NATIONAL WORKSHOP ON DESALINATION AND RE-USE OF TREATED WATER

AREAS OF APPLICATION

R. MANGANO, NAPOLI, 24TH JUNE 2024

ITALY WATER EMERGENCY

WATER EMERGENCY

- **Climate change:** Rising temperatures and changing weather patterns have led to prolonged droughts and reduced water availability.
- **Poor management of water resources:** high consumption rates exacerbate the problem.
- **Inefficient use of water** in agriculture, industry etc leads to unnecessary wastage.
- **Water loss** within the water distribution network - Aging infrastructure and lack of maintenance result in significant water leakage.
- **Low reuse of water** – (4% in Italy) - Instead of recycling and reusing wastewater, it is often discarded, leading to a greater demand for fresh water.

Action required

- **Raising awareness** is crucial - more responsible water use.
- Rain water **collection.**
- **Infrastructure** renewal.
- Diversifying water sources – water generation with **Desalination** technologies.

DESALINATION APPLICATION

DESALINATION APPLICATION

Potable Water generation:

Island – Arid area – low availability of fresh water.

Industrial use:

Oil refinery / chemical plant / power plant: the industry requires big quantity of water for industrial use.

Process and service water: high quality standard is required.

Agriculture and irrigation:

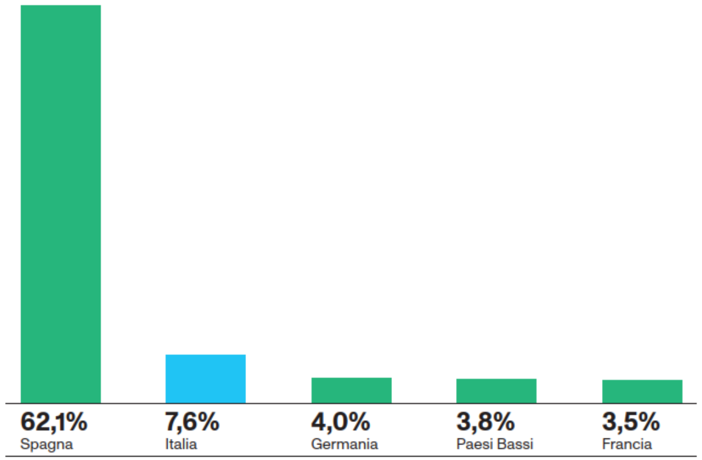
Greenhouse and farming: require fresh water.

Tourism:

Resort, Hotel, Cruise and military ships: the hotel and cruises require potable water for the guest and the crew.

Emergency and critical situation:

Natural disaster and temporary camp: it is required fresh water due to the temporary absence of network and infrastructure.



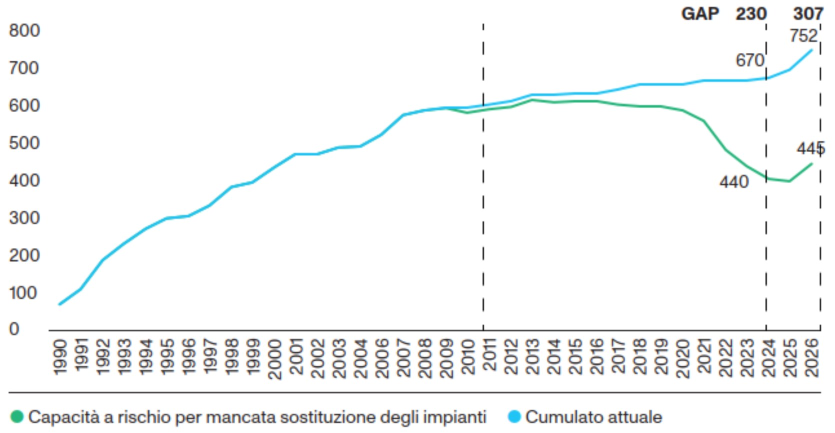
Source: Elaborazione The European House – Ambrosetti su dati Commissione Europea e GWI, 2024

DESALINATION APPLICATION

CONSULTING ENGINEERS

DESALINATION AS SUSTAINABLE SOLUTION

- By products reduction/recovery
- Brine management
- Coupling with Renewable Energy
- **Energy efficiency**
  - Reducing the footprint / maximizing the production
  - Engineering otpimization



Elaborazione The European House – Ambrosetti su dati Global Water Intelligence, Autorità Idrica Toscana e Acquedotto Pugliese, 2024

"…….a plant with maximum specific water production, minimum energy consumption at low CAPEX and OPEX …."

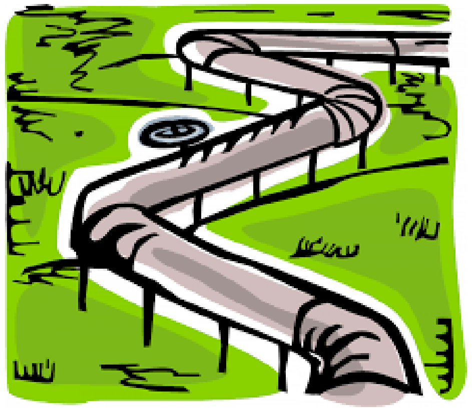
"…possible saving of 1GW/day."

