WATER REUSE
Role for Integrated Resource Management in Islands and Tourist Areas

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SOCIETE POLYNESIENNE
DES EAUX ET DE L'ASSAINISSEMENT

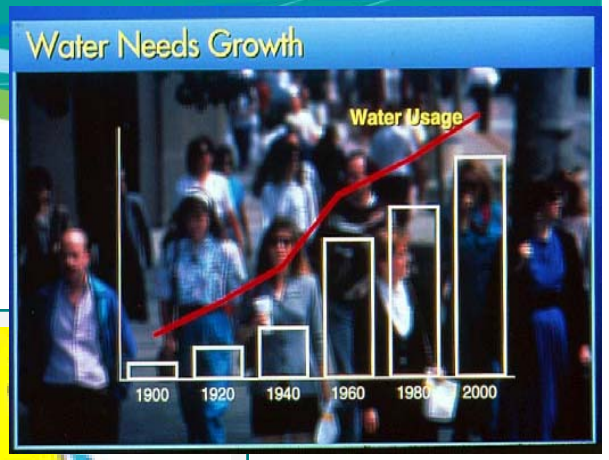
SUEZ ENVIRONMENT

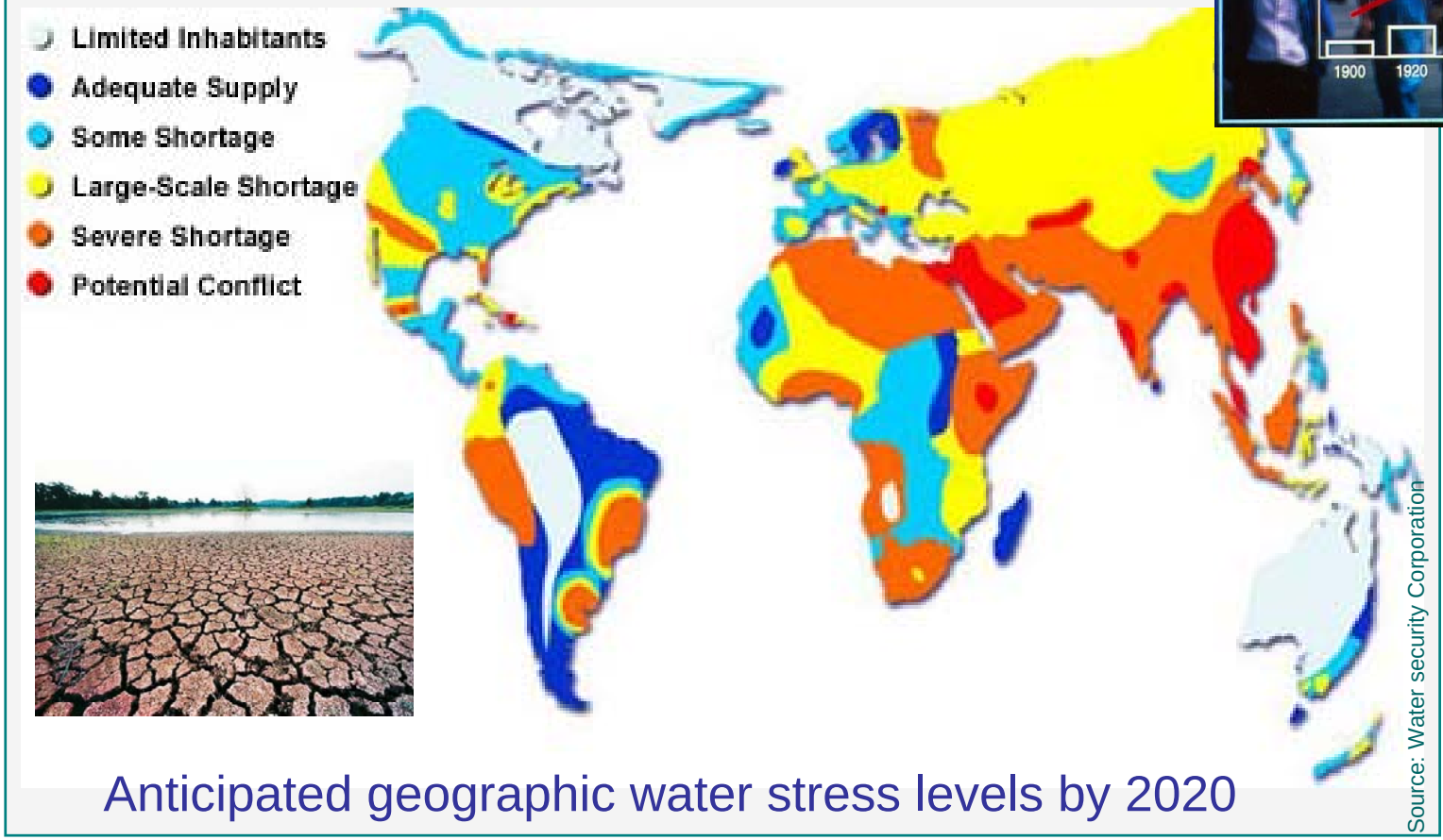
Outline

- **Introduction**: Drivers of Water Reuse
- **Technical Challenges** in Closing Water Cycle by Water Reuse
- **Examples**: What is the Best Technology for a Given Water Reuse Application?
- **Conclusions**: Costs, Benefits and Keys of Success of Water Reuse

Main drivers of water reuse

- Increased water demand
- Reduced water availability





Anticipated geographic water stress levels by 2020

Source: Water security Corporation

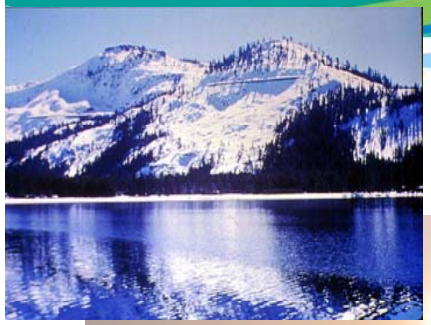
1999 ⇨ 2025
Moderate or high water stress:
- 2/3 of the world's population

Main drivers of water reuse

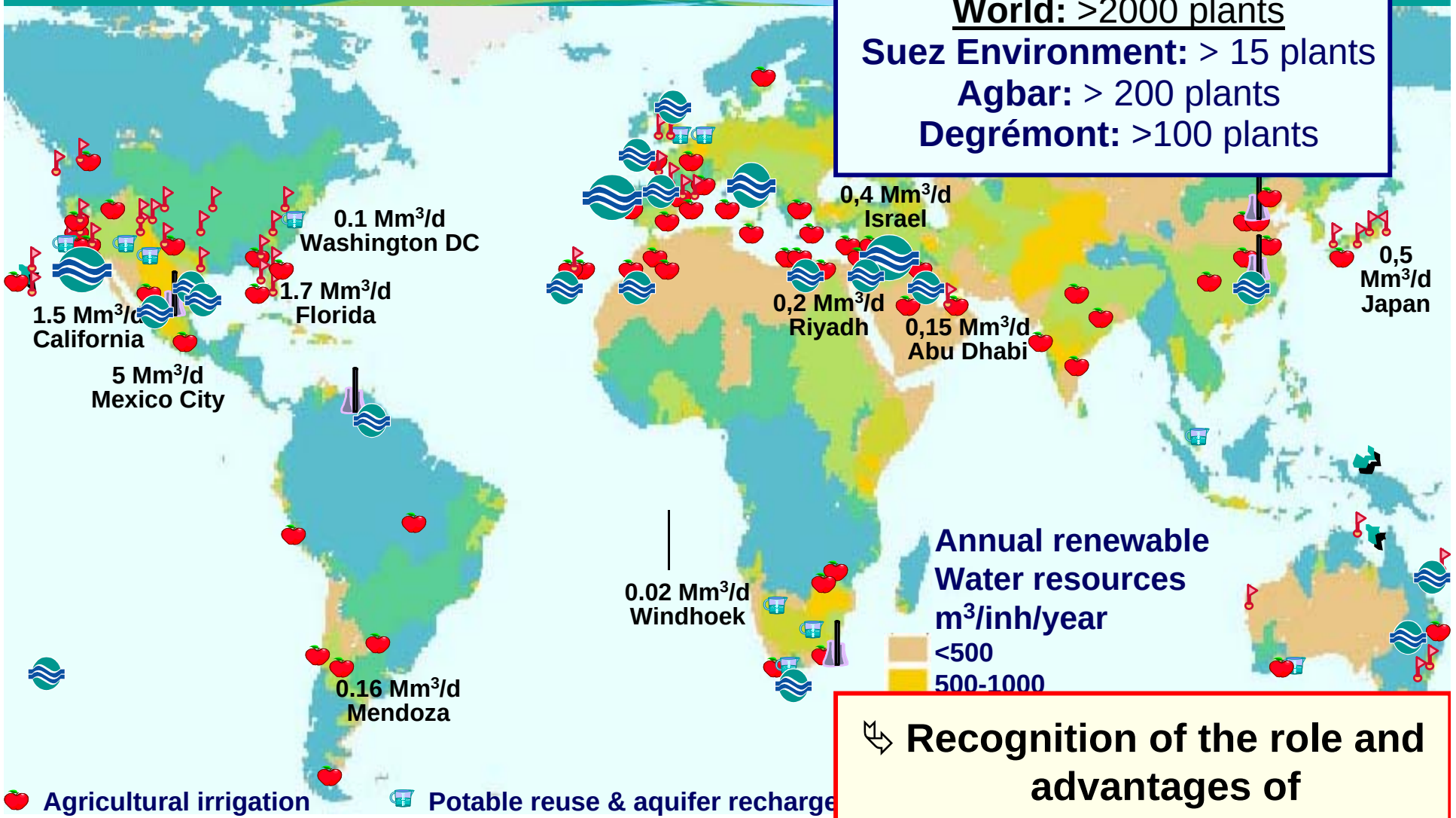
- Wastewater management needs
- Environment protection
- Impact of the new laws, policies & regulations
- Public awareness and politic pressure
  - Increase in drinking water price
  - Sustainable development

- **Water reuse is included in several state / national policies: Australia, California, Florida, Hawaii, Israel, Japan, Singapore…**
- **More and more regulations introduce requirements for water reuse: volume, %, given types of reuse as golf courses, high-rise buildings or industry)**

What's the Solution?
Integrated Resource Management

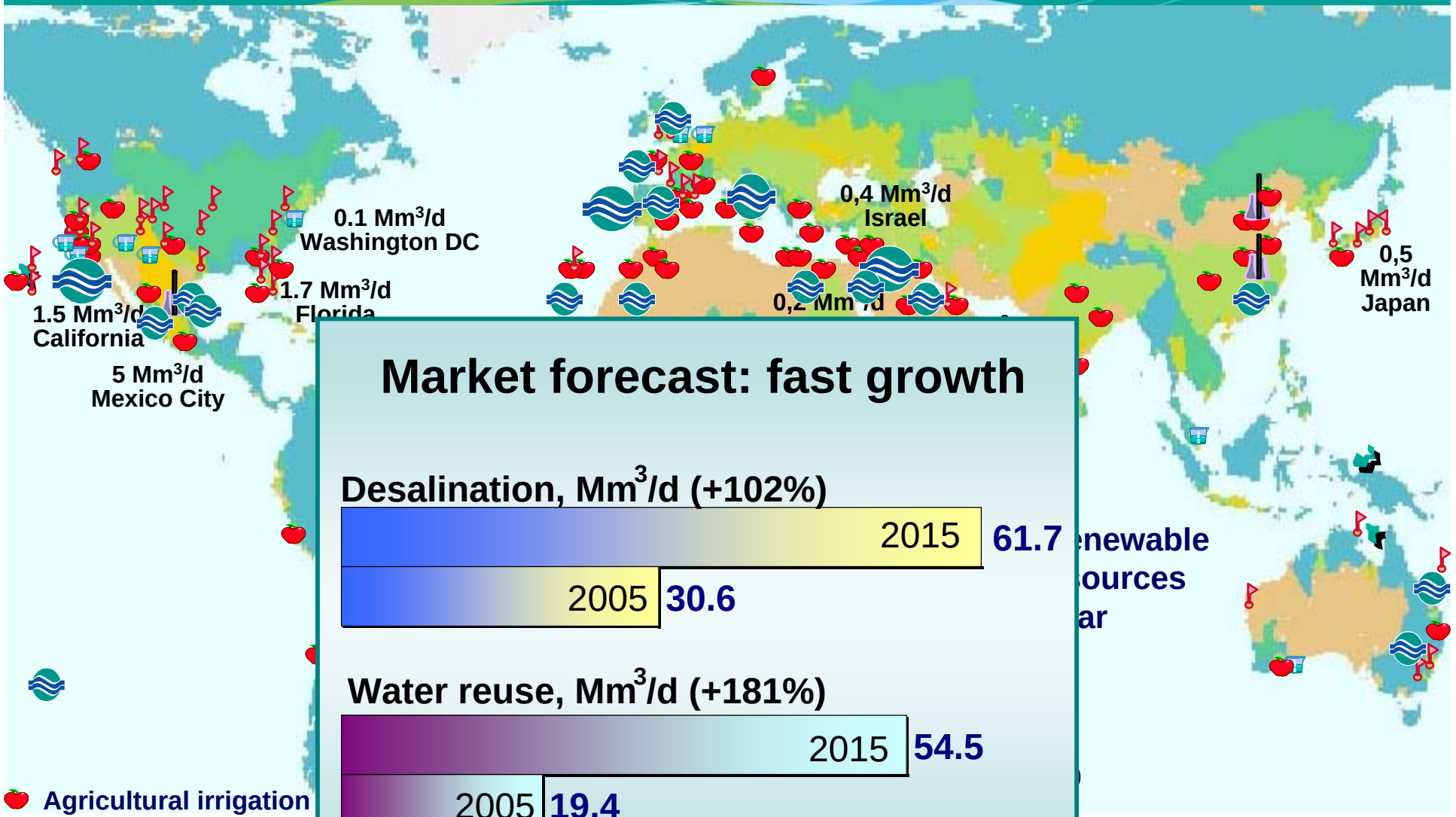


Water reuse experience worldwide



Recognition of the role and advantages of Public-Private Partnership

Water reuse experience worldwide



Market forecast: fast growth

Desalination, Mm³/d (+102%)

2015	61.7	
2005	30.6	

Water reuse, Mm³/d (+181%)

2015	54.5	
2005	19.4	

Global World

*Source: Global Water Intelligence

Water Reuse Challenges

Economic
Costs of construction and operation in *macro-economic scale*

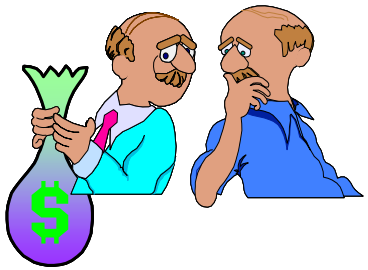
Financial
Price and market value of the services

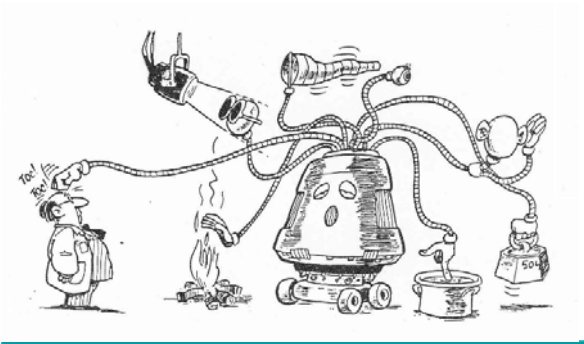
Socio-psychological
Public acceptance and education

Regulatory
Standards and regulations

Organisational
Administrative structure

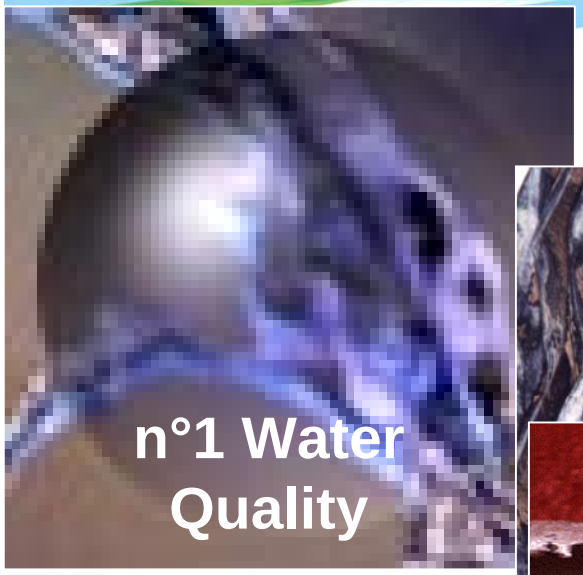
Technical






Technical Challenges
in Closing Water Cycle

Main Technical Challenges of Water Reuse



① **Variability**

② **Contaminants** *(Ammonia, bacteria, trace organics, etc.)*

③ **Salinity** *(TDS)*

④ **Emerging parameters**

① **Water quality control**

② **Scale, fouling and corrosion control**

③ **Best reuse practices**

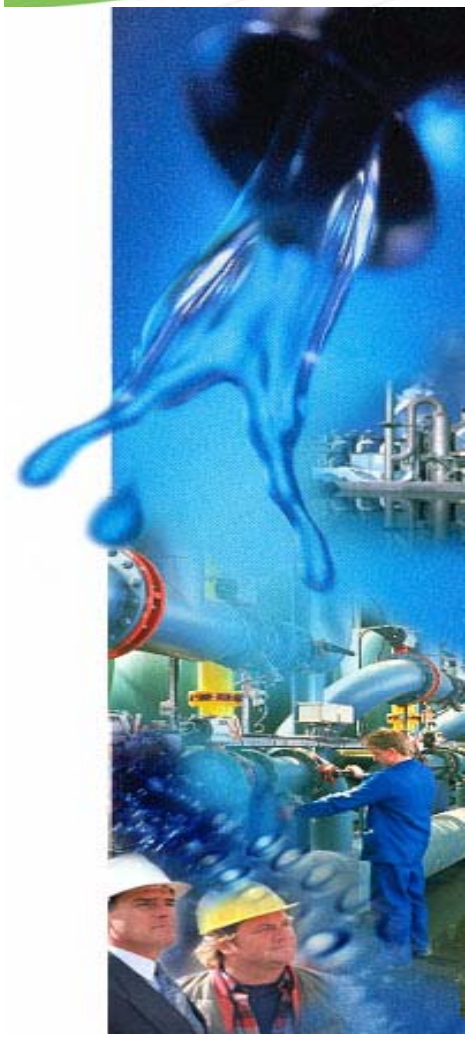
① **High performances**

② **Economic viability**

③ **Best available technologies**

④ **Redundancy**

How to Manage Risks in Water Reuse Operation?



1. Science

State of the Art Knowledge

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Pilot Plant Studies

2. Engineering

Best Available Technologies

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Good Plant Operation

Science: *R&D Programs and Technical Support of Suez Environment*

UK-Langford/ Northumbrian Group

Application: Indirect Potable Reuse

R&D: Advanced Treatment/ Endocrine disruptors/ Environmental Impacts

DORE (CIRSEE), France

R&D: Water quality contro/ Treatment systems

Bolivia / Aguas de Illimani

Applications: Irrigation

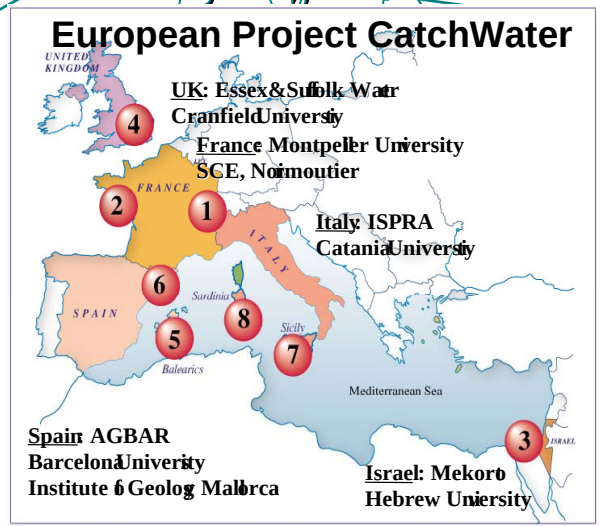
Techniques: Red beeds

R&D: Capex/Opaex optimization, Disinfection

West Basin / WBMWD and United Water

Application: aquifer recharge, irrigation, industrial uses

R&D: - UV/ Aquifer recharge/Trace organics/Quality in distribution network



Spain / AGBAR

Applications: Irrigation and aquifer recharge

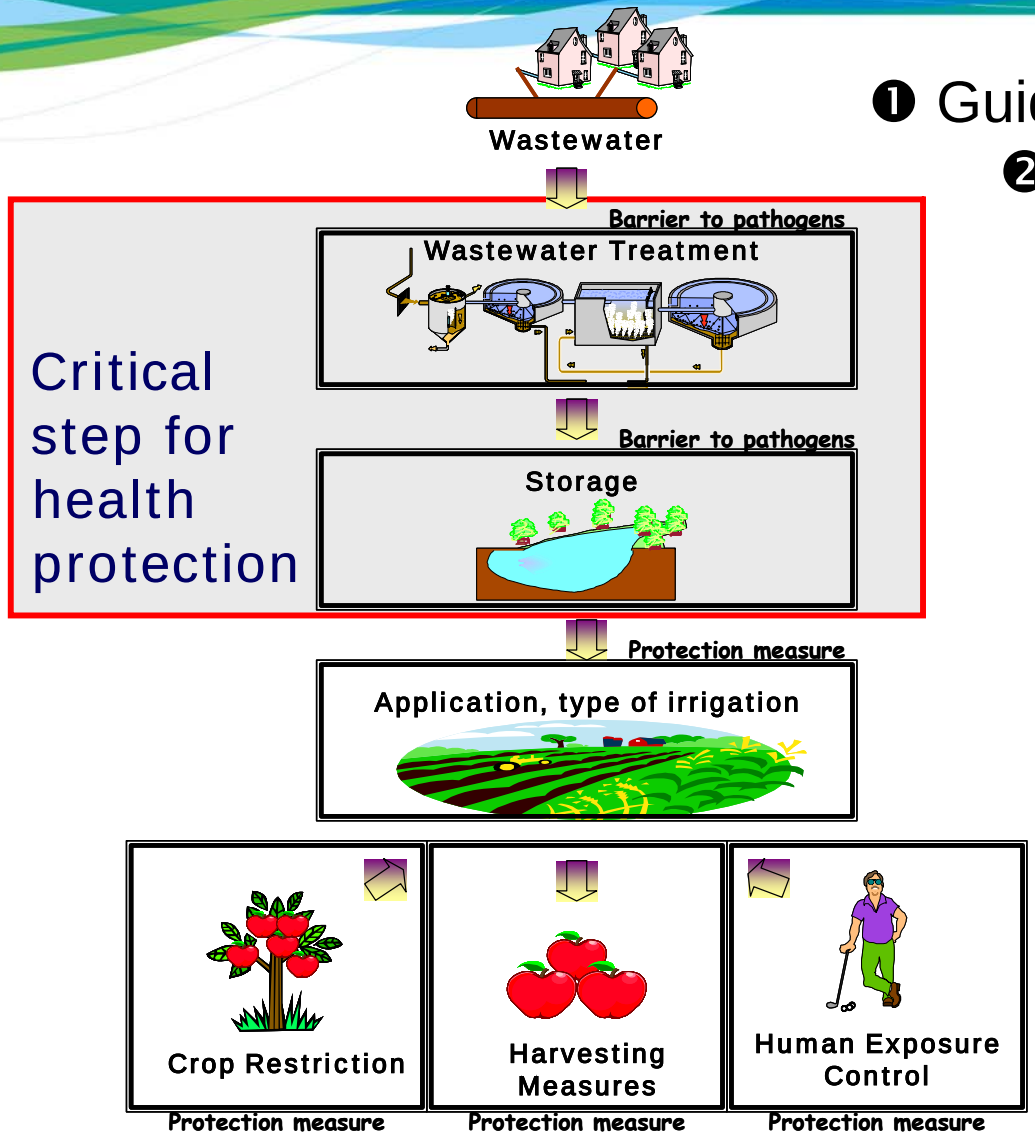
R&D: - Treatment lines including Infiltration-percolation, UV, ozone

- membranes (MF/RO, MBR)

- cost optimisation

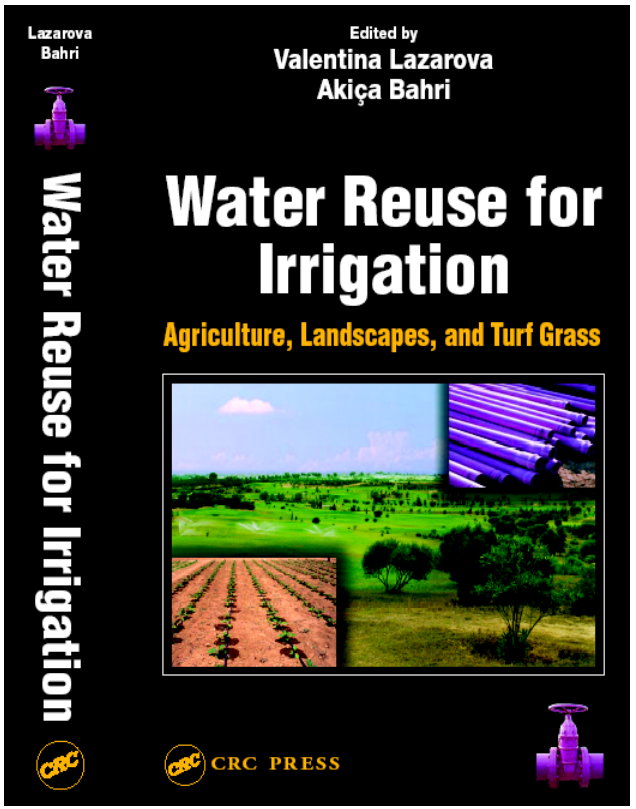
Science and Know-how management

Development of best practices and guidelines



❶ Guidelines for design and operation

❷ Best practices of irrigation with recycled water (published book)

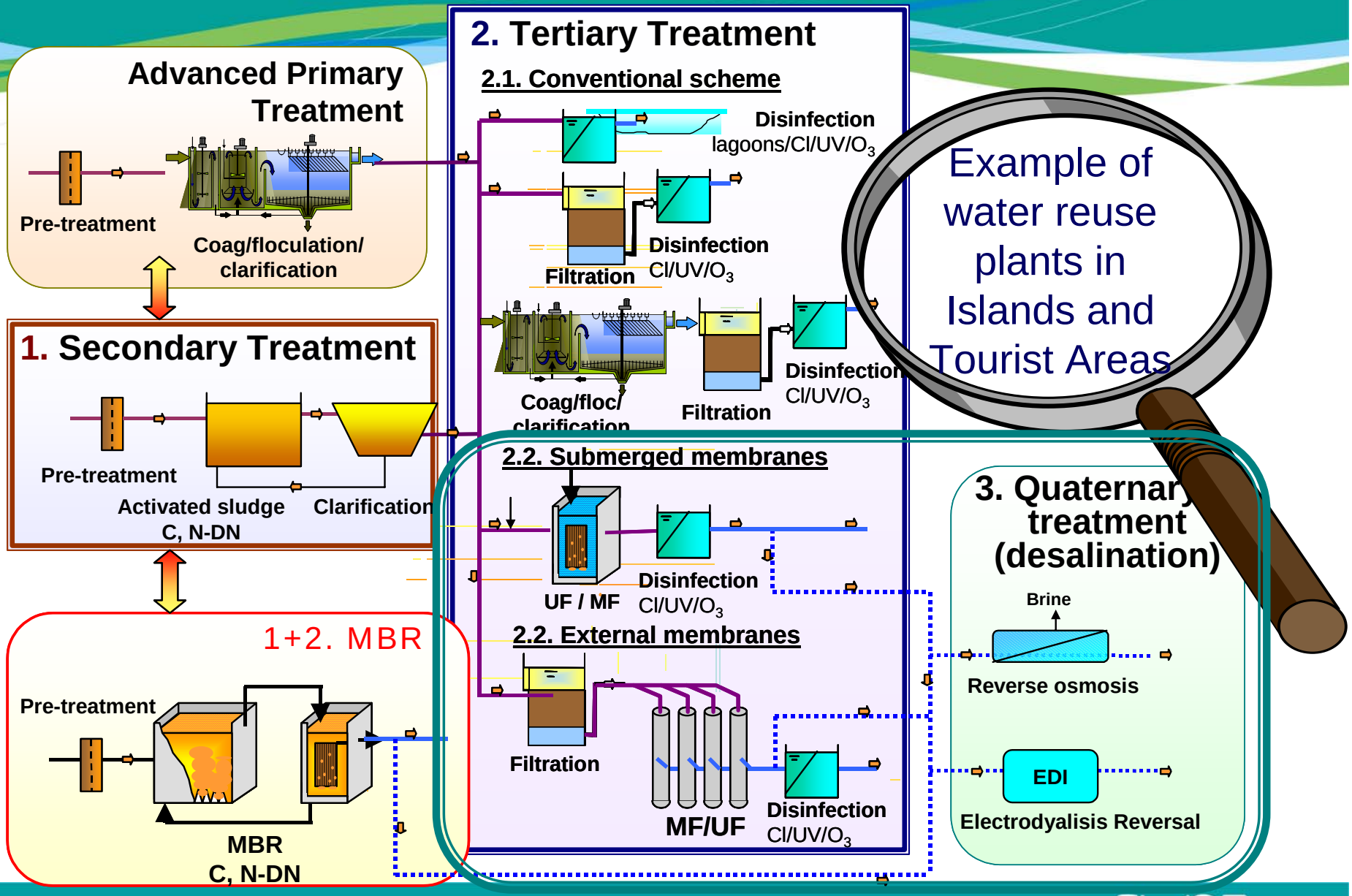


Operation: Goals and challenges of operation of water reuse facilities

- Support the client's goals
- Provide technical assistance and R&D support
- Safely, reliably and cost effectively operate all treatment processes
- Control and optimise tertiary treatment
- Maintain 24 hour operability 365 days a year
- Suggest innovative uses of high-quality recycled water


Examples: what is the best technology for a given use?

Common tertiary treatment trains

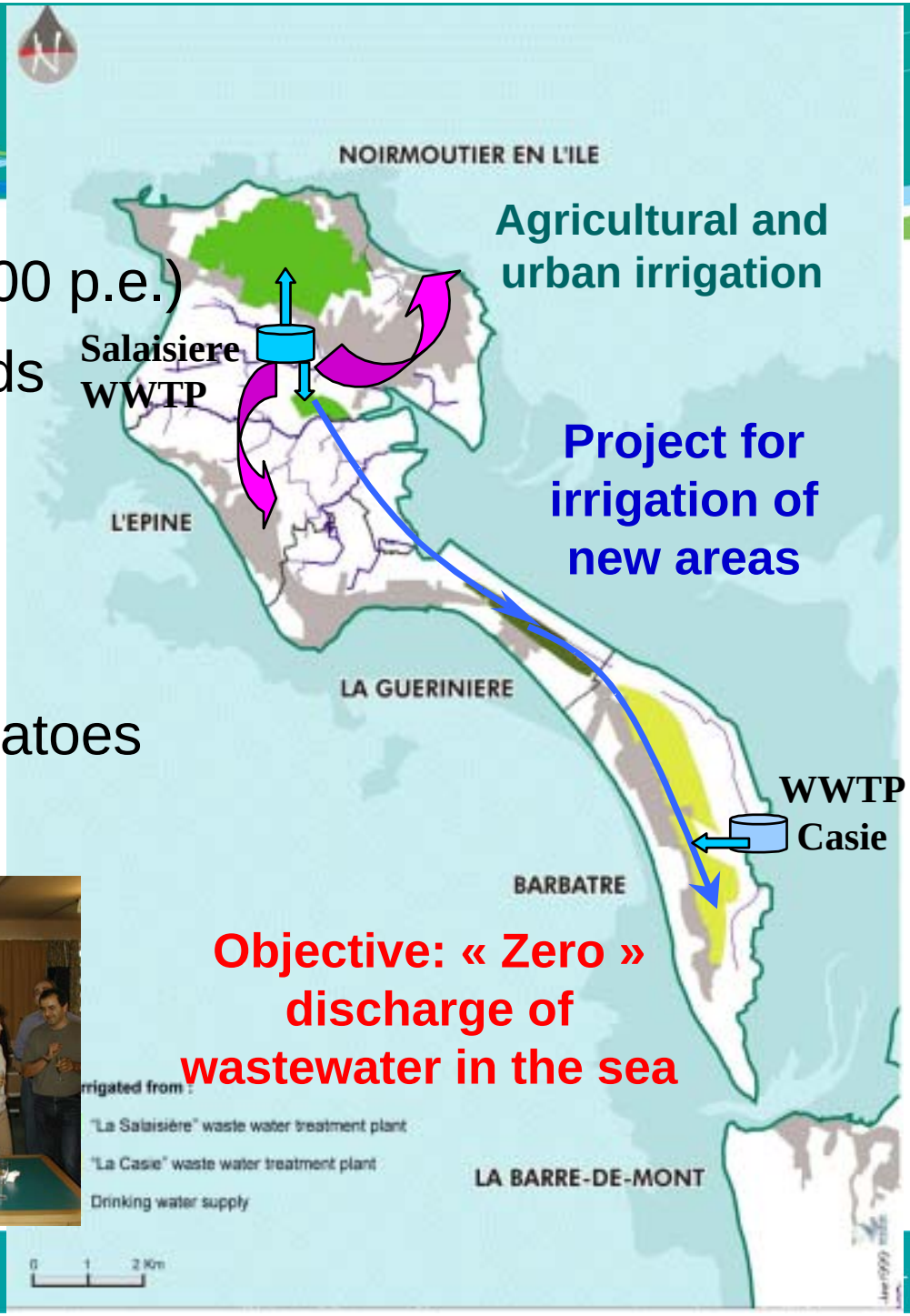


Non conventional technologies

- **Applications**: Irrigation (agriculture, landscape)
- **Target for disinfection**: <1000 FC or *E.coli*/100 mL
- **Optimum size**: small to medium treatment facilities
- **Main advantages**: Low operation costs and ease of operation

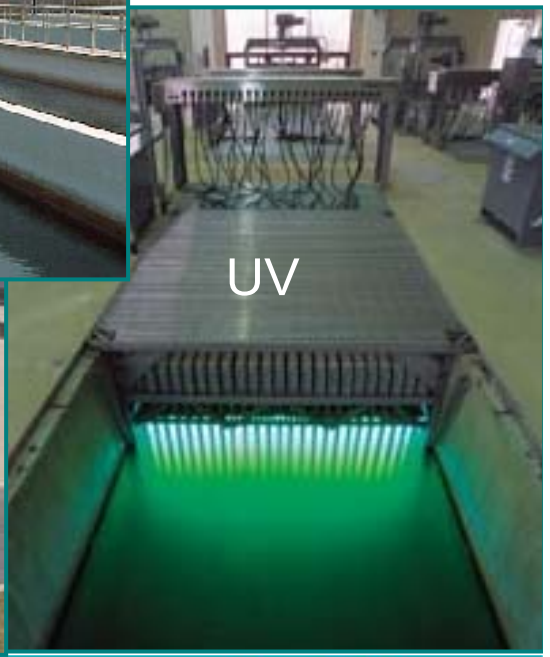
Noirmoutier Island, France

- 2 WWTP (55,000 p.e.+30,000 p.e.)
- Polishing by maturation ponds
- Reuse of 30% of treated wastewater
  - 215 000 m^3/year
  - Irrigation of 500 ha of potatoes
- Project extension (710 ha)



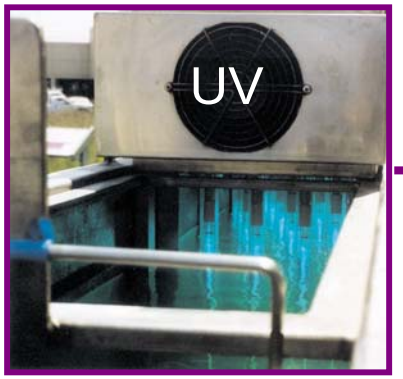
Conventional tertiary treatment

- **Applications** (non-potable uses)
  - ✓Landscape irrigation
  - ✓Urban uses
  - ✓Industrial uses
- **Targets for disinfection**:
  - ✓0 to 200FC/100 mL)



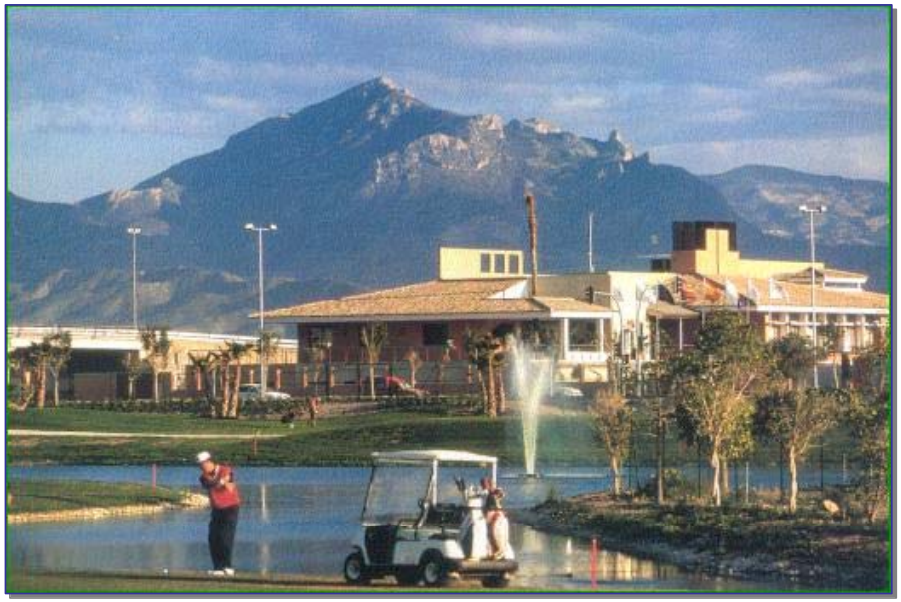
Golf course of Tina, New Caledonia

- Golf course of 90 ha, 18 holes
- Treatment: sand filtration and UV disinfection
- Capacity: 1700 m^3/j
- Operated since >20 years by SE (Calédonienne des Eaux)
- Covered storage reservoir (bacterial regrowth)



Golf course of Monte Orgegia, Alicante, Spain

- Golf course of 18 holes
- Capacity: 2,6 Mm^3/year
- Operated by SE (Agbar) since >15 years
- Treatment:
  - coagulation,
  - flocculation,
  - lamelar settling,
  - filtration,
  - disinfection



Augmentation of drinking water reservoir, Langford, UK

- Contract conditions and term
  - ✓Construction and operation
  - ✓Operator: Essex&Suffolk Water
- Project characteristics
  - ✓Tertiary treatment: 45,000 m^3/d
  - ✓Start-up: 2003
- Treatment technology
  - ✓Densadeg (P removal)
  - ✓Biofor N + Biofor DN (N removal)
  - ✓UV disinfection

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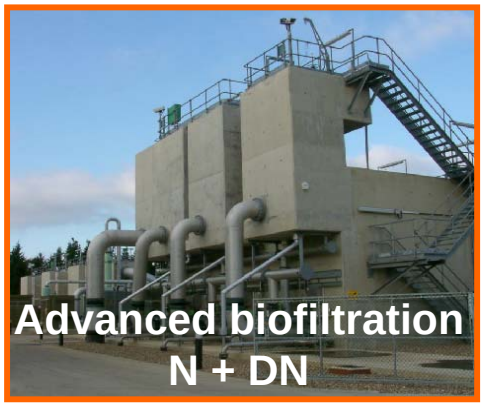

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No evidence of oestrogenic effect of recycled water (feminisation of fish)

Membrane treatment

⇨High growth and demand for membrane systems

- Physical barrier for microorganisms
- Improved removal of priority substances and emerging parameters
- Small land footprint
- Fully automated
- Numerous proved technologies
- Decreasing capital costs

Membrane treatment and repurification

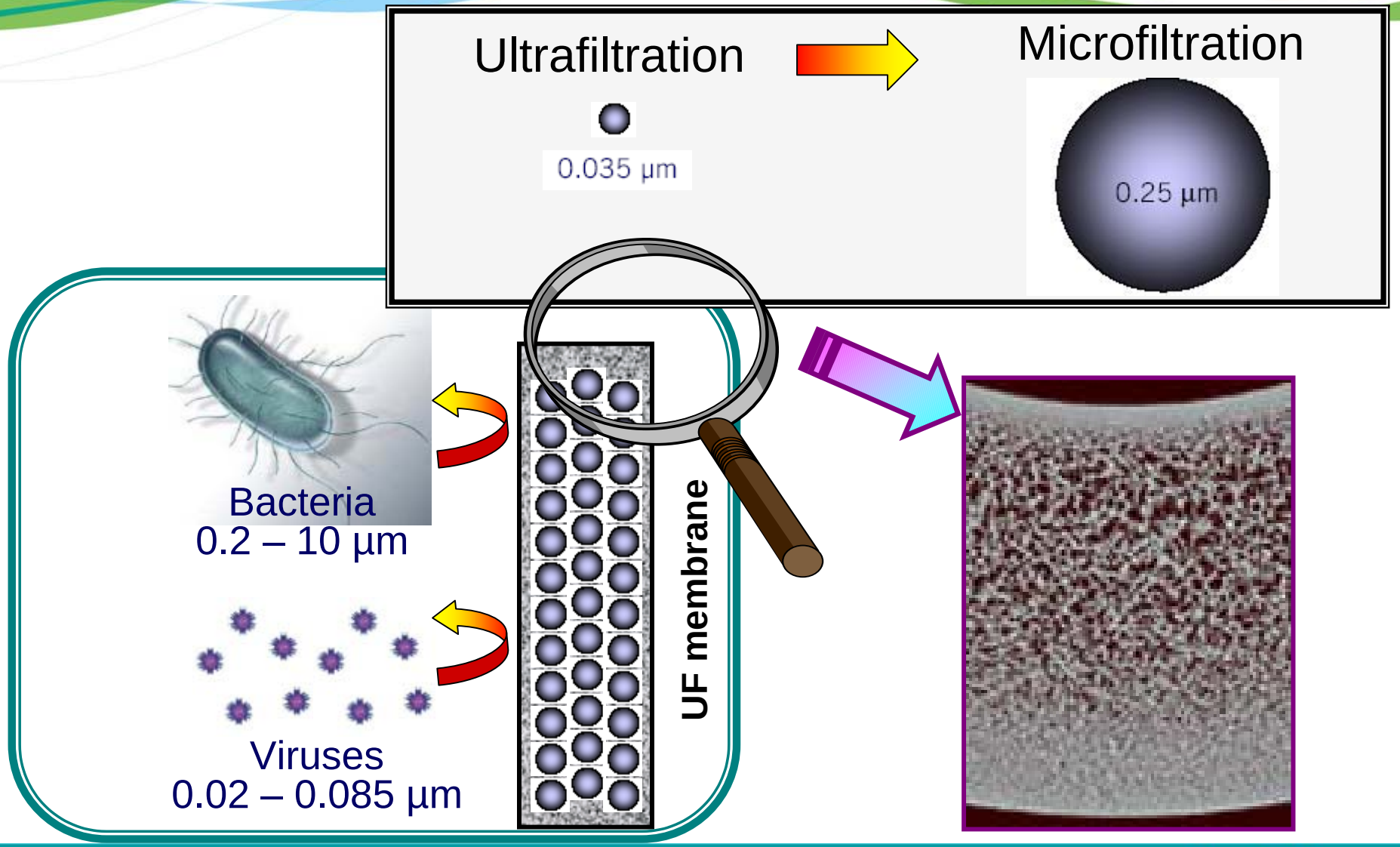
- **Applications**
  - ✓Unrestricted urban uses
  - ✓Indirect potable reuse/Aquifer recharge
  - ✓Industrial uses
- **Targets for disinfection**
  - ✓0 to <200FC/100 mL)
- **Other Targets**
  - ✓Trace organics, emerging parameters, desalination, etc…


Microfiltration


Reverse osmosis


Submerged membranes

Disinfection efficiency of ultrafiltration



Urban water reuse in Bora Bora

- Drivers: water shortage and repetitive droughts
- Political awareness: incentives of the Bora Bora's Major
- Policy of sustainable development
  - « Pavillon Bleue d'Europe » (since 6 years)
  - 1st Price of SUEZ 2005 Innovation Trophies

Water recycling facility of Bora Bora

- Project characteristics
  - ✓Secondary treatment (AS): 6250 m^3/d
  - ✓Tertiary treatment (new): 300 m^3/d
  - ✓Start-up: 2005
- Treatment technology
  - ✓Degrémont ULTRAFOR (Zenon submerged UF membranes ZeeWeed)
  - ✓Storage reservoir
  - ✓Chlorination

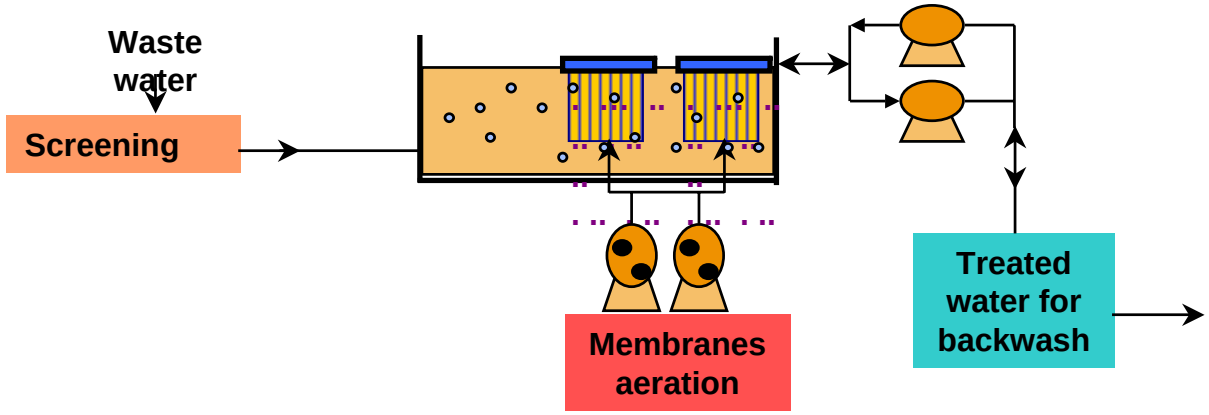

WWTP of Povai (Bora Bora)
UF Skid


MBR

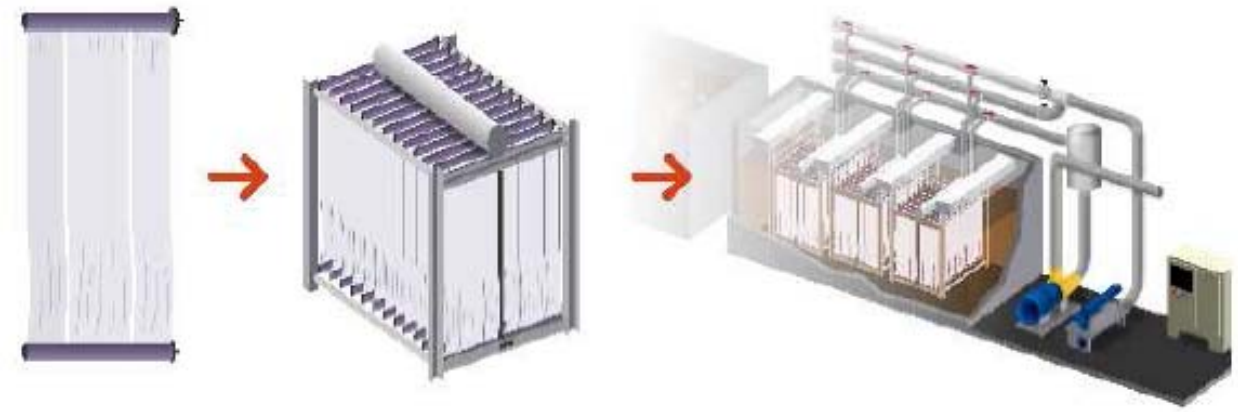

The MBR building

Principle of operation of tertiary submerged membranes

- Filtration / cleaning cycles based on the following scheme:

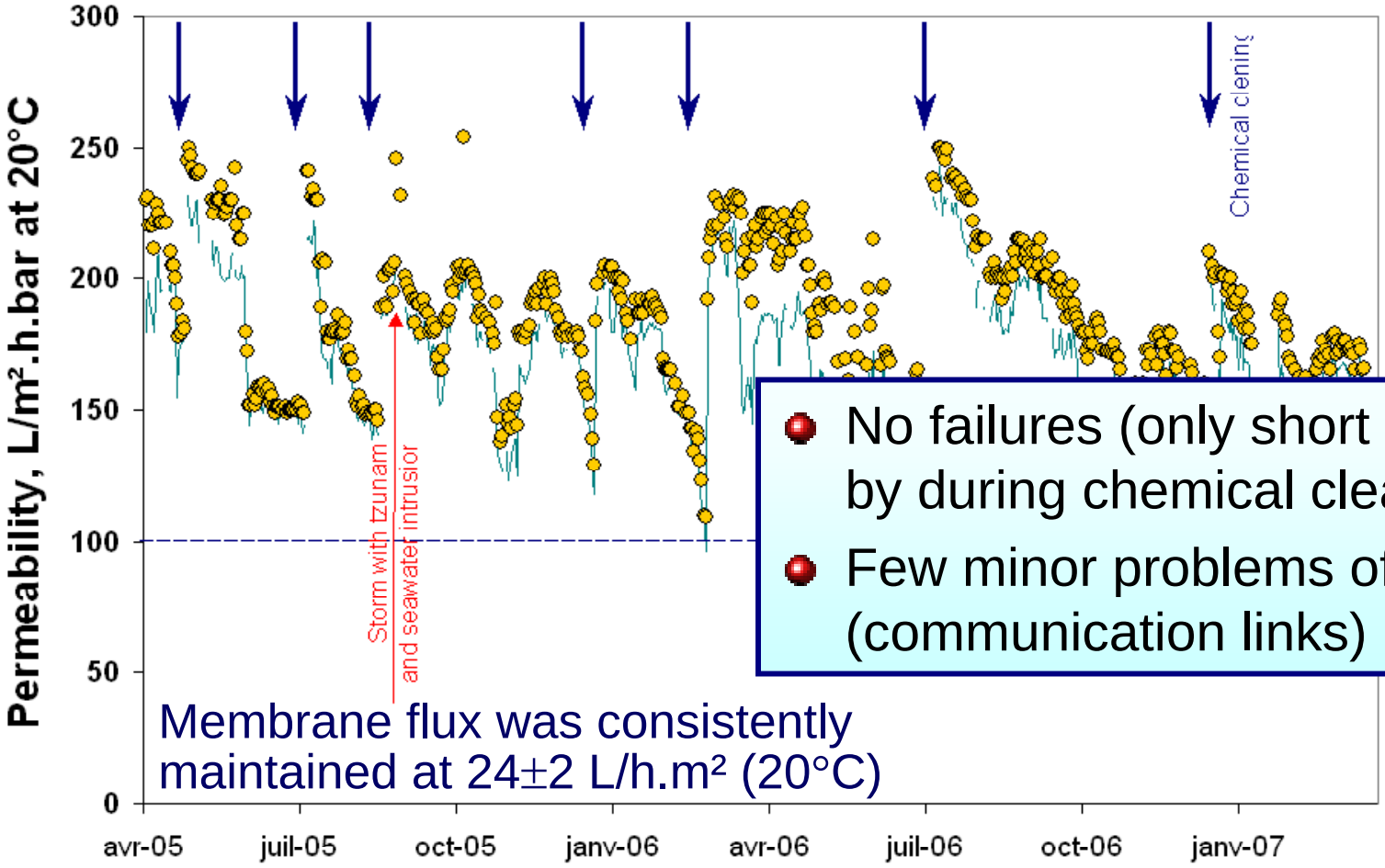


- Modularity: module ⇨ cassette ⇨ racks



Reliability of operation of tertiary membrane treatment

- **Higher** compared to conventional tertiary treatment



- No failures (only short stand-by during chemical cleaning)
- Few minor problems of PLC (communication links)

Recycled water end-users

- Luxury hotels, mostly landscape irrigation
- Boat and sea plane washing
- Washing of construction engines and pressure tests of concrete
- Fire protection

Cleaning

Non-potable uses

Concrete preparation

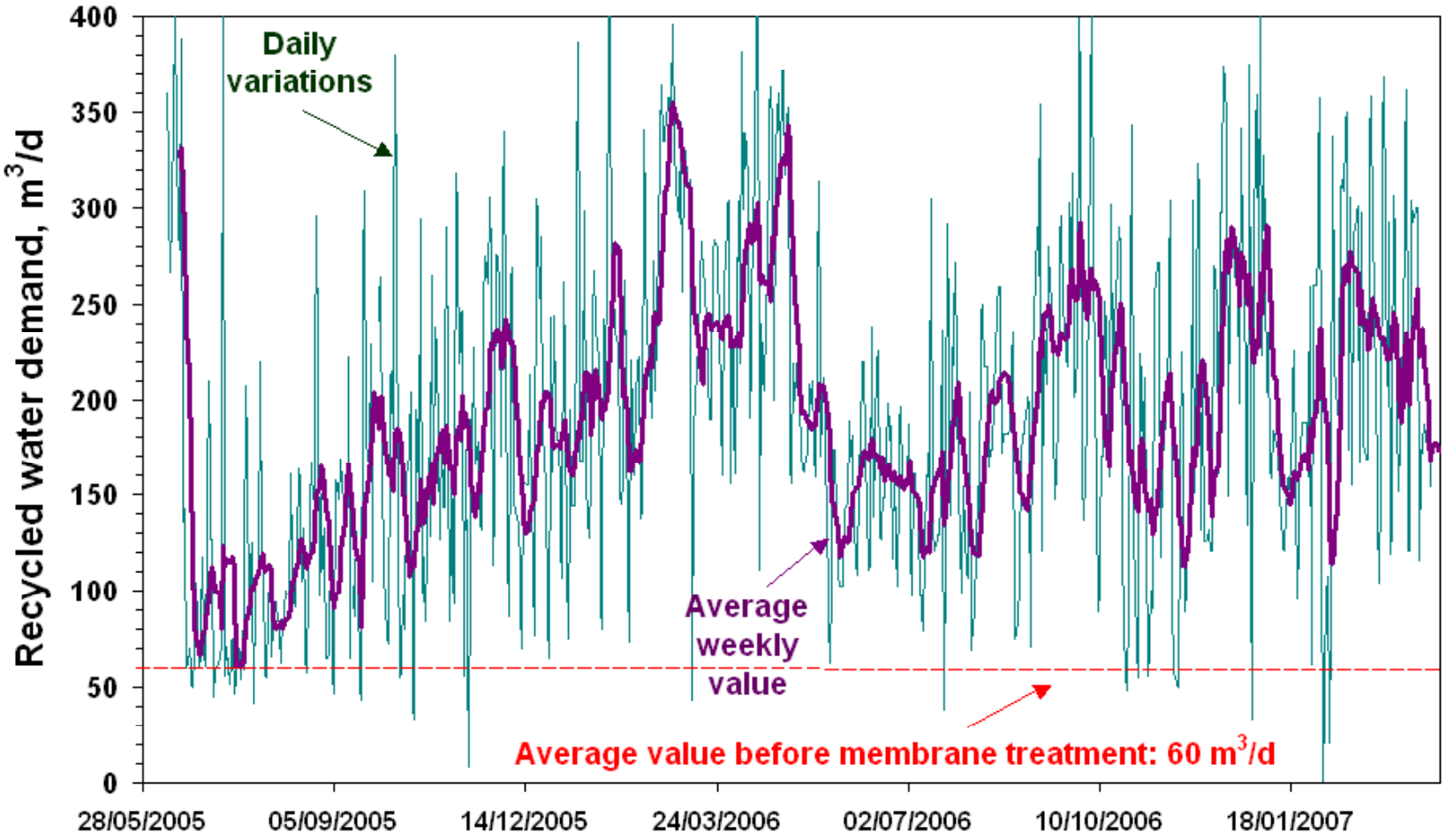
Water quality characteristics

*April 2005-May 2007

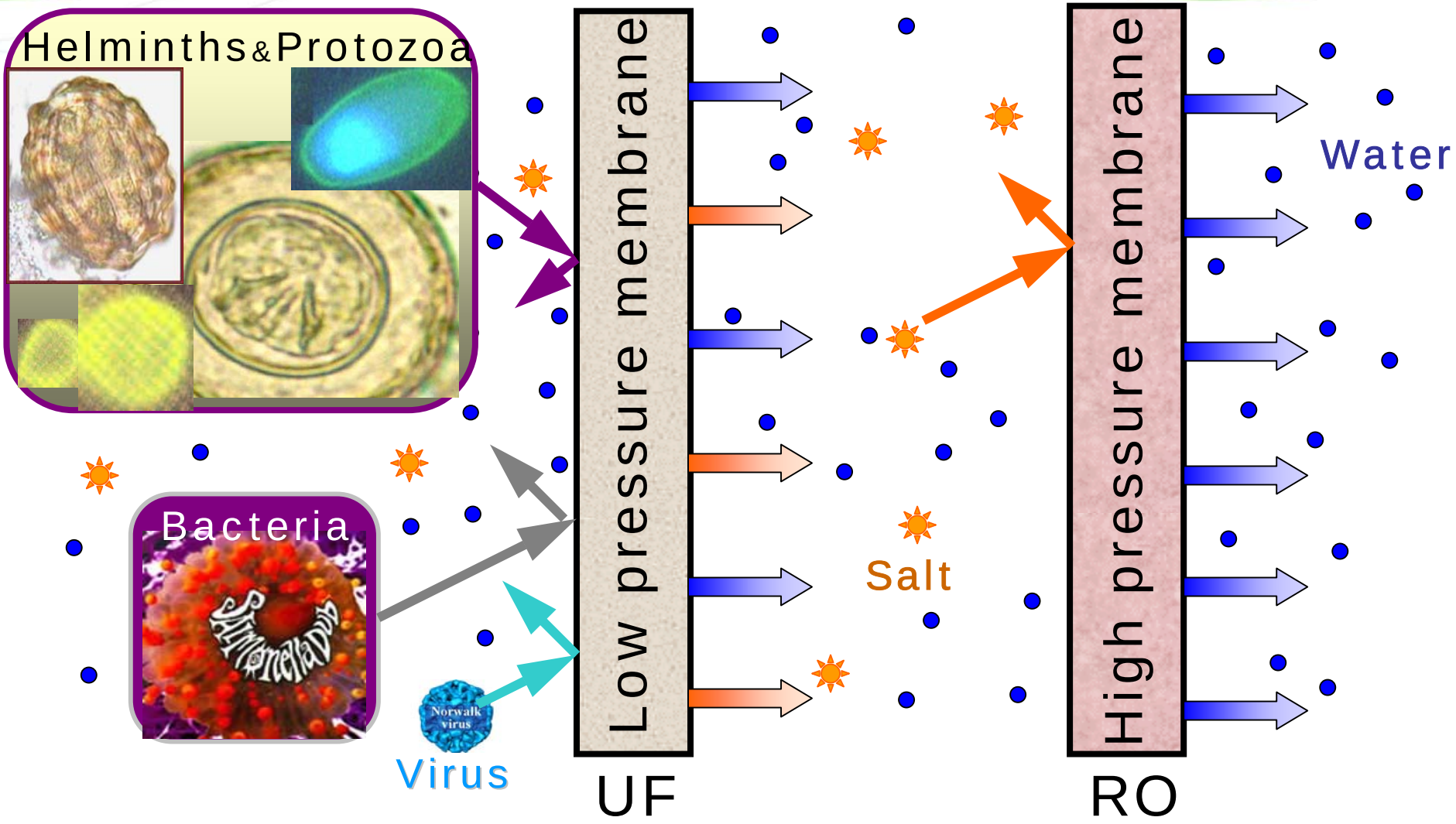
Parameter	Raw sewage	Secondary effluent		Recycled water (UF permeate)	
		Measured	Consent	Measured	Guide value
COD mg/L	595 (270-837)	31 (21-65)	90	15 (4-34)	40
BOD_5 mg/L	349 (200-540)	7 (<5-22)	25	4 (1-6)	20
TSS mg/L	238 (125-275)	9.5 (4-19)	35	< 5	20
N_{tot} mg/L	47 (30-70)	8.3 (2-18)	20	7.3 (2-17)	20
P_{tot} mg/L	6.8 (4.1-8.1)	2.5 (1.0-5.8)	-	1.9 (0.45-5.8)	-
E.coli /100 mL	ND	10^5-10^7	-	< detection limit	0/100 mL

*Average value and limit of variations
(32 composite samples, excluding *E.coli* that was monitored in grab samples)

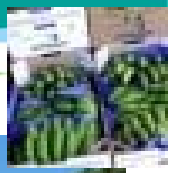
Evolution of the recycled water demand



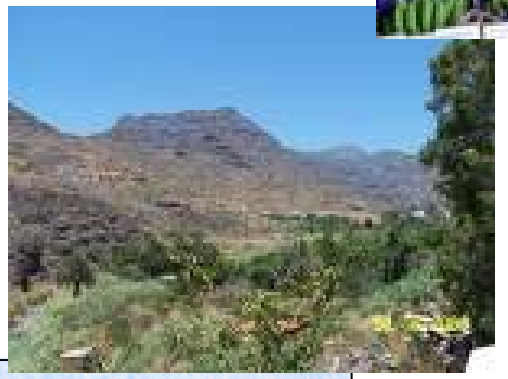
Membrane coupling

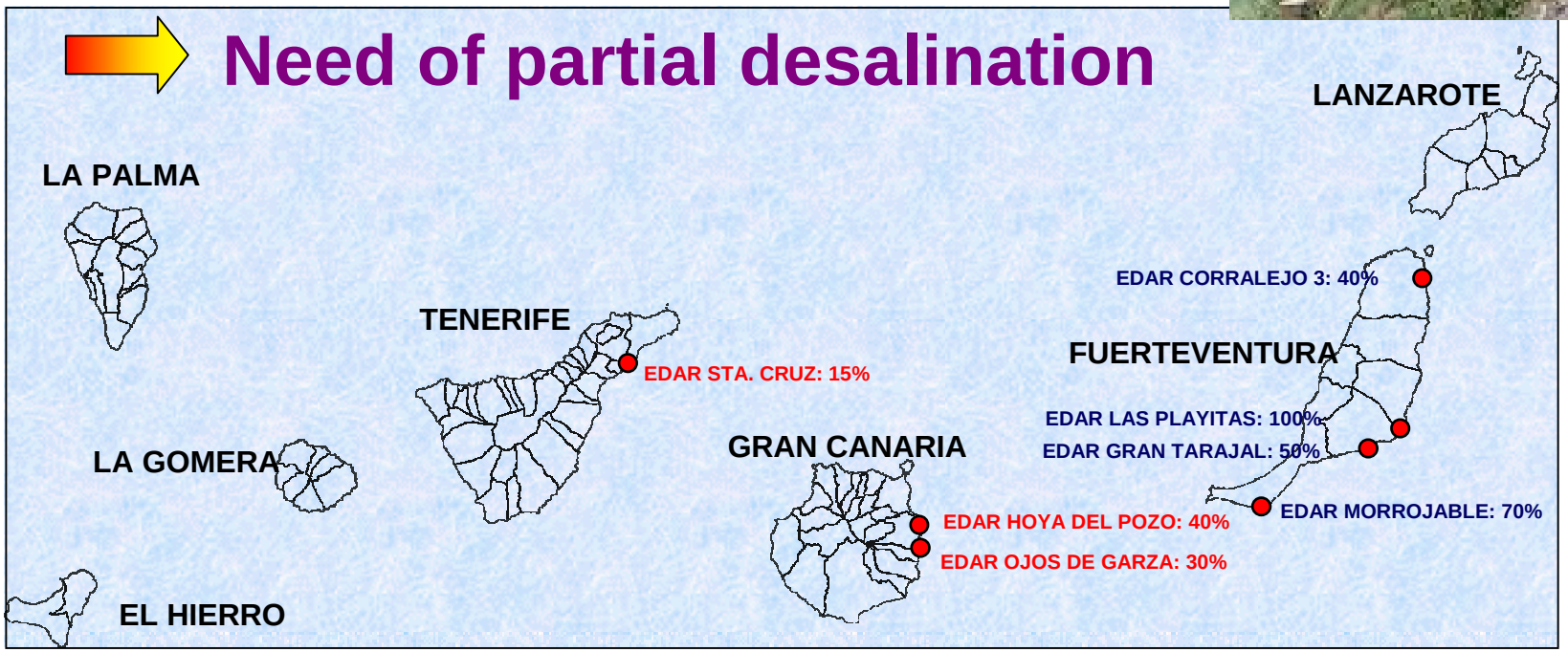


Irrigation of banana and landscapes, Canaria Islands, Spain



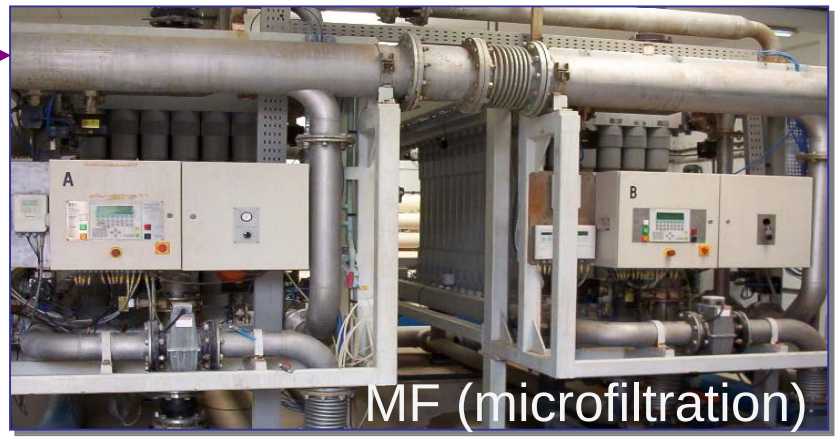
- Hoya del Pozo, Gran Canaria: 10,000 m^3/d (dual sand filtration + MF/RO)
- Santa Cruz de Tenerife: 46,000 m^3/d (sand filtration + electrodyalisis reversal)



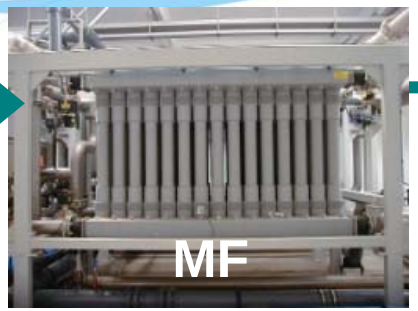


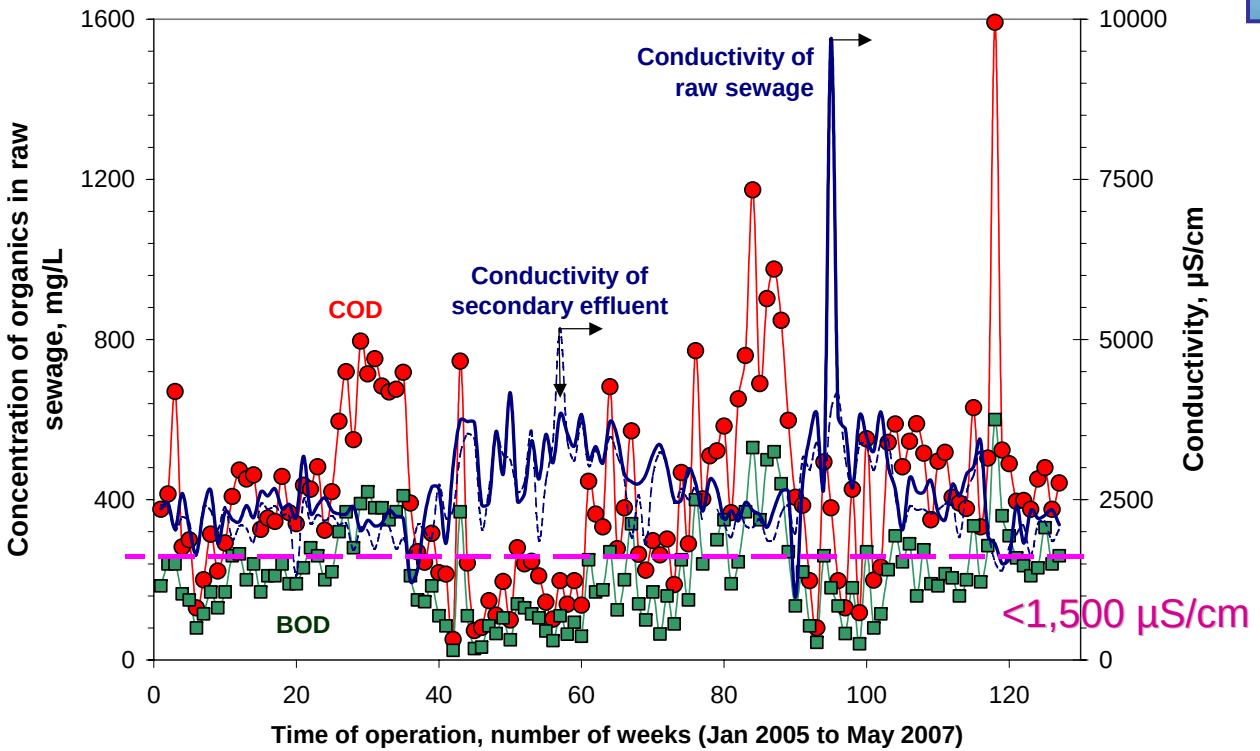
Irrigation of banana and landscapes, Canaria Islands, Spain

- Target salinity: below 400 μS/cm



Golf course of Calafell, Spain



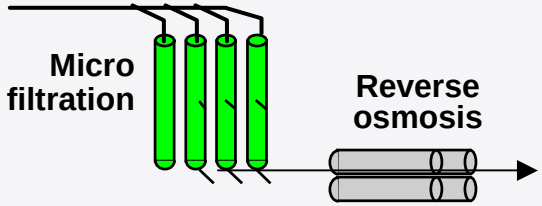


- Calafell Golf Course: 18 holes
- Target salinity <1500 µS/cm
- Capacity: 4,700 m^3/d
- Disinfection requirements: <200 *E.coli*/100 mL

West Basin Water Recycling Facility, CA

One of the largest recycling plants in the world

Since 1995
2006: 215,000 m^3/d
Final by 2010: 340,000 m^3/d

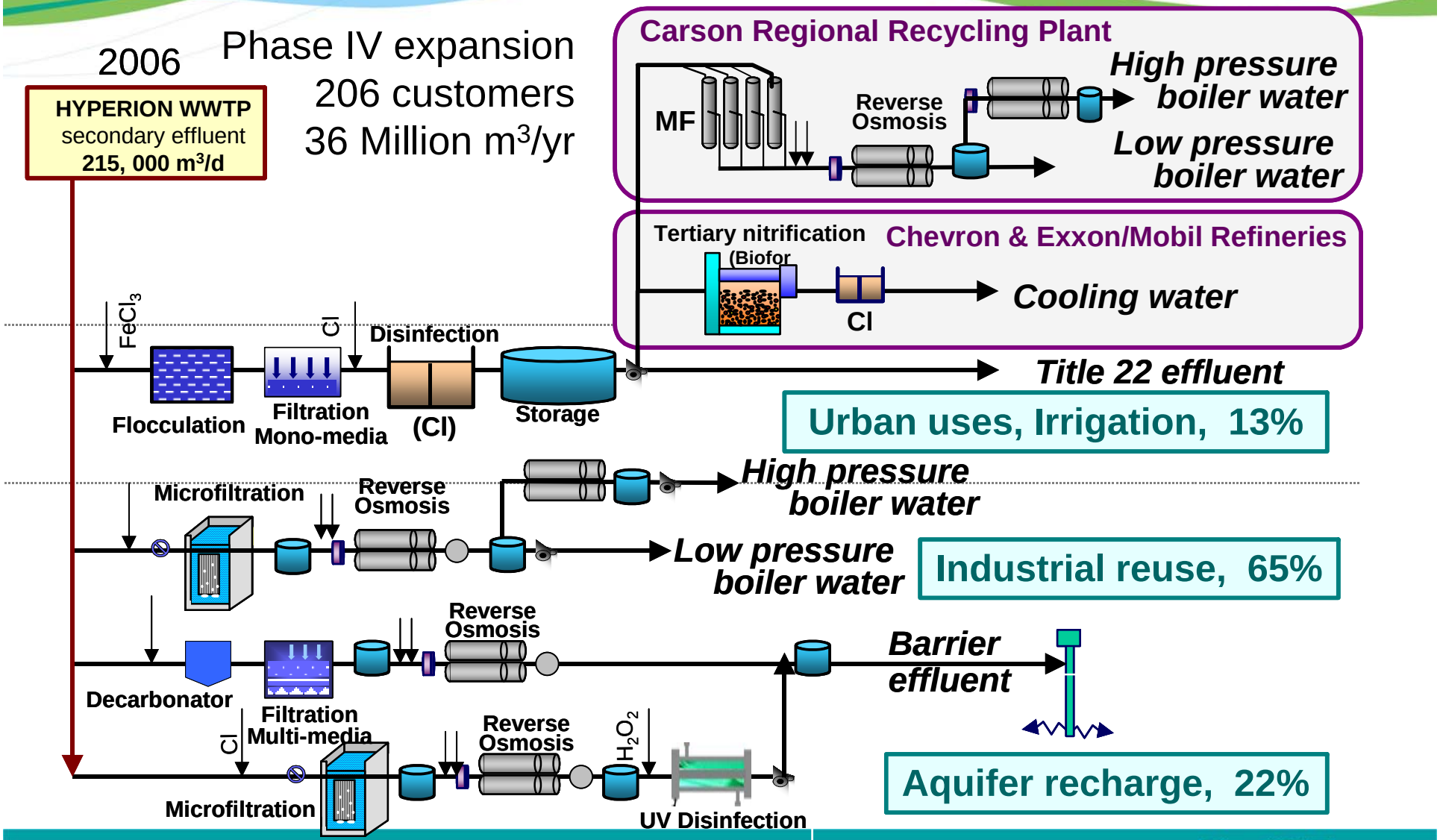


1997: the first MF/RO treatment

West Basin Water Recycling Facility
Key figures

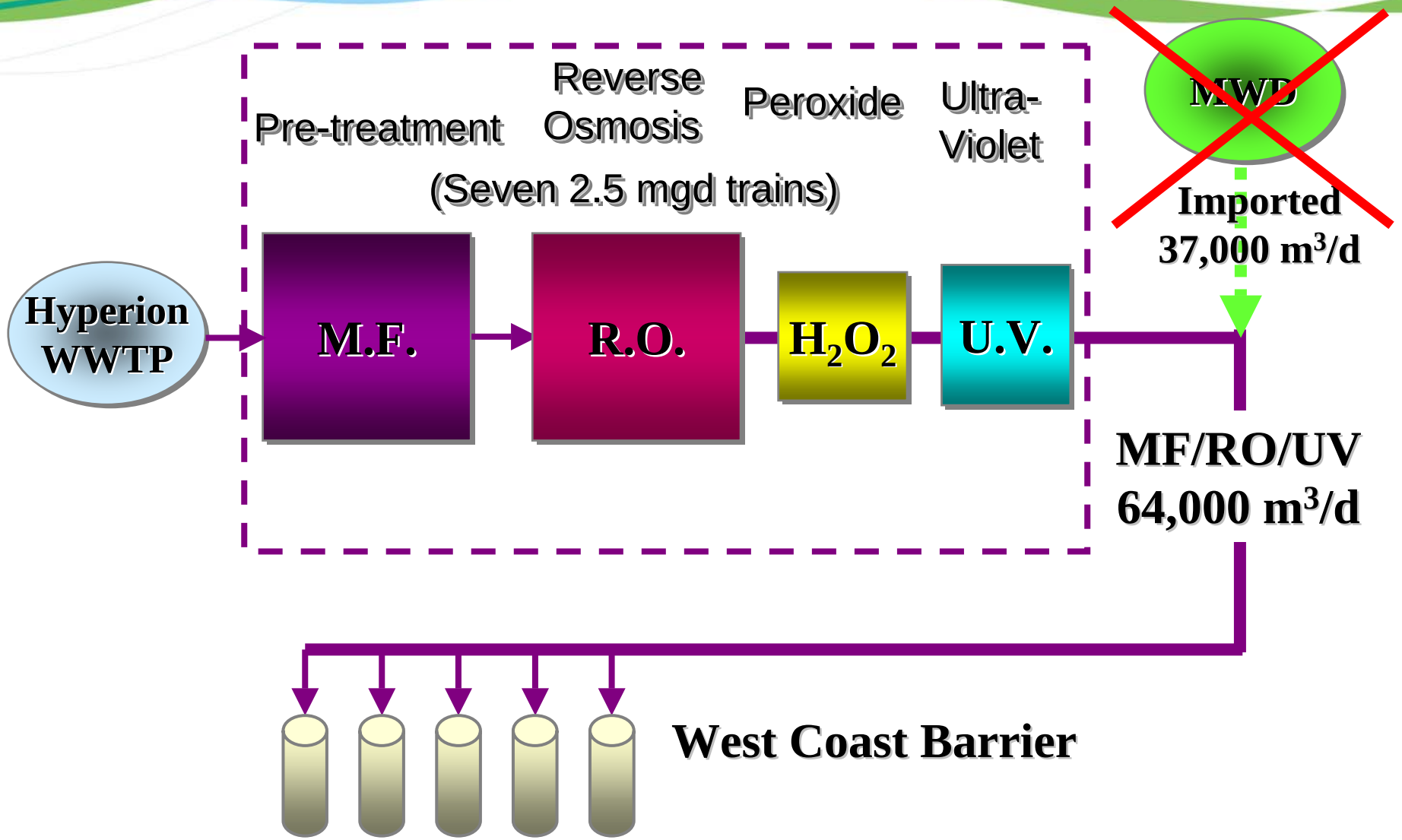
- **National Center** for Water Treatment Technologies
- Production of **5 types** of designer recycled water
  - Tertiary (T22): *Irrigation, industrial and urban uses*
  - Nitrified: *Cooling towers*
  - Softened RO (MF-RO-UV/H_2O_2/Lime): *Groundwater injection (salt intrusion barrier)*
  - Single RO (MF-RO): *Low-pressure boiler feed*
  - Double RO (MF-RO-RO): : *High-pressure boiler feed*
- Annual production of **36 Million m³**

West Basin Water Recycling Facility
Treatment Trains and Satellite Plants



West Basin Water Recycling Facility

Barrier Water Treatment Train



West Basin Water Recycling Facility
Submerged microfiltration membranes (Memcor)

- Memcor submerged membranes 0.1 µm

West Basin Water Recycling Facility
Reverse osmosis and UV disinfection


New RO train


Trojan UV disinfection

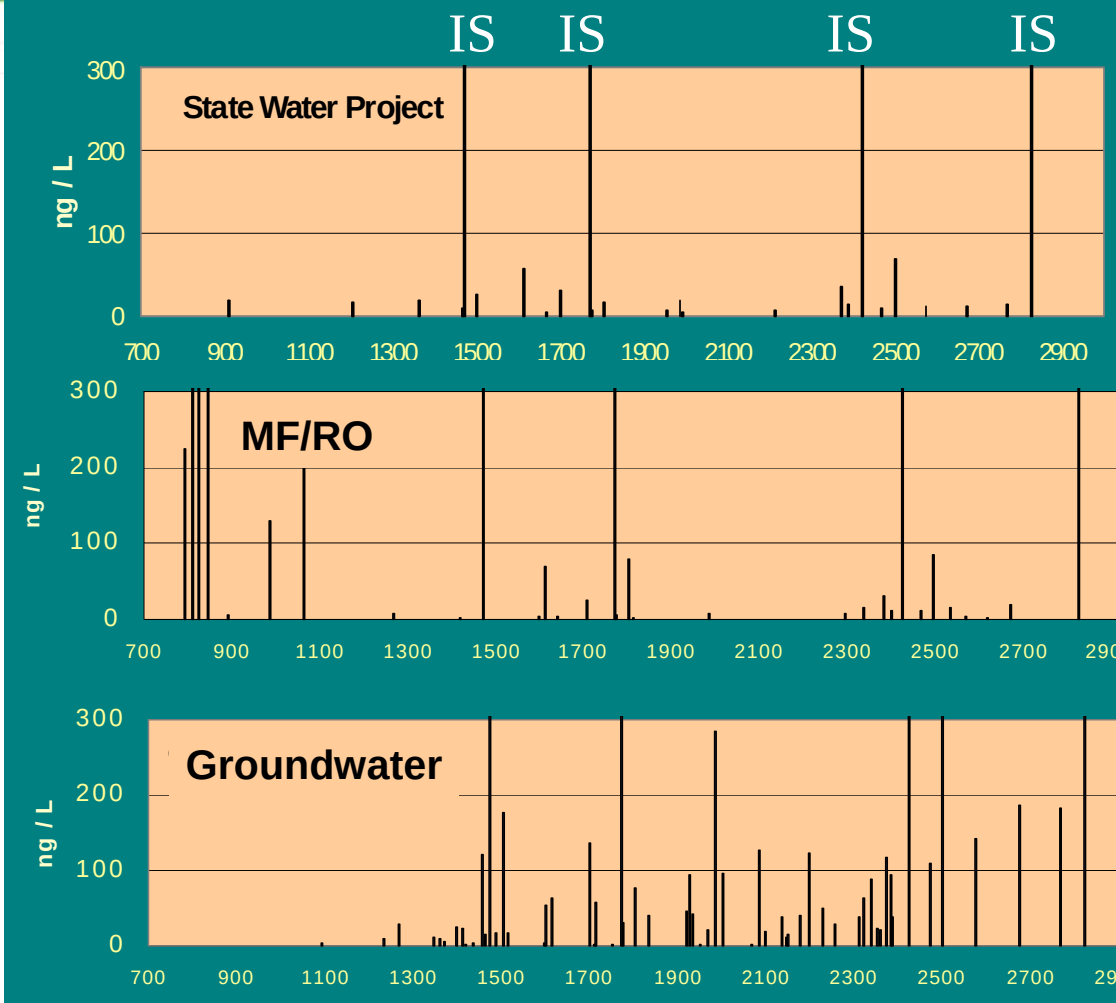
- Capacity 64,000 m^3/d
- RO membranes: Hydranautics
- Reverse osmosis recovery 85%

West Basin Water Recycling Facility
Removal of micropollutants

Constituent	Detection Limit	Title 22 Water		Barrier Water	
INORGANICS (mg/L)	***mg/L***	**MCL**	**Range**	**MCL**	**Range**
Nickel	*0.01*	0.02	0.02-17.4	ND	ND
Mercury	*0.001*	0	ND-0.24	ND	ND
Cadmium	*0.001*	0	ND-0.24	ND	ND
VOLATILE ORGANICS (µg/L)	***µg/L***	**MCL***	**Range**	**MCL**	**Range**
Chloroform	*0.2/0.5*	-	0.2-12	*100*	ND-1.1
Dibromochloromethane	*0.3/0.5*	-	0.3-3.0	*100*	ND-0.6
Bromodichloromethane	*0.3/0.5*	-	0.3-3.2	*100*	ND-0.6
Methylene chloride	*1.0/0.5*	-	2.4-3.5	*5*	ND-0.9
1,2,4 – Triichlorobenzene	*0.2/0.5*	-	0.2-2.2	*5*	ND
Tetrachloroethylene	*0.3/0.5*	-	0.8-4.8	*5*	ND
Bis (2 – Ethylhexyl) phthalate	*0.4/3.0*	-	0.4-3.0	*4*	ND-0.5
Diethyl phtalate	*0.2/5*	-	ND	-	ND
Phenol	*1*	-	0.0-1.0	-	ND
Pentachlorophenol	*0.2/1*	-	ND	*1*	ND
2,4,6 Trichlorophenol	*1/10*	-	ND	-	ND
Halomethanes	*0.2/0.5*	-	8.8-15.2	*100*	ND-2.4
Naphtalene	*0.2/0.5*	-	ND	-	ND
N-Nitrosodiphenylamine	*1/5*	*5*	ND	-	ND

ND – not detected above the detection limit, MCL – maximum contaminant level
*MCL for Title 22 – reporting limit 0.5 µg/L

West Basin Water Recycling Facility
Removal of micropollutants



Indirect Potable Reuse

Surface water
Presence in **low concentrations** of high MW compounds

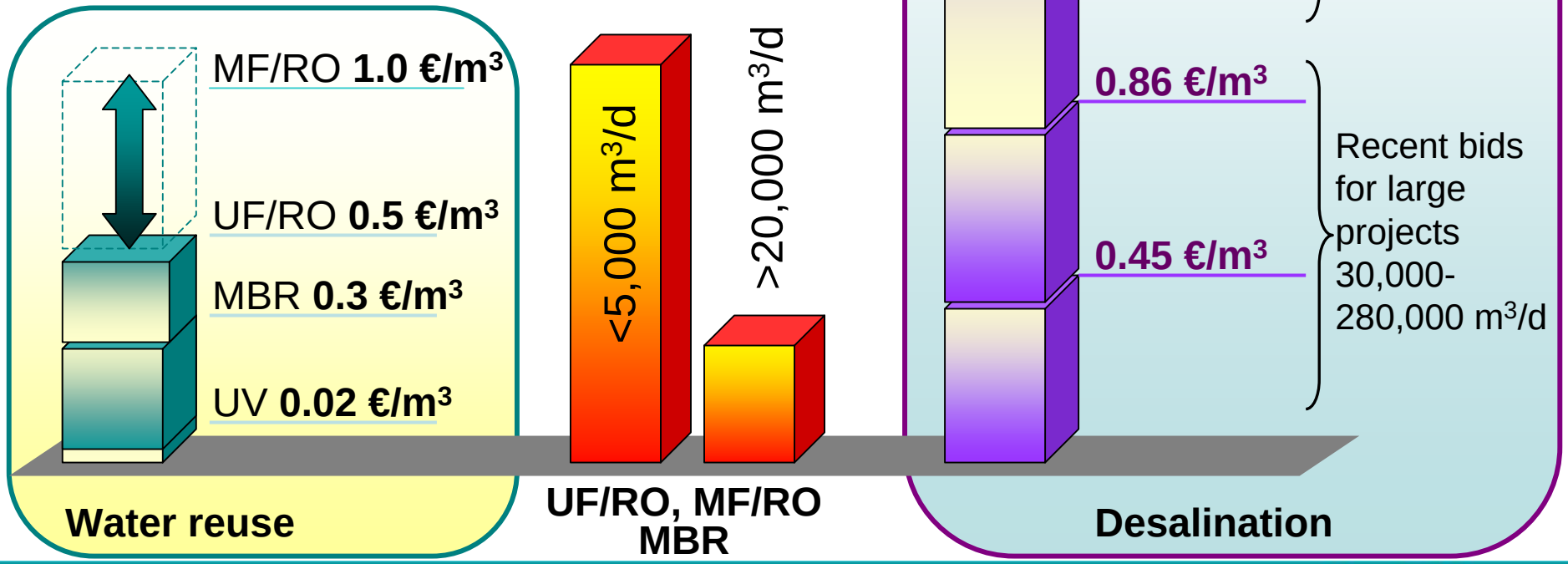
Presence of **drinking water disinfection by-products**
TOC<0.7 mg/L

Groundwater
Possible **non-point source pollution**

CONCLUSIONS
Costs of water recycling

Typical water reuse costs

Predominantly small and medium size projects <5,000-40,000 m^3/d



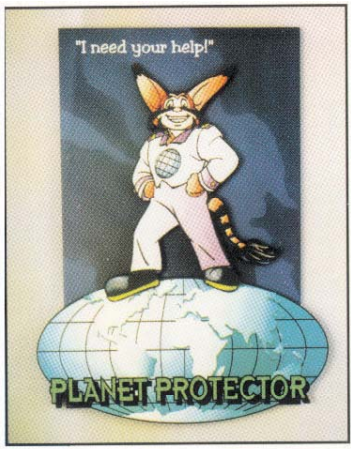
CONCLUSIONS
Benefits of water recycling

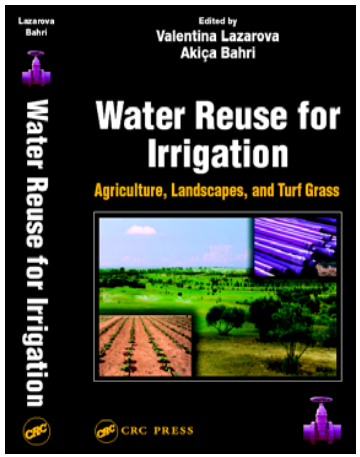
- **Alternative resource**
  - ⇨ Reliable, secure and drought-proof water source
  - ⇨ Fast and easier implementation than new freshwater supply (high value for Islands)
- **Water conservation**
  - ⇨ Saving of high quality freshwater water for potable water supply (high value in tourist areas)
- **Environmental value**
  - ⇨ Reduced pollutant discharge (beaches, lagoons)
- **Economic value**
  - ⇨ Avoided costs for new freshwater resources development, transfer and pumping (water transfer, new desalination plants, etc.)
  - ⇨ Secondary economic benefits for customers and industries
    - ✓ for example in 2005 in Bora Bora, 2-3 M€ saving for construction companies and hotels thanks to the supply of recycled water

CONCLUSIONS

The keys of success of water recycling

- **Strong support** by local authorities and end-users with recognition of water reuse benefits
- **Careful design** and **good operation** for reliable production of high-quality recycled water
- **Technical know-how** and R&D support
- **Communication** and **public education**





Maurururu !