LIFE PHOENIX

LIFE19 ENV/ES/000278

LIFE PHOENIX is a project co-funded by the European Union under the LIFE Programme Grant Agreement no. LIFE18 ENV/ES/000278

LIFE PHOENIX Project Overview

Enrique Lara, AQUALIA

Isaac Fernández, CETIM

LIFE PHOENIX
LIFE19 ENV/ES/000278

Innovative cost-effective multibarrier treatments for reusing water for agricultural irrigation

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Phoenix

Project presentation & objectives

Isaac Fernández, **CETIM**

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Innovative cost-effective multibarrier treatments for reusing water for agricultural irrigation

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Call: LIFE 2019

Life Programme Priority Area: Environment and Resource Efficiency project application

Sector: Water including the marine environment

Coordinator: AQUALIA

Partners: AdP, CETIM, CHG, DIPALME, NEWLAND, UAL-CIESOL, microLAN

Budget: 3,390,078 €

EU Contribution: 1,855,113 €

Duration: 01/09/2020 – 29/02/2024 (42 months)

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LIFE PHOENIX
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Innovative cost-effective multibarrier treatments for reusing water for agricultural irrigation

LIFE PHOENIX PARTNERSHIP

EU 4th largest private water company, the biggest in ES. Broad experience and commitment on R&D and EU projects

Integrated management of urban water cycle in PT with nationwide presence (80% population)

RTO with wide experience in R&D of water and WW treatment, waste valorisation and LCA/LCC

Responsible for water management in the hydrographic demarcation of Guadalquivir. Water regulatory body.

Public Administration of Almeria province. Involved in the management of Almeria water resources and WWTPs operation

Specialist in O_3 and UV treatments with 30 years of experience

RTO with large expertise in solar regeneration of water and water quality monitoring

SME specialized on online monitoring devices to protect water quality, including bacteria and toxicity.

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LIFE PHOENIX MOTIVATION

Intensification of **water scarcity** in Europe caused by **global warming**:

-During summer, up to 30% of total UE population lives under water stress situation.

-This problem is exacerbated in the Mediterranean countries.

Agriculture accounts for about 40% of overall EU use but rising up to 60-80% in southern countries during summer.

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LIFE PHOENIX MOTIVATION

Water reuse in Europe:

- Still limited and implemented in countries with severe scarcity
- About 1,000 Mm^3/yr.
- 2.4% of the treated WW, <0,5% freshwater abstraction
- Spain, Portugal and Italy jointly accounting for >60%

European regulation for water regeneration in order to avoid individual actuations, which could lead to technical issues and higher implementation costs.

→ 25th of May 2020 -- Regulation (UE) 2020/741

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LIFE PHOENIX OBJECTIVES

1

Demonstrate cost-effective multibarrier treatments to obtain reclaimed water meeting A quality (WWR-EU):

-Solutions for large-medium populations

-Solutions for small populations

2

Develop a **Decision Support System (DSS)** and a **Sustainability Tool** to ensure feasibility for each case & waste water.

3

Minimize environmental & health effects caused by reclaimed water use by reduction of:

-Harmful disinfection/oxidation products & eco-toxicity

- Compounds of Emergent Concern (CECs) & antibiotic resistant bacteria (ARB)

- Microplastics (MPs)

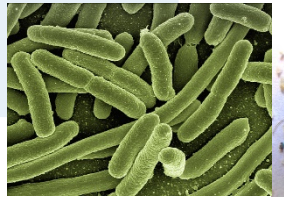
- C footprint

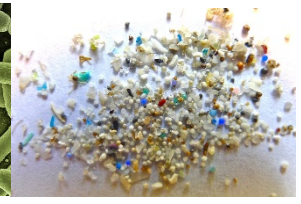
4

Ensure water quality by:

-Online monitoring: toxics & pathogens

-Offline analyses: MPs, eco-toxicity, ARB





5

Recover nutrients (N,P)

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LIFE PHOENIX OBJECTIVES

6 Test reclaimed water & recovered fertilizer at experimental crop fields

7 Reduce OPEX of the 3ary treatment:

- Lower fouling membranes
- Low energy UV-LED & Solar Photo-Fenton
- Residual O_3 reuse to advanced flotation (20%)
- Reduce size of disinfection due to efficient pretreatment
- Optimal technologies configuration by DSS

8 Study of WWR-EU incidence in existing WWRTPs-Almeria-ES inventory

9 Promote replication, transferability & market uptake by a Stakeholder Panel

10 Evaluation of environmental, social & economic impacts

11 Results Dissemination

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LIFE PHOENIX LOCATIONS

Technologies for MEDIUM-LARGE WWTPS

El Toyo WWTP

ulises

Almonte WWTP

Fonte Quente WWTP

Technologies for SMALL WWTPS

El Toyo WWTP

biosol water recycling

INCOVER

Talavera de la Reina WWTP

INText

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LIFE PHOENIX EXPECTED RESULTS & IMPACTS

1

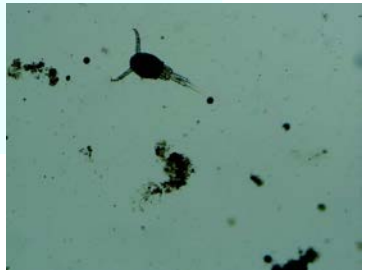
Obtain reusable water meeting class A quality (WWR-EU):

-Up to 88 k m^3/yr. (large-medium populations)

-Up to 48 k m^3/yr. (small populations)

2

Validation of **indicator microorganisms and performance targets**



3

Minimize environmental & human health effects:

-Lower eco-toxicity

-Lower discharge of macrolide antibiotics and oestrogens

-Lower discharge of microplastics

-Lower C footprint

-Reduced loss of nutrients

4

Contribute to protection of Doñana National Park: reducing the use of freshwater for irrigation

5

Lower OPEX

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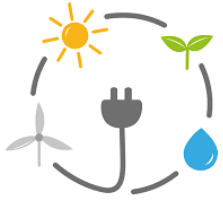
LIFE PHOENIX EXPECTED RESULTS & IMPACTS

OBJETIVES

6 Lower energy consumption



7 Obtain N-P loaded zeolite and test it together with reused WW in crop fields

8 Obtain the PHOENIX DSS and sustainability ICT tool

9 Obtain a replicability and transferability guide. Obtain a business plan.

10 Maximize visits to the website, participation in events and workshops and publication of articles

12 Establish a participative Stakeholder Advisory Panel involving all relevant audience

11 Create jobs

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Project motivation & technologies

Enrique Lara (**Aqualia**)

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LIFE PHOENIX MOTIVATION: EU REGULATION

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	*ESCMERICHIA COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
2.- USOS AGRÍCOLAS[1]					
CALIDAD 2.12 a) Riego de cultivos con sistema de aplicación del agua que permita el contacto directo del agua regenerada con las partes comestibles para alimentación humana en fresco.	1 huevo/10 L	100 UFC/100 mL Teniendo en cuenta un plan de muestreo a 3 clases[3] con los siguientes valores: n =10 m=100 UFC/100 mL M=1.000 UFC/100 mL c=3	20 mg/L	10 UNT	OTROS CONTAMINANTES Contenidos en la autorización de vertido de aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. *Legionella spp.* 1.000 UFC/L (si existe riesgo de aerosolización) Es obligatorio llevar a cabo la detección de patógenos Presencia/Ausencia (Salmonella, etc.) cuando se repita habitualmente que c=3 para M=1.000

1/10

1/2

1/2

a) Requisitos mínimos de calidad de las aguas

Cuadro 2 — Requisitos de calidad de las aguas regeneradas para el riego agrícola

New

Clase de calidad de las aguas regeneradas	Tratamiento indicativo	Requisitos de calidad				
		E. coli (número/100 ml)	DBO_5 (mg/l)	STS (mg/l)	Turbidez (UNT)	Otros
A	Tratamiento secundario, filtración y desinfección	≤ 10	≤ 10	≤ 10	≤ 5	*Legionella* spp.: < 1 000 UFC/l cuando exista un riesgo de aerosolización Nematodos intestinales (huevos de helmintos): ≤ 1 huevo/l para el riego de pastos o forraje
B	Tratamiento secundario y desinfección	≤ 100	De conformidad con la Directiva 91/271/CEE (anexo I, cuadro 1)	De conformidad con la Directiva 91/271/CEE (anexo I, cuadro 1)	–	
C	Tratamiento secundario y desinfección	≤ 1 000			–	
D	Tratamiento secundario y desinfección	≤ 10 000			–	

Real Decreto 1620/2007, de 7 de diciembre, reutilización de las aguas depuradas.

REGULATION (EU) 2020/741
of 25 May 2020 on
minimum requirements for water reuse

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LIFE PHOENIX MOTIVATION: EU REGULATION

Table 4 – Validation monitoring of reclaimed water for agricultural irrigation

Reclaimed water quality class	Indicator microorganisms (*)	Performance targets for the treatment chain (log_{10} reduction)
A	*E. coli*	≥ 5,0
	Total coliphages/F-specific coliphages/somatic coliphages/coliphages (**)	≥ 6,0
	Clostridium perfringens spores/spore-forming sulfate-reducing bacteria (***)	≥ 4,0 (in case of *Clostridium perfringens* spores) ≥ 5,0 (in case of spore-forming sulfate-reducing bacteria)

(*) The reference pathogens *Campylobacter*, Rotavirus and *Cryptosporidium* may also be used for validation monitoring purposes instead of the proposed indicator microorganisms. The following log_{10} reduction performance targets shall then apply: *Campylobacter* (≥ 5,0), Rotavirus (≥ 6,0) and *Cryptosporidium* (≥ 5,0).

(**) Total coliphages is selected as the most appropriate viral indicator. However, if analysis of total coliphages is not feasible, at least one of them (F-specific or somatic coliphages) shall be analysed.

(***) *Clostridium perfringens* spores is selected as the most appropriate protozoa indicator. However, spore-forming sulfate-reducing bacteria are an alternative if the concentration of *Clostridium perfringens* spores does not make it possible to validate the requested log_{10} removal.

Indicador virus

Indicador protozoos (Cystosporidium, Giardia)

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PATHOGENS INACTIVATION BY UV

-Chlorine not effective for virus and protozoa indicators. Only useful as residual chlorine
-Clostridium spores removal by ozone under controversy.
-UV is effective but require high doses to obtain 6 log removal of coliphages (150 mJ/cm^2) and for protozoa indicators 4 log clostridium spores (220 mJ/cm^2), although Crytos can be used directly (45 mJ/cm^2)

UV dose mJ/cm^2	1 log	2 log	3 log	4 log	5 log	6 log
E. coli	5	10	20	25	30	40
Total Coliphages (MS2)	20	40	60	90	120	150
Clostridium perfringens spores	40	95	145	220	-	-
Campylobacter	2	4	6	8	10	20
Rotavirus	16	25		35		
Cryptosporidium	2.5	5.8	12	22	45	85

"*Inactivation credit of UV radiation for viruses, bacteria and protozoan (oo)cysts in water: A review*". W.A.M. Hijnen, E.F. Beerendonk, G.J. Medema
". Gabriel Chevrefils et al. *UV dose required to achieve incremental Log inactivation of bacteria, protozoa and viruses"*

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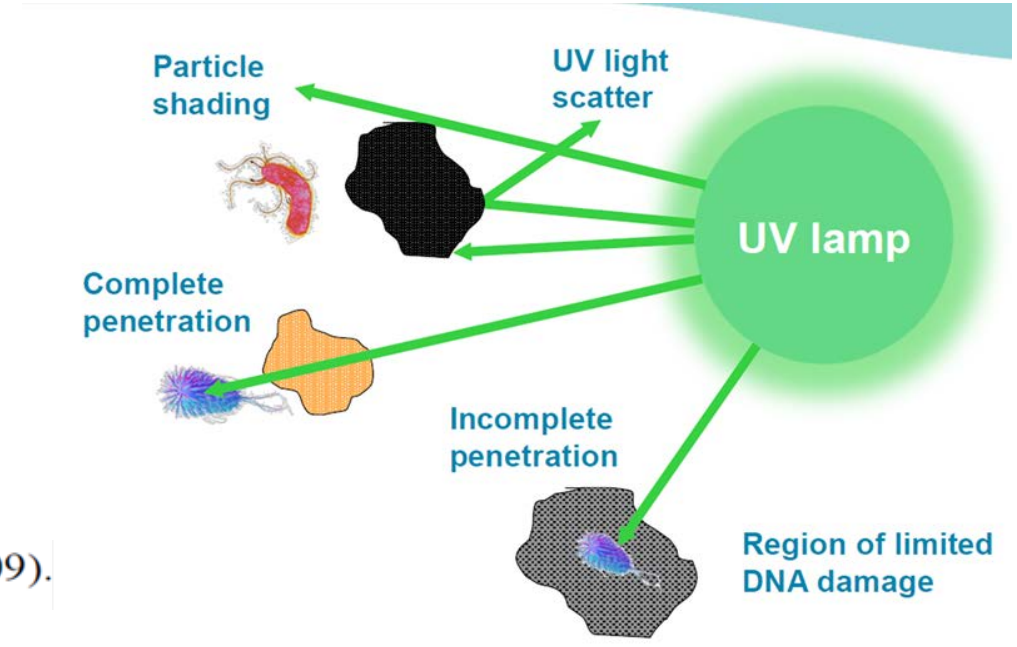
Transmittance improvement

1) Particles creates shading, regions of limited DNA damage, UV light scatter
2) Transmittance greatly influences UV energy consumption
3) Transmittance improvement is related to CECs removal

(Gerrity et al. 2012, Nanaboina and Korshin 2010, Wert et al. 2009).



PRETREATMENTS ARE ESSENTIAL

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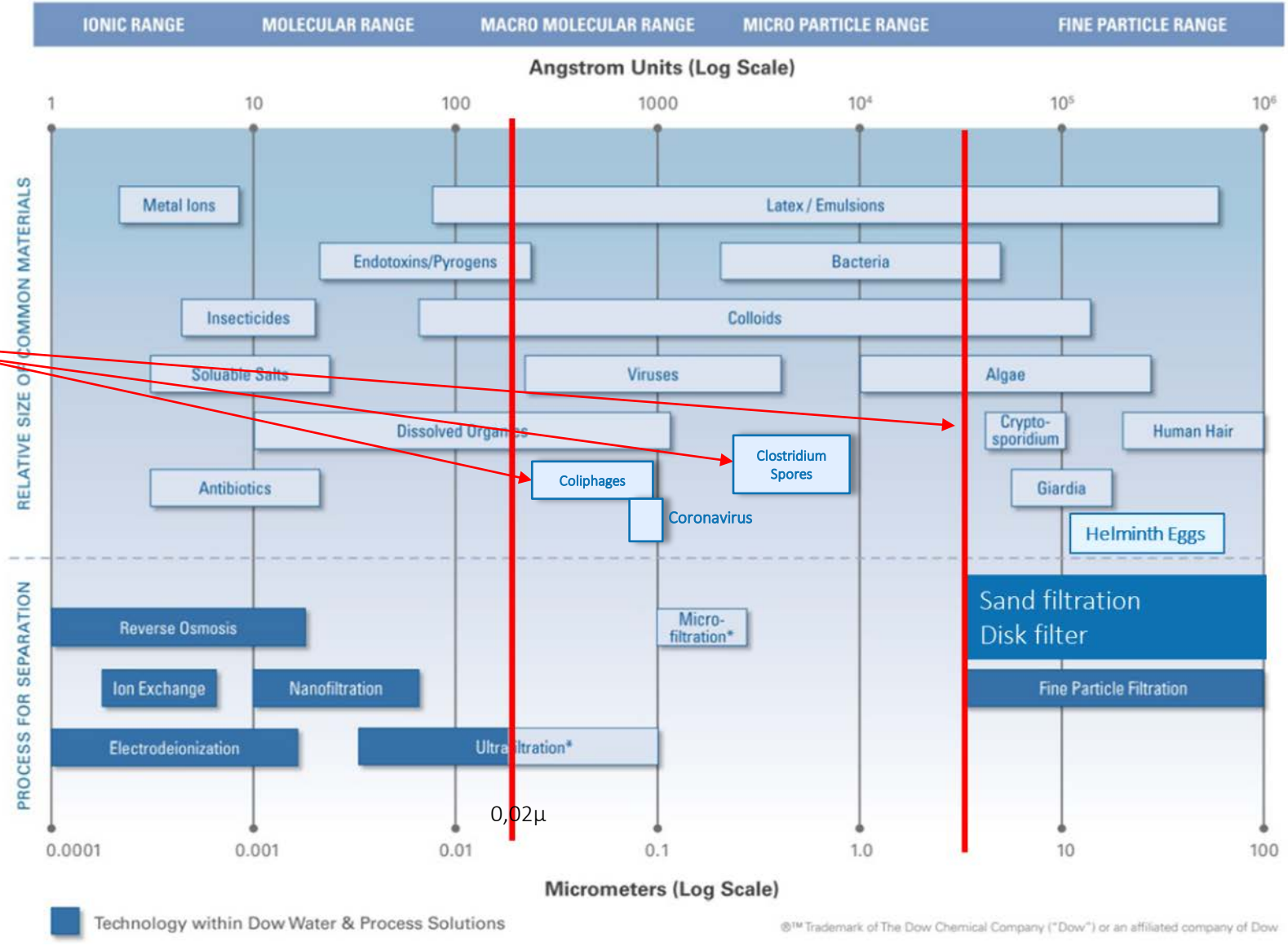
MICROORGANISM SIZE

Essential pretreatment TFQ/filtration to remove microorganisms resistant to disinfection



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LIFE PHOENIX STRATEGY

WATER REUSE CASE STUDIES

DECISION SUPPORT SYSTEM

REPLICABILITY: ALMERIA CASE STUDY

Large-Medium WWTPs

PRETREATMENTS

Ballasted lamella clarification,
high rate disolved ozoned flotation (DOF),
disk filter,
Combined deep bed filtration
O3+BAC
PAC+coag+multimembrane UF

DISINFECTION + AOPs

Ozone, UV
Advanced Oxidation Systems (AOPs)

PATHOGEN ONLINE MONITORING

Small WWTPs

PRETREATMENTS

Microalgae HRAP + DAF
Innovative constructed wetlands

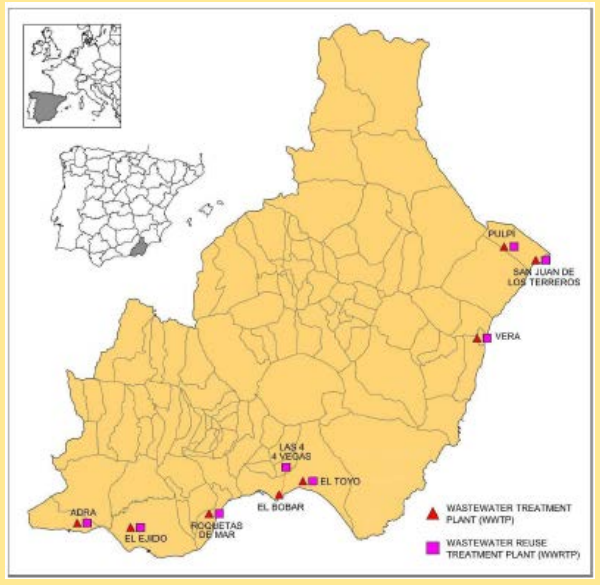
DISINFECTION + AOPs

Solar driven AOPs, UV-LED

NUTRIENT RECOVERY BY ZEOLITE
PATHOGEN ONLINE MONITORING

TRANSFERABILITY AND MARKET UPTAKE

CROP FIELD TEST



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ACTION B.1 Design of FPP

Technologies for small WWTPs

El Toyo

Algae Pond 3000 m2

DAF/WETLANDS

5.4 m3/h

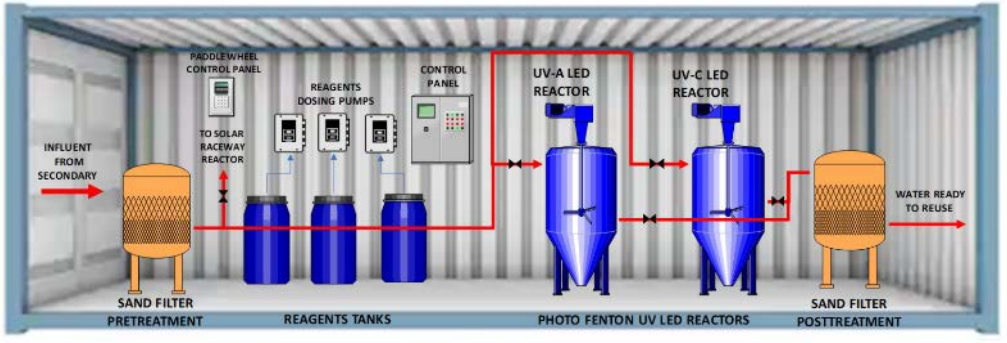
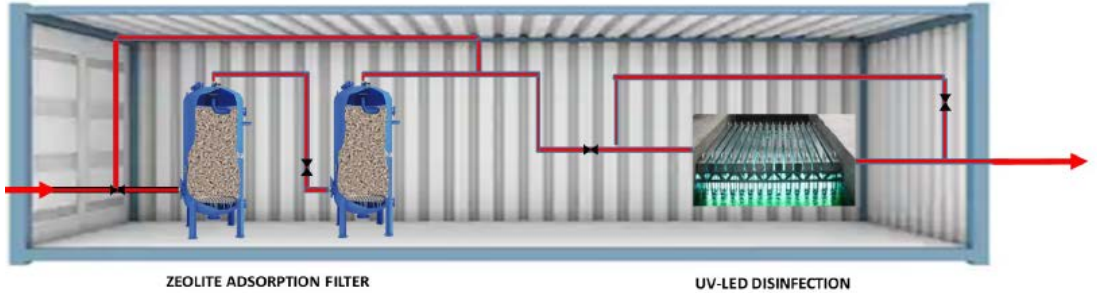


Foto-phenton container

Talavera

Wetlands

5.4 m3/h



Nutrient recovery and UV-LED disinfection container

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CLARIFAST:PAC+BALLASTED CLARIFICATION

State of the art:
BALLASTED FLOCULATION

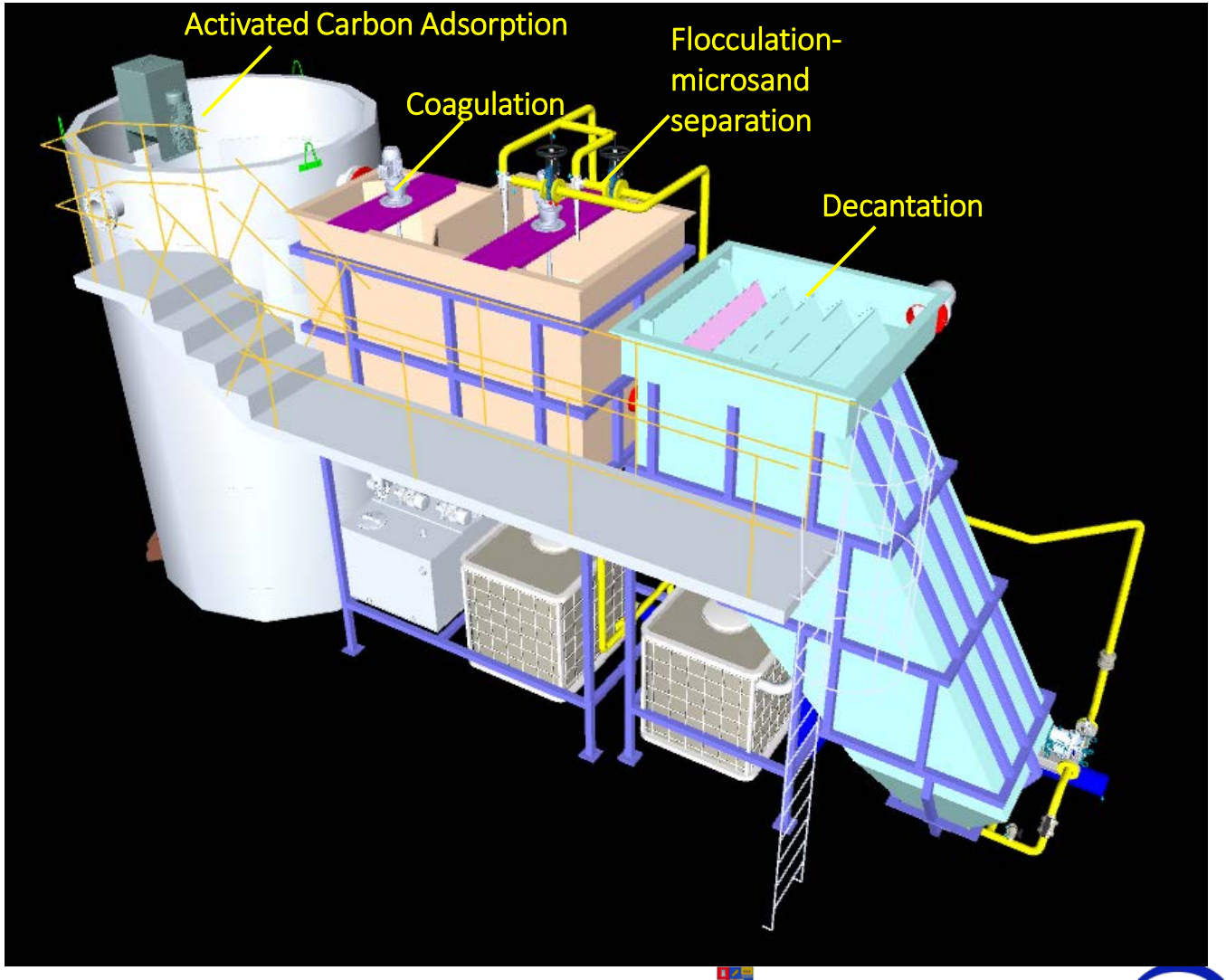
-Velocities up to 50 m/h in tertiary Treatment

-About 50 times area reduction

Beyond state of the art
CLARIFAST

-New hydraulic lamella distribution system

-New ballasted media to test (adsorption) PAC/GAC



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DAFAST/DOFAST: DISSOLVED OZONE FLOTATION

State of the art

HIGH RATE FLOTATION

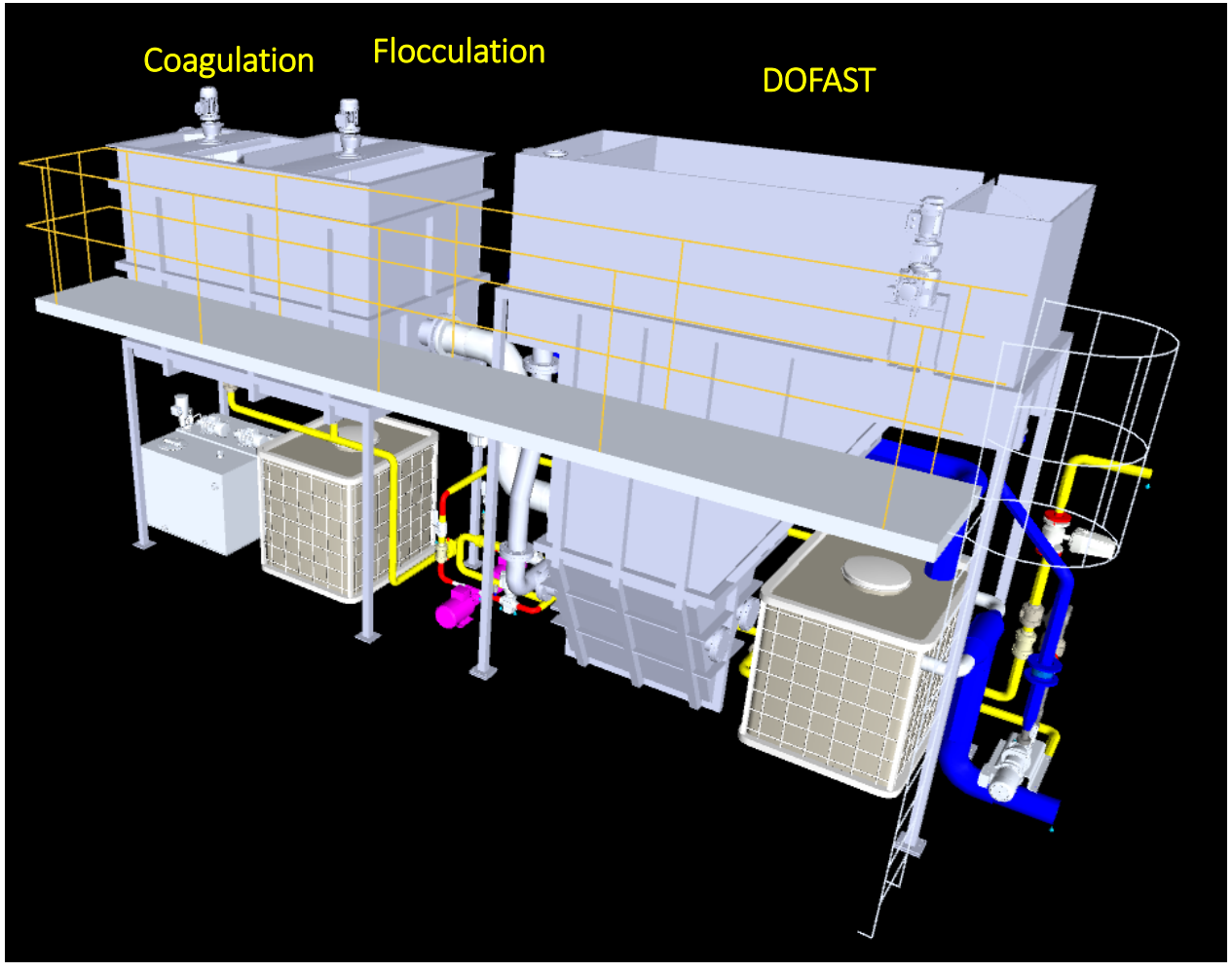
up to 30 m/h, mainly for drinking water applications

SPIDFLOW, Veolia
DAFRAPIDE, Purac
AQUADAF, Suez
ITT, Leopold

Beyond state of the art

DAFAST/DOFAST

-Downflow velocity up to 50 m/h
-Innovative lamella distribution system
-PAC dosing
-No compressor/pressurized vessel
-DOF system.



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PURASAND: CONTINOUS BAKCWASH SAND FILTER

State of the art
PURASAND

-Continuous backwash sand filter
-Aqualia patent

Beyond state of the art
PURASAND high recovery

90% WASH WATER REDUCTION
90% COMPRESSED AIR REDUCTION
50% SUSPENDED SOLIDS AND TURBIDITY EFFLUENT REDUCCTION

OFICINA ESPAÑOLA DE PATENTES Y MARCAS

ESPAÑA

(11) Número de publicación: **2 196 949**

(21) Número de solicitud: 200100863

(51) Int. Cl.: **B01D 24/30**
B01D 24/46
B01D 24/48

(12) PATENTE DE INVENCIÓN B1

(22) Fecha de presentación: **11.04.2001**

(43) Fecha de publicación de la solicitud: **16.12.2003**

Fecha de la concesión: **08.02.2005**

(45) Fecha de anuncio de la concesión: **16.03.2005**

(45) Fecha de publicación del folleto de la patente: **16.03.2005**

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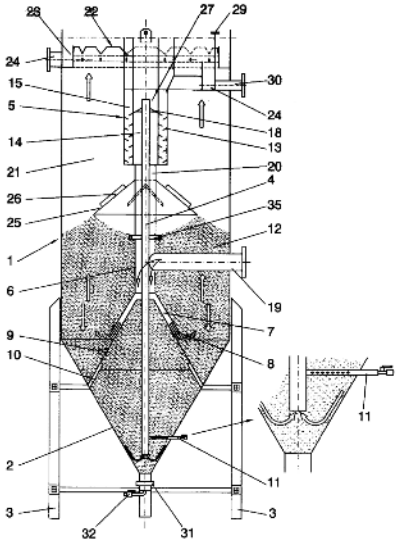
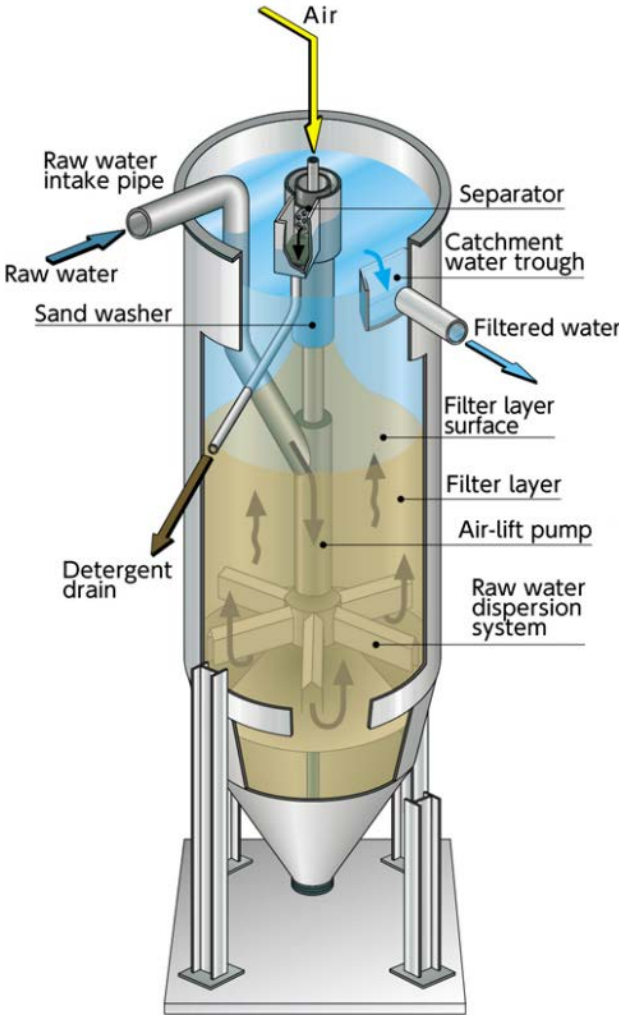


Fig. 1



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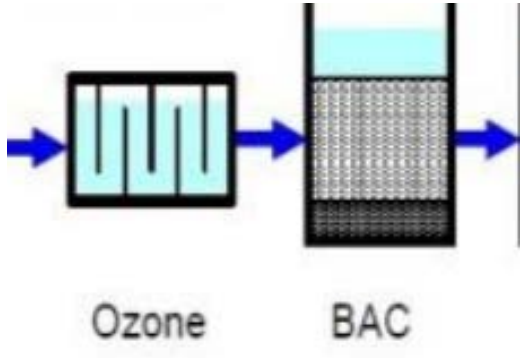
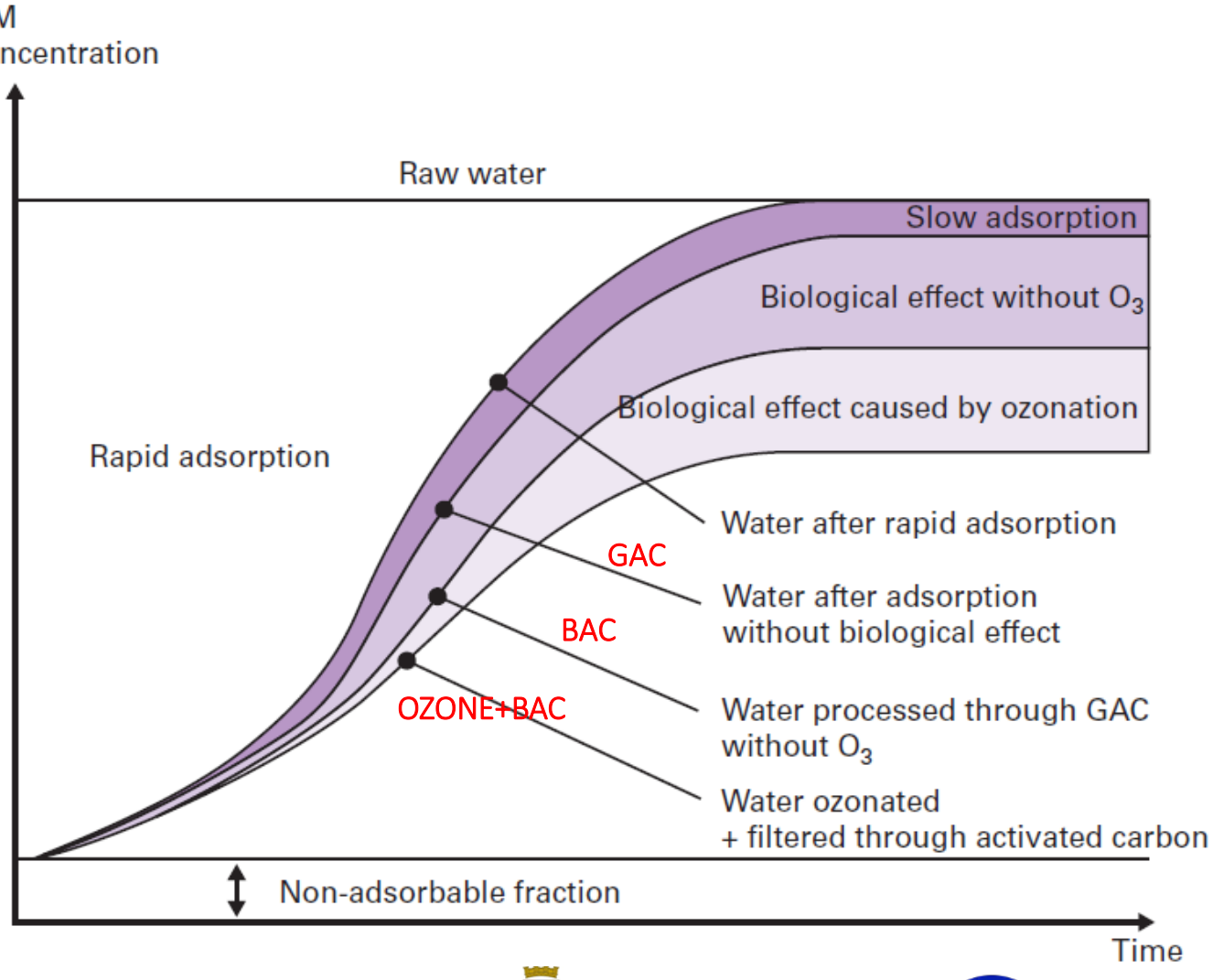
OZONE+BAC

-Ozone oxidizes OM/CECs improving biodegradability
-BAC with GAC combines biodegradation and adsorption to remove OM/CECs that are not biodegradable.
-Activated carbon can be continuously biologically regenerated





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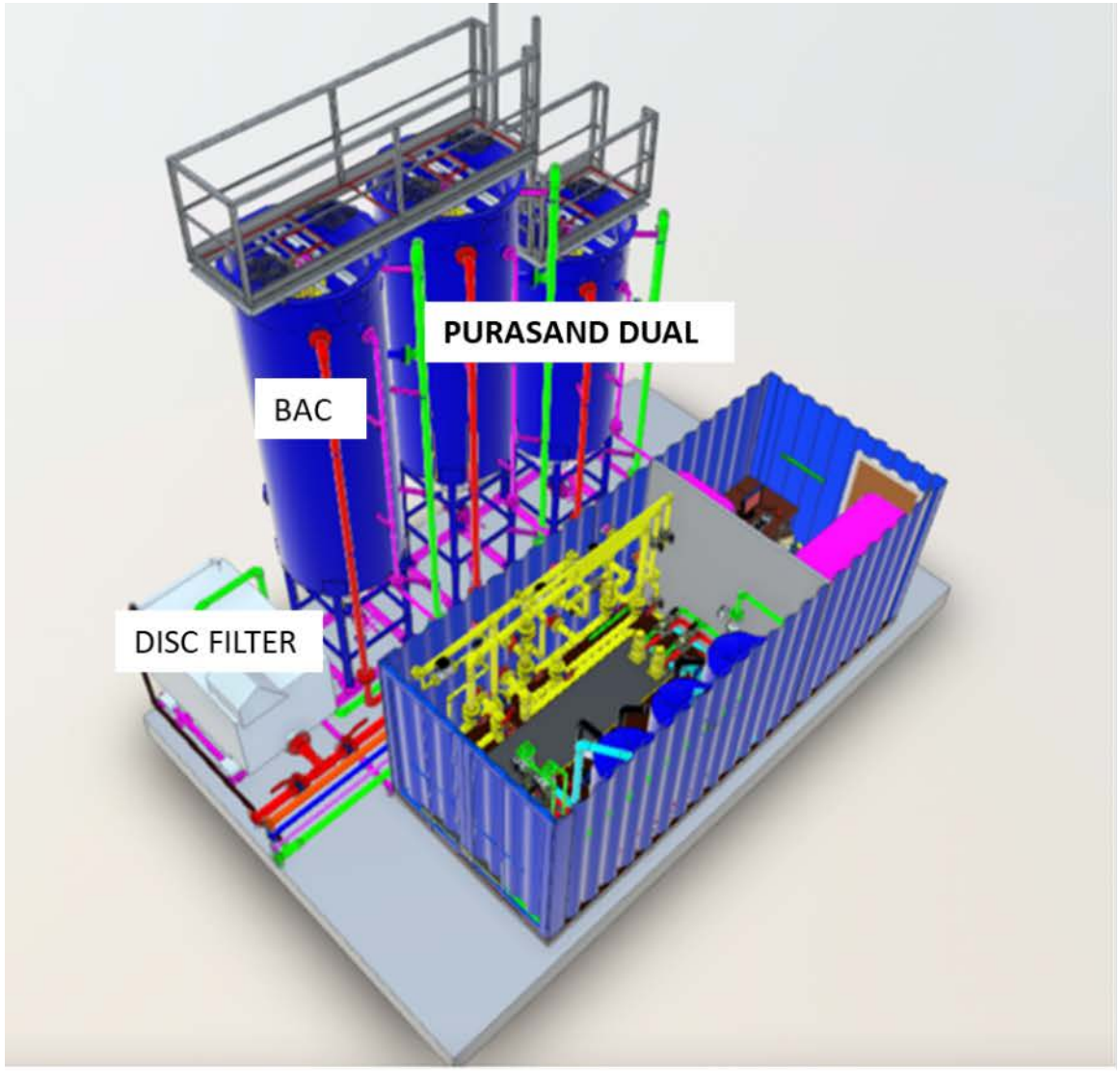