DESALINATION APPLICATION

SUSTAINABLE DESALINATION APPLICATION

The typical parameters considered at the preliminary stages of the development of a SWRO Plant can be summarized by the following:

- Seawater quality knowledge
- Site identification and Land availability
- Readiness of potable water infrastructures and power availability
- Equipment selection
- Environmental and social viability

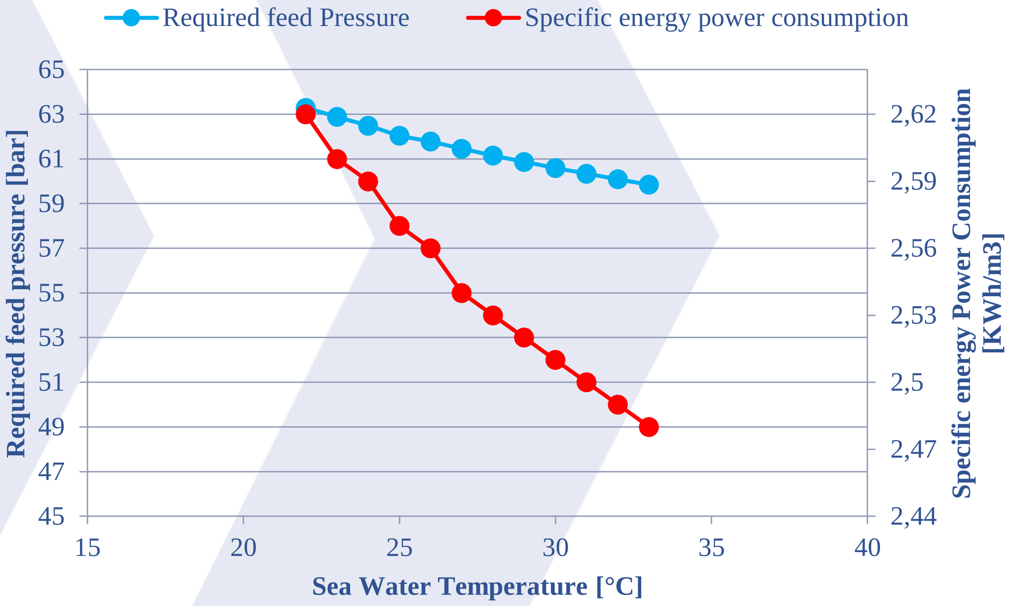


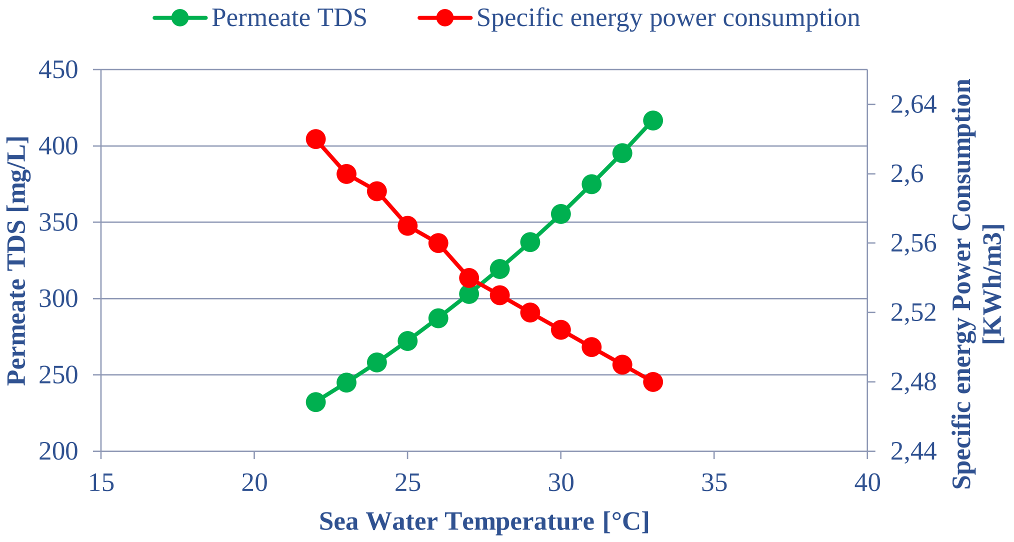
SUSTAINABLE DESALINATION APPLICATION – 3 CASE STUDY

1. Seawater quality and intake location
2. Footprint – multiple level building – UF configuration
3. RO section optimization

SUSTAINABLE DESALINATION

SEAWATER QUALITY AND INTAKE LOCATION – ROLE OF THE TEMPERATURE

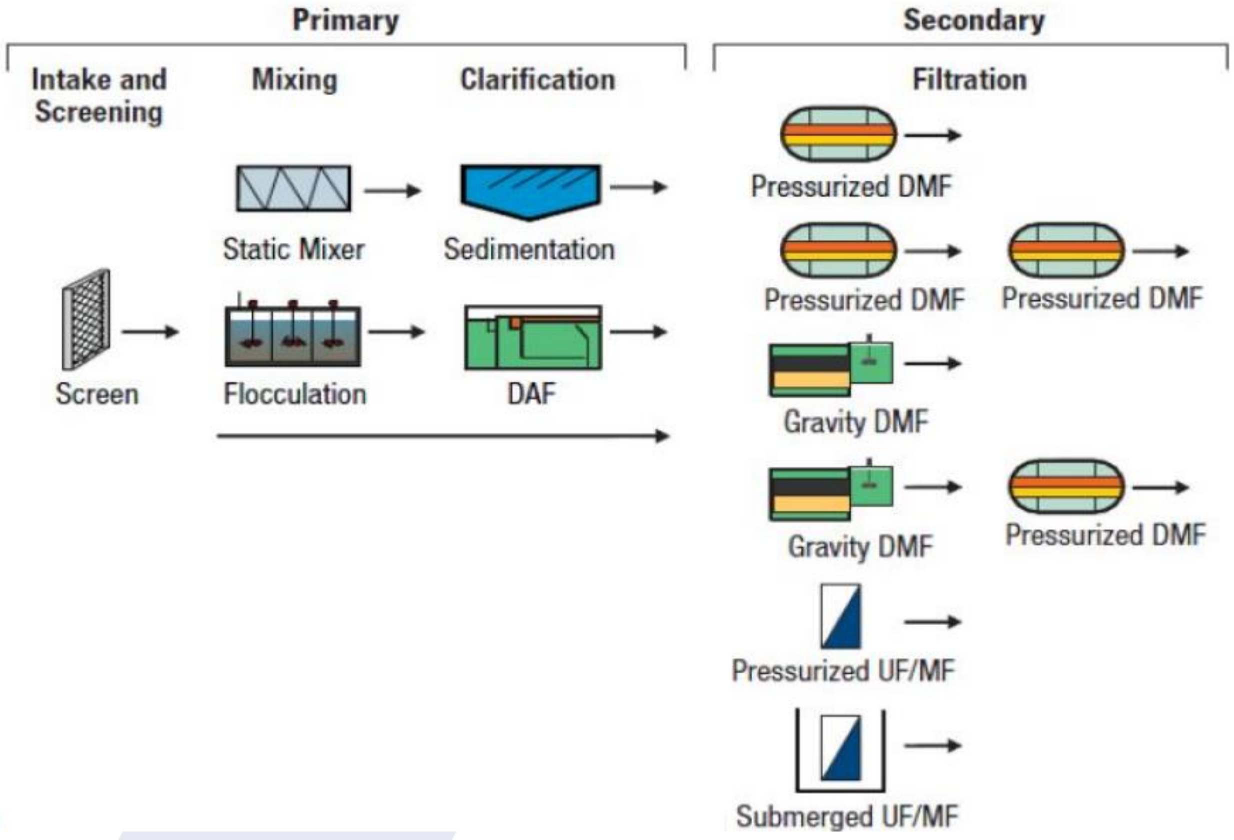




Optimization of the RO system – size of the RO racks and distribution of 1st RO pass and 2nd RO pass system.

SUSTAINABLE DESALINATION

SEAWATER QUALITY AND INTAKE LOCATION – ROLE OF THE PRETREATMENT

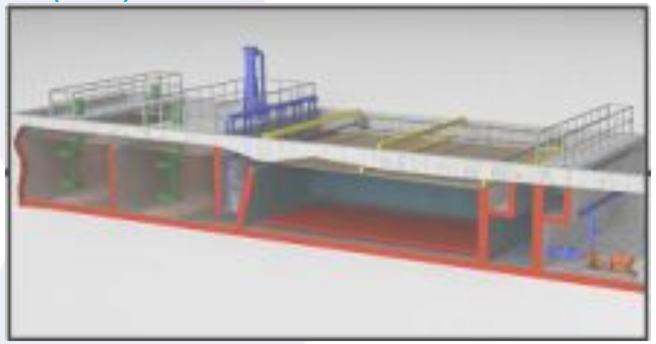


Parameters				
Type	DAF+DMF	DAF+UF	DMF	UF
Recovery (%)	96.00	93.00	98.00	95
Ability to treat high water TSS (≥30 ppm)	**Yes**	**Yes**	**Yes – in-crease in Backwash frequency**	**Yes – in-crease in CEB and CIP frequency**
Availability during Red Tide	**Yes**	**Yes**	**No**	**No**
Sludge Treatment	**Required – dedicated treatment for the DAF sludge**	**Required – dedicated treatment for the DAF sludge**	**Required**	**Required**

SUSTAINABLE DESALINATION

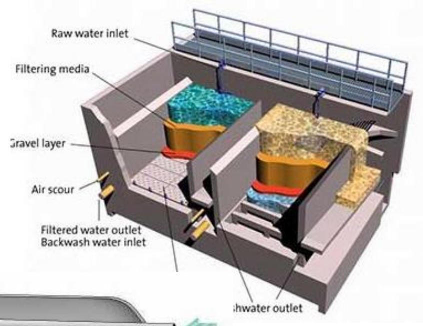
SEAWATER QUALITY AND INTAKE LOCATION – ROLE OF THE PRETREATMENT

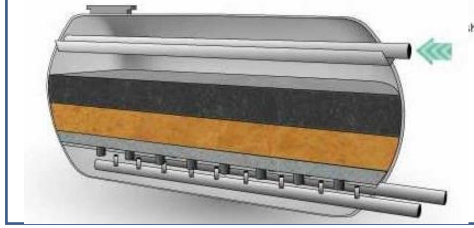
Dissolved Air Floatation (DAF)



UltraFiltration (UF)

Dual Media Filter (DMF) (gravity/pressurized)





Technology	Total Suspended Solids (TSS) removal capability		Algae removal capability		Hydrocarbon removal capability
DAF	+	only organic TSS	++		++
DMF	+++	up to 50 ppm - 80% reduction	+	Reduction in production	-
UF	++	up to 12 -15 ppm	+	Reduction in production	-

SUSTAINABLE DESALINATION

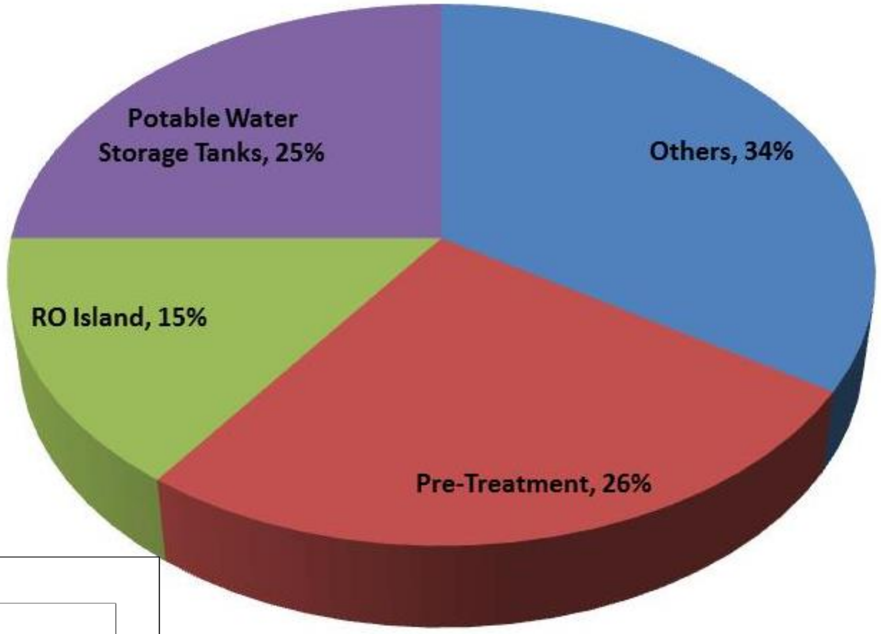
FOOTPRINT ANALYSIS – MULTIPLE LEVEL BUILDING

The area and land requirement of SWRO desalination plant depends on:

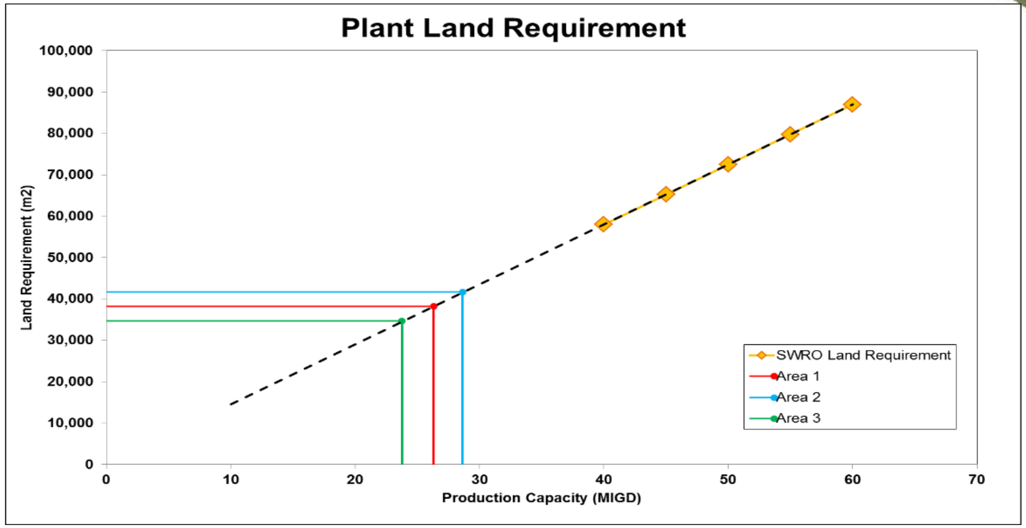
- SWRO capacity
- Seawater and Product water quality

Three major systems having high footprint requirements

- Pre-treatment
- RO island
- Potable water storage tanks



Production Capacity (MIGD)	SWRO Land Requirement (m^2)
40	58,000
45	65,250
50	72,500



SUSTAINABLE DESALINATION

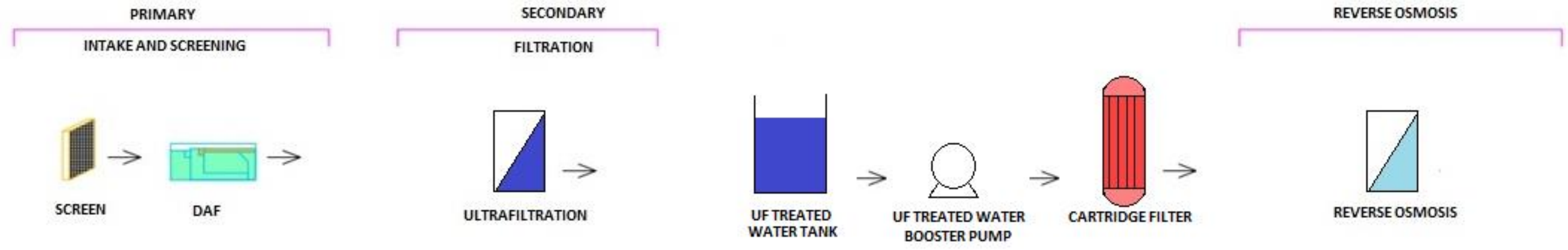
CONSULTING ENGINEERS

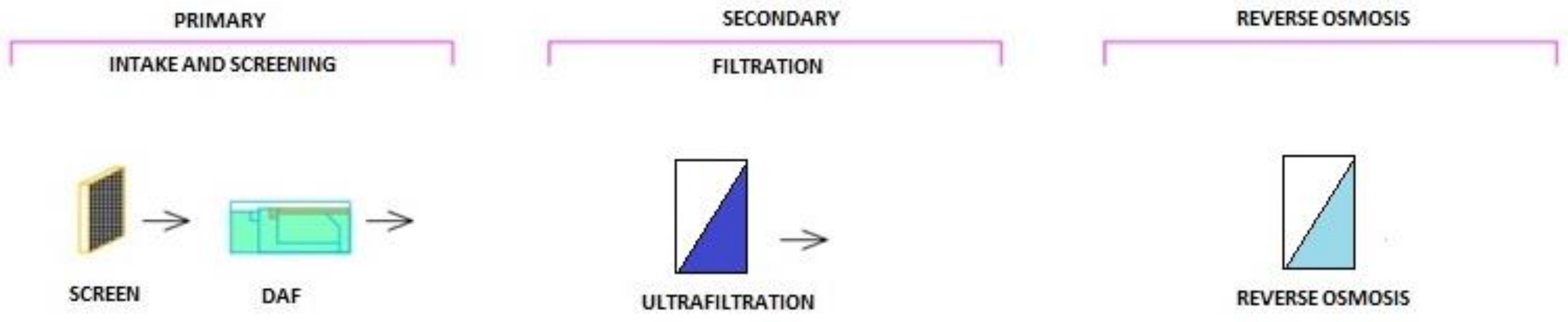
FOOTPRINT ANALYSIS – MULTIPLE LEVEL BUILDING

- Expansion of the plant vertically
- Common in power generation industry
- Few cases in SWRO application
- Difficult O&M concept

SUSTAINABLE DESALINATION

FOOTPRINT ANALYSIS – UF CONFIGURATION

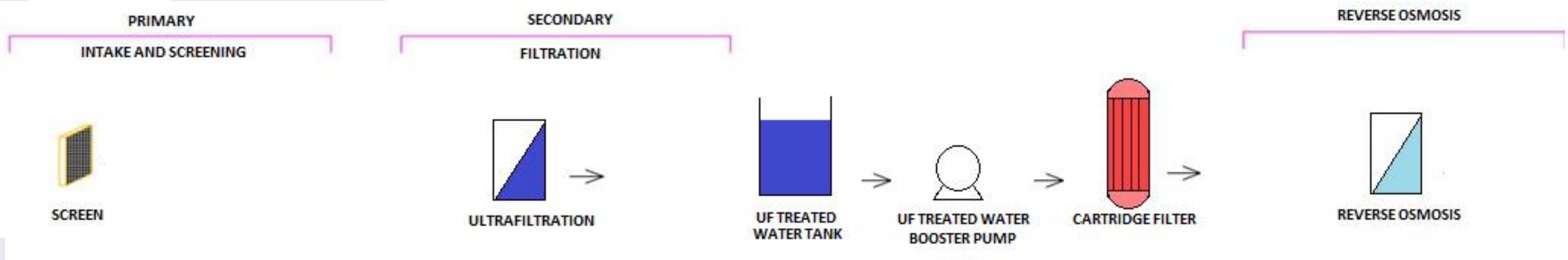




SUSTAINABLE DESALINATION

CONSULTING ENGINEERS

FOOTPRINT ANALYSIS – UF CONFIGURATION



Advantages:

- Quality of UF permeate is high
- Easy to feed the RO

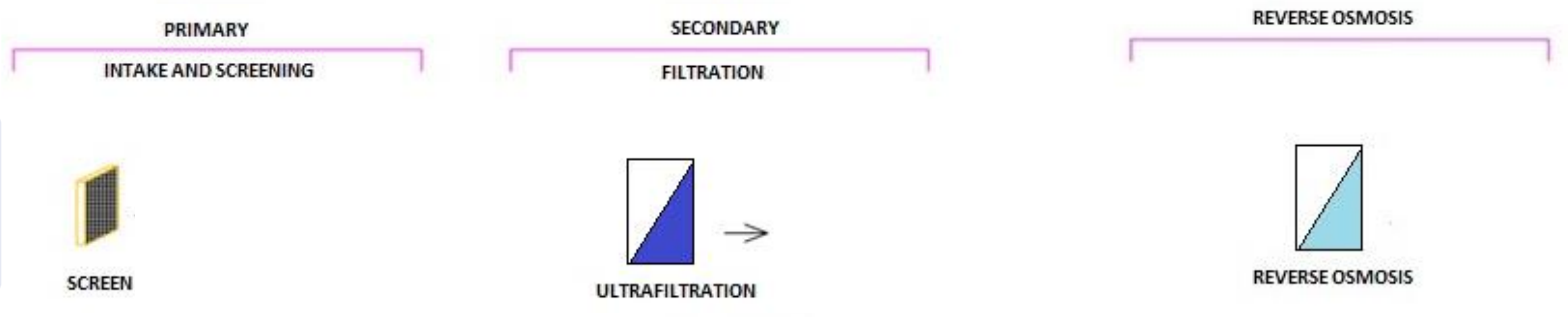
Disadvantages:

- Contamination in the Treated water tank
- Need of Cartridge filter required before RO
- Break of the UF residual pressure
- Relatively high foot print (tank capacity)
- UF design for peak flux

SUSTAINABLE DESALINATION

CONSULTING ENGINEERS

FOOTPRINT ANALYSIS – UF CONFIGURATION



How to overcome ?

Removal of Tank

Install In Line UF

Advantages

- No microbiological contamination
- No Cartridge Filter and Booster Pump
- Lower footprint and Lower energy consumption

Disadvantages

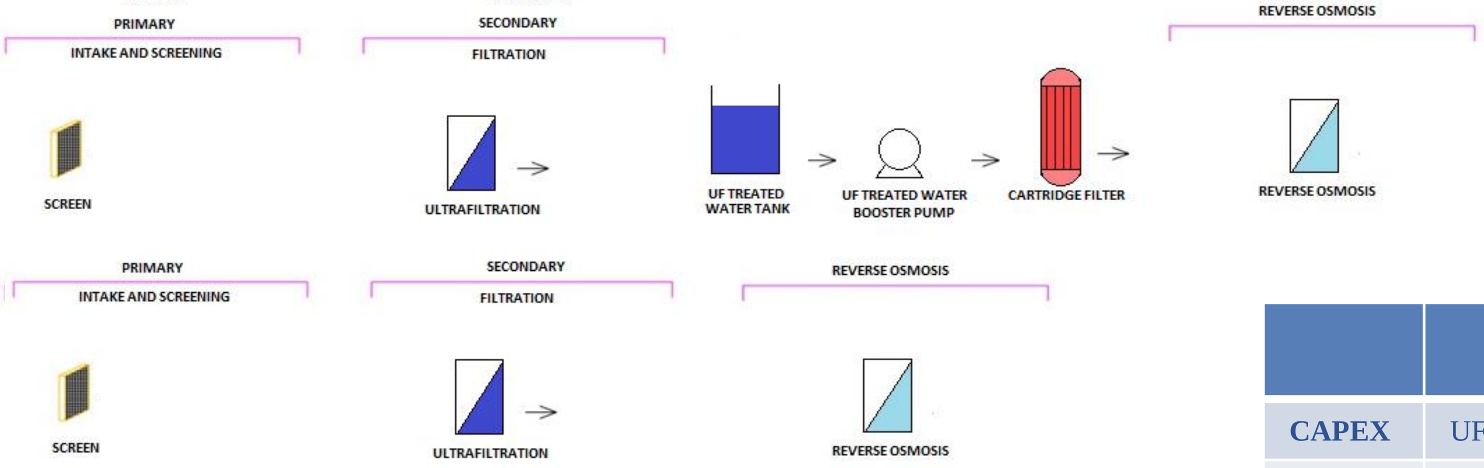
- Installation of dedicated backwash tank – overdesign of the UF

Challenges:

- Maintain constant RO production during UF backwash and cleaning
- UF shall operate at higher pressure: ΔP across the membrane + NPSH

SUSTAINABLE DESALINATION

FOOTPRINT ANALYSIS – UF CONFIGURATION



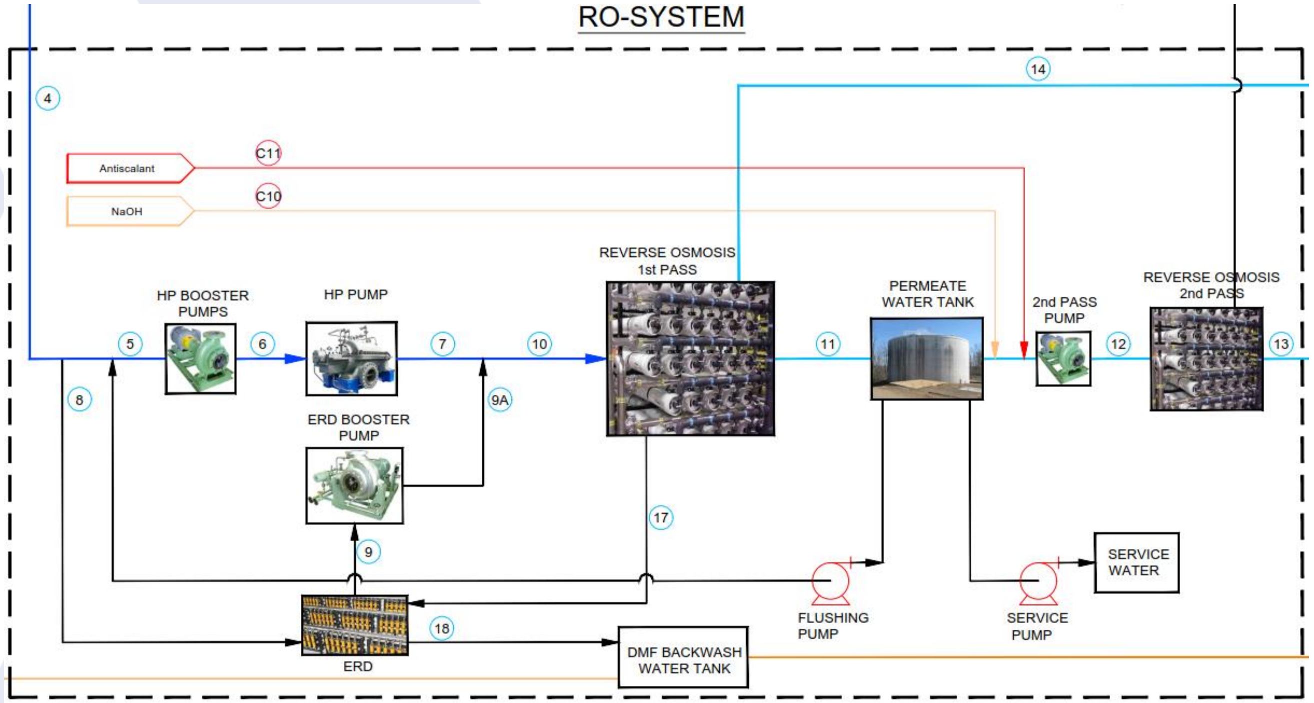
Parameters	UF	IN LINE UF
Recovery (%)	95	95
Chlorine Tolerance	Very Good	Very Good
Guaranteed Filtrate quality - SDI 95% of time	<3	<3
Guaranteed Filtrate quality - SDI 100% of time	<4	<4
UF treated water break tank	Required	Not required
UF treated water Booster Pump	Required	Not required
Cartridge Filter before SWRO feed	Required	Not required

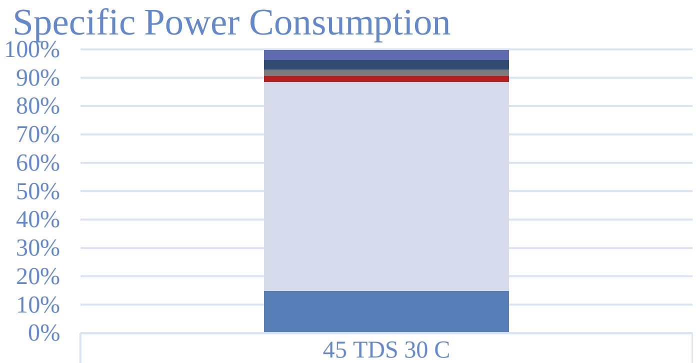
		UF	IN LINE UF
CAPEX	UF Treated water tank	↑	↓
	UF treated water Booster Pump	↑	↓
	UF feed Pump	↓	↑
	Cartridge Filter	↑	↓
	Dedicated BW tank	↓	↑
	Footprint	↑	↓
OPEX	UF treated water Booster Pump	↑	↓
	UF feed Pump	↓	↑
	Cartridge Filter	↑	↓
	RO CIP frequency	↑	↓

SUSTAINABLE DESALINATION

CONSULTING ENGINEERS

RO SECTION OPTIMIZATION





	45 TDS 30 C
Others	4%
HVAC and lightening	3%
PW Pumps	2%
Post-Treatment	2%
RO system	74%
Intake and Pre-Treatment	15%

SUSTAINABLE DESALINATION

ILF CONSULTING ENGINEERS

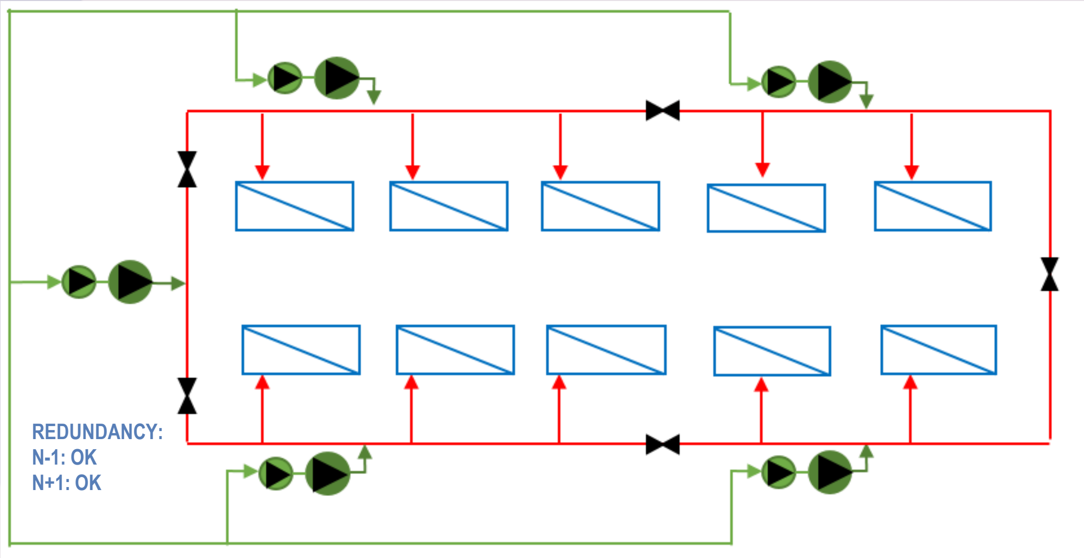
RO SECTION OPTIMIZATION - RO FEED PUMPS MAIN POSSIBLE CONFIGURATION

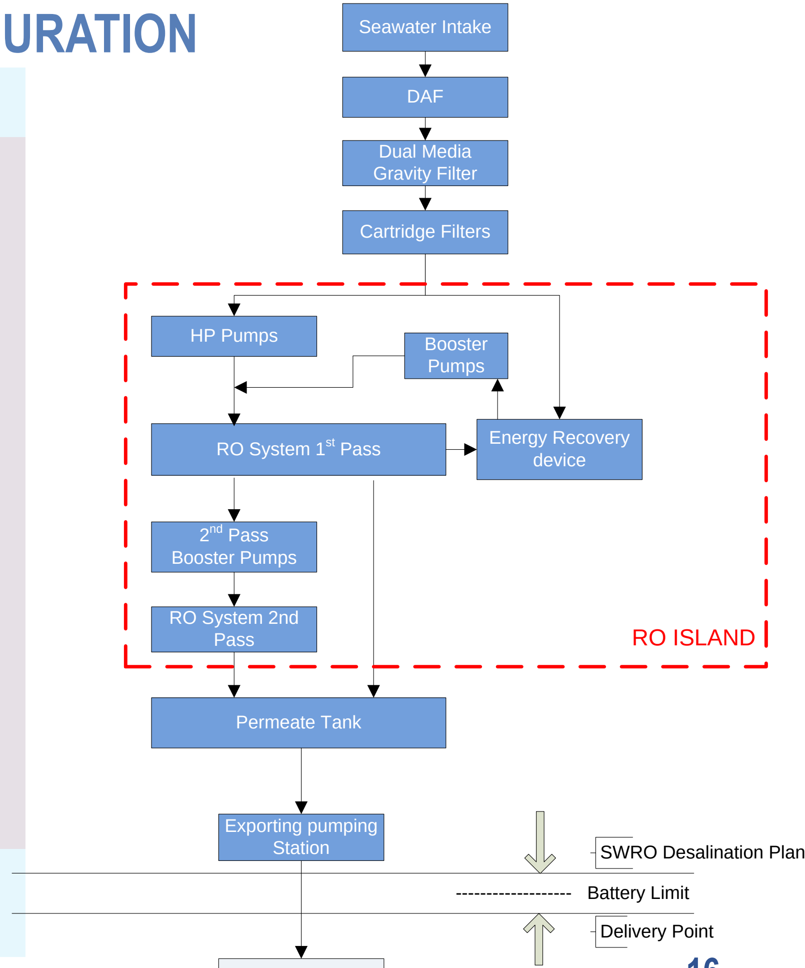
Pressure Center (**ring**)

AVAILABILITY RISK:
PIPE: 10-20%
PUMPS: 0%

Pumps: **same size**

EFFICIENCY
MAXIMUM CAPACITY: HIGHEST
MIDDLE CAPACITY: MEDIUM
LOW CAPACITY: LOW





SUSTAINABLE DESALINATION

ILF CONSULTING ENGINEERS

RO SECTION OPTIMIZATION - RO FEED PUMPS MAIN POSSIBLE CONFIGURATION

Pressure Center (**ring**)

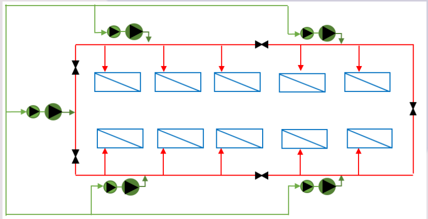
AVAILABILITY RISK:
PIPE: 10-20%
PUMPS: 0%

General **collectors** / line

AVAILABILITY RISK:
PIPE: 25-50%
PUMPS: 0%

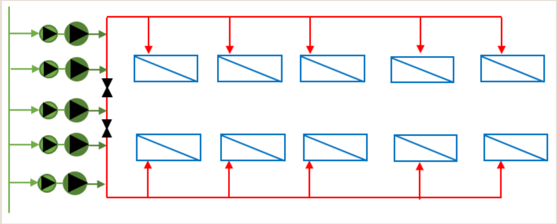
Pump to RO rack(s)

Pumps
same size



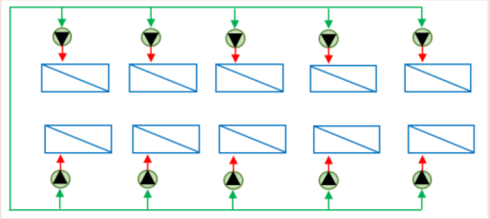
EFFICIENCY
MAXIMUM CAPACITY: HIGHEST
MIDDLE CAPACITY: MEDIUM
LOW CAPACITY: LOW

REDUNDANCY:
N-1: OK
N+1: OK



REDUNDANCY:
N-1: TBD
N+1: TBD
CASE BY CASE STUDY

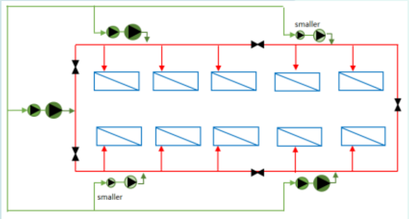
One pump for
one rack



EFFICIENCY
MAXIMUM CAPACITY: MEDIUM
MIDDLE CAPACITY: MEDIUM
LOW CAPACITY: MEDIUM

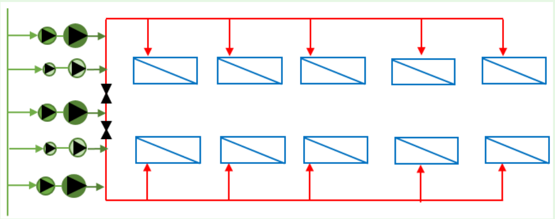
REDUNDANCY:
N-1: OK
N+1: OK

Pumps
different size



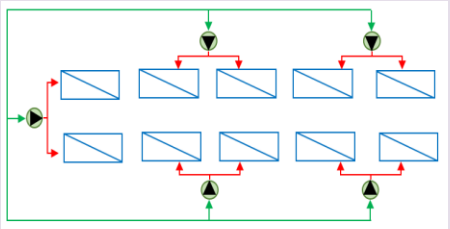
EFFICIENCY
MAXIMUM CAPACITY: HIGH
MIDDLE CAPACITY: HIGH
LOW CAPACITY: HIGH

REDUNDANCY:
N-1: OK
N+1: OK



REDUNDANCY:
N-1: TBD
N+1: TBD
CASE BY CASE STUDY

One pump for
two rack



EFFICIENCY
MAXIMUM CAPACITY: MEDIUM
MIDDLE CAPACITY: LOW
LOW CAPACITY: MEDIUM

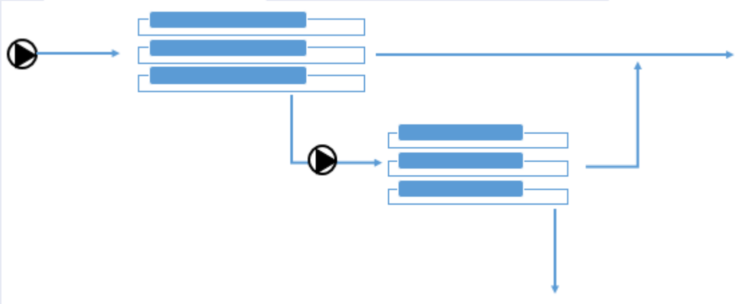
REDUNDANCY:
N-1: NO
N+1: NO
ONLY VALID IF N+2 OR N-2

AVAILABILITY RISK:
PIPE: 10-20%
PUMPS: 10-20%

SUSTAINABLE DESALINATION

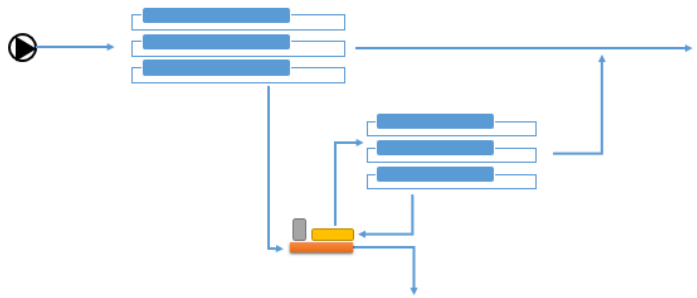
RO SECTION OPTIMIZATION - RO FEED RACK MAIN POSSIBLE CONFIGURATIONS

RO RACK WITHOUT ENERGY RECOVERY



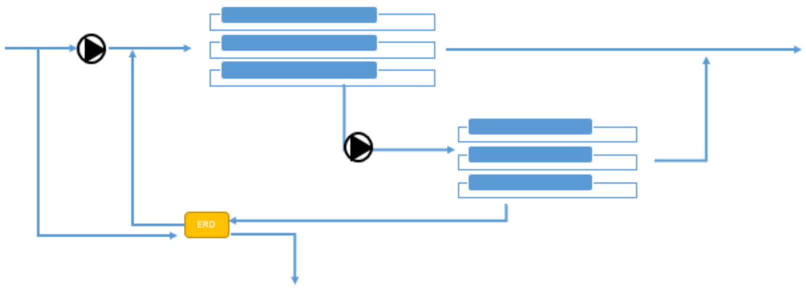
EFFICIENCY: LOWER
FLEXIBILITY: HIGH

RO RACK BOOSTER PUMP WITH ENERGY RECOVERY INTERGRATED



EFFICIENCY: MEDIUM
FLEXIBILITY: MEDIUM

RO RACK WITH ENERGY RECOVERY TO FEED STREAM



EFFICIENCY: HIGH
FLEXIBILITY: LOWER

CONCLUSIONS

"…….a sustainable SWRO plant with maximum specific water production, minimum energy consumption at low CAPEX and OPEX…."

Engineering optimization	Selection of site - water and land	Readiness of infrastructure

THANK YOU FOR YOUR ATTENTION!

Roberto Mangano
Roberto.mangano@ilf.com
T +971 (0)50 111 24 76

WWW.ILF.COM

ILF CONSULTING ENGINEERS