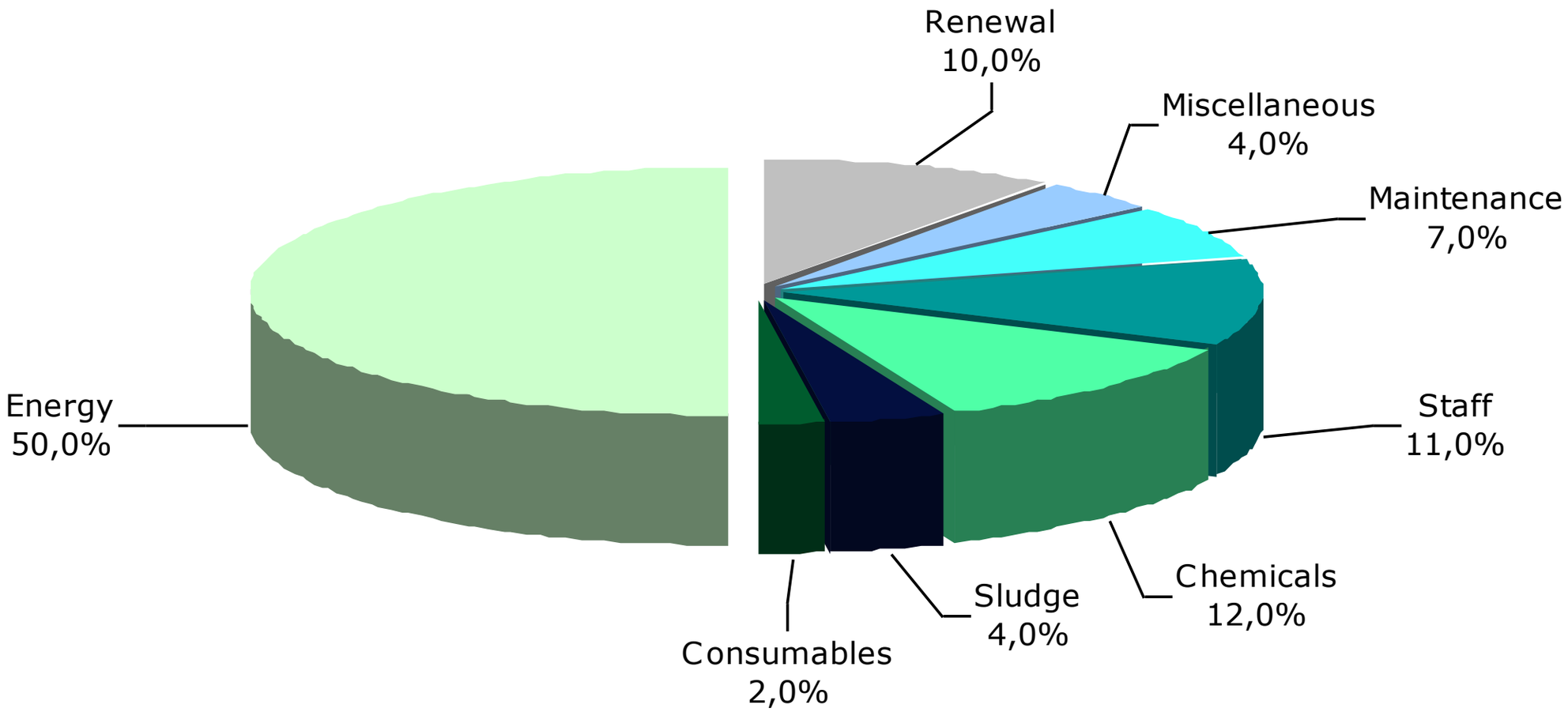
* Organised by the journal Global Water Intelligence

Reverse Osmosis Desalination: Power consumption improvement



Evolution of electrical consumption for sea water first pass RO

Reverse Osmosis Desalination – OPEX %s



OPEX is impacted up to 50 % due to energy consumption
(energy recovery device included)

Reverse Osmosis Desalination: Capex & Opex

- **CAPEX**
  - Total = 1.000 – 1.200 € / m^3/d

- **OPEX**

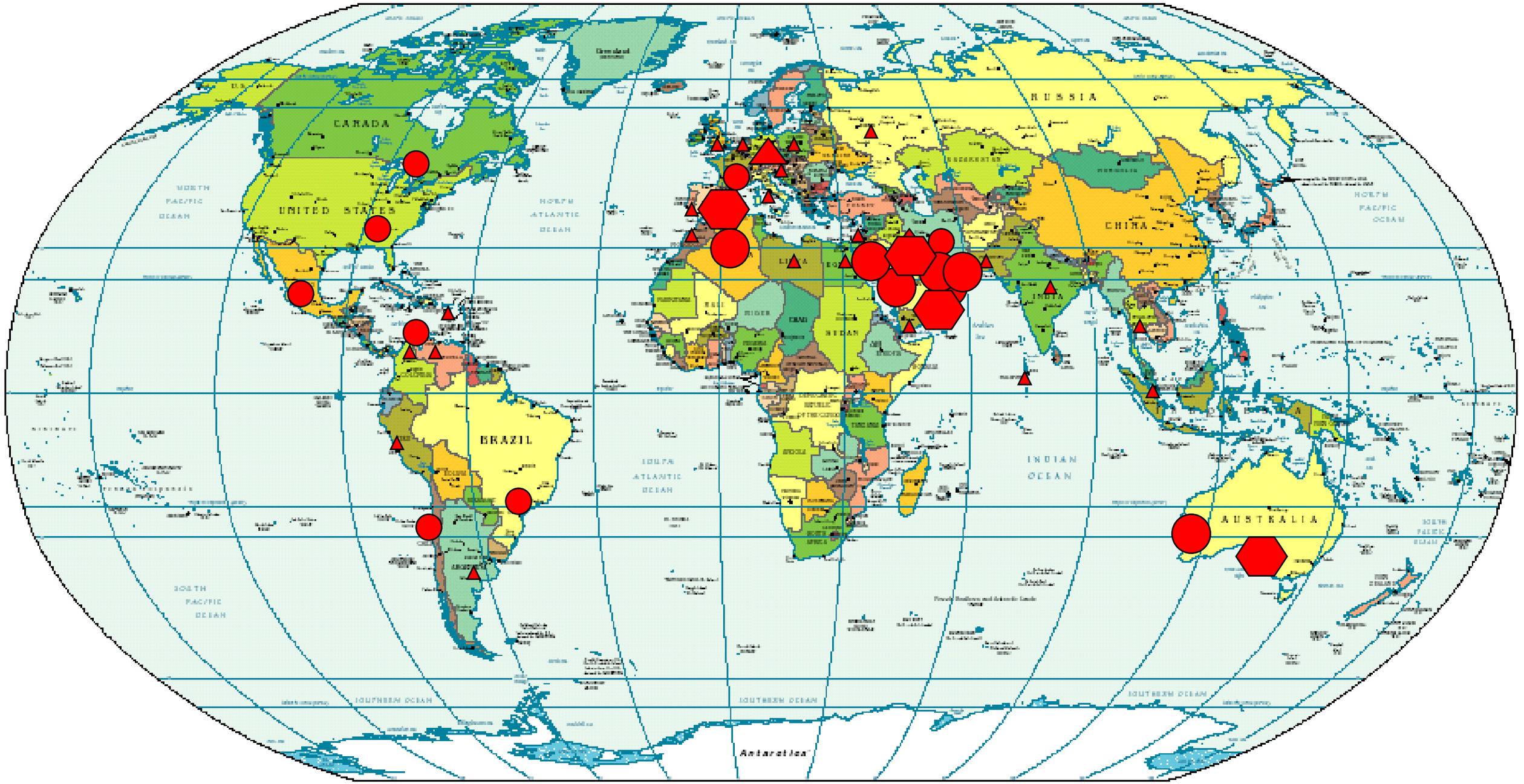
Electrical consumption:

  - First pass = 2 – 2,3 kWh / m^3
  - Total = 3 – 4 kWh / m^3

Total operational costs:

  - Sea Water RO Desalination Plants: 0,45 – 0,5 € / m^3

Reverse Osmosis Desalination: Main References



▲ < 10 000 m³/d

● > 10 000 m³/d < 50 000 m³/d

▲ > 50 000 m³/d < 100 000 m³/d

● > 100 000 m³/d < 500 000 m³/d

⬢ > 500 000 m³/d

Reverse Osmosis Desalination: Main References

Year		Plant	Country		Flow m3/day		Water Use
1999	-	Bahía de Palma	Spain	–	68 000 MCD	–	Potable, Tourism
2002	-	Carboneras	Spain	–	120 000 MCD	–	Potable, Agriculture
2003	-	Fujairah	UAE	–	170 500 MCD	–	Potable, Agriculture
2004	-	Curaçao	Ned. Ant.	–	18 500 MCD	–	Potable, B< 0.3
2004	-	Minera Escondida,	Chile	–	45 000 MCD	–	Industry, Mining
2006	-	Perth	Australia	–	143 700 MCD	–	Potable
2008	-	Barka	Oman	–	120 000 MCD	–	Potable, Industry
2009	-	Barcelona	Spain	–	200 000 MCD	–	Potable
2011	-	Al Dur	Bahrain	–	218 000 MCD	–	Potable, Industry
2012	-	Melbourne	Australia	–	450 000 MCD	–	Potable
2014	-	Mirfa (under construction)	UAE	–	130 000 MCD	–	Potable
2016	-	Barka (under construction)	Oman	–	281 000 MCD	–	Potable
2016	-	Rosarito (awarded)	Mexico	–	190 000 MCD	–	Potable

Melbourne / Australia

Treatment lines

Sea water intake and discharge tunnels and structures up to 1.5 km out to sea.

Water line

- **Pretreatment:**
  - Chemical dosing system
  - Dual media pressure filters (3 x 24)
  - Cartridge filters (3 x 14)
- **Reverse osmosis:** double pass system:
  - 1st pass 27 (9 x 3) trains (20,850 m³/d each) – recovery 48%
  - 2nd pass: 24 (3 x 8) trains (18,800 m³/d each) – recovery 90%
  - Energy recovery by pressure exchanger
- **Post-treatment:**
  - PH adjustments by CO_2 and remineralization
  - Fluoridation and disinfection

The project includes two undersea tunnels (total 2.7 km); 84 km of treated water pipeline (comprising 7,000 pipes); 87 km of 220kV underground connection; 29 buildings ; 51 RO trains, 55,000 membranes; 72 dual media filtration pumps; and 486 ERI PX 260 energy recovery systems.

Desalination

Capacity
450,000 m³/d

Key dates
D&B completion: Dec. 2012
O&M period: 2012 – 2039

The Victorian Desalination plant is able to provide a source of drinking water independent of rainfall for Melbourne and some regional communities.

SUEZ process

Key datas

Client
AquaSure (PPP: Public Private Partnership) and the Victorian Government

Project main contractor
D&B: JV SUEZ (35%) / Thiess (65%)
O&M: JV SUEZ (60%) / Thiess Services (40%)

Type of contract
Design & Build, Operation & Transfer (BOT)

One of the biggest reverse osmosis plant in the world

- The most technically advanced, environmentally friendly and energy efficient desalination facility.
- Minimal energy use is achieved through systems that minimize power consumption, with all energy usage 100% offset by green electricity from two wind farms and a significant green roof featuring 40,000 plants.
- The plant is totally integrated into its surrounding and preserves the natural environment. The plant is almost invisible from any public viewing point.
- The project also overcame the human resources challenge, operating with a peak of 4,200 workers from 20 nationalities on the site each day.

Barcelona / Spain

Treatment lines

Water line

- **Seawater intake**
  - Offshore open intake located 2,2 km from the coast with the water inlet 25 m below the surface.
  - Pumping station located 3.5 km away from the SWRO plant (6 pumps for 21,000 m^3/h total flow of seawater).

- **Complete pretreatment**
  - Screening
  - Seawater clarification through rapid flotation(10 Seadaf)
  - 2 stages of dual media open filters (20 Mediazur GH)
  - Pressurized multi-media filtration (20 Seaclean)
  - 18 cartridge filters with 360 cartridges of 5 microns each
  - Chemical dosing system
- **Reverse osmosis (double-pass systems)**
  - 1st pass: 10 trains (recovery rate of 45%)
  - 2nd pass : 2 trains (recovery rate of 85%)
  - Energy recovery device: pressure exchangers allow to save 50% in energy consumption for reverse osmosis
- **Post-treatment:** Remineralization lime filters; Neutralization with CO_2; Disinfection with hypochlorite
- **Treated water storage tank and pumping station**

Sludge line:
Sludge storage tank; Clarification and thickening (2 Densadeg); Sludge dewatering (centrifuge) and storage

Brine innovative treatment: blended with treated water from the Wastewater Treatment Plant of Baix Llobregat in a ratio lower than 1:1 and discharge thought diffusers at 50 depth over 3 km from the intake.

Green label: adding a wind generator and photovoltaic panels in all building and reservoir roofs allowing to produce 1.3 MW and to minimize the electric internal consumption, saving more than 850 CO_2 Ton/year.

Desalination

Capacity
200,000 m^3/d

Key dates
Completed in July2009
O&M period 2009-2012

A pilot plant was operating for two years to help in design and for getting experience with Mediterranean seawater

SUEZ process
- Densadeg
- Mediazur
- Seaclean
- Seadaf
- Reverse Osmosis

Key data

Client
ATLL (Aguas Ter LLobregat), private company with public shareholders

Contract type
Design, Build & Operate (including 2-year O&M)

Contractor
JV SUEZ (Degrémont (25%) & Abgar (65%)) / Drace (10%)

The Barcelona-Llobregat Plant is the largest in Europe and was awarded the prize of the Desalination plant of the year in the Global Awards 2010

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suez environnement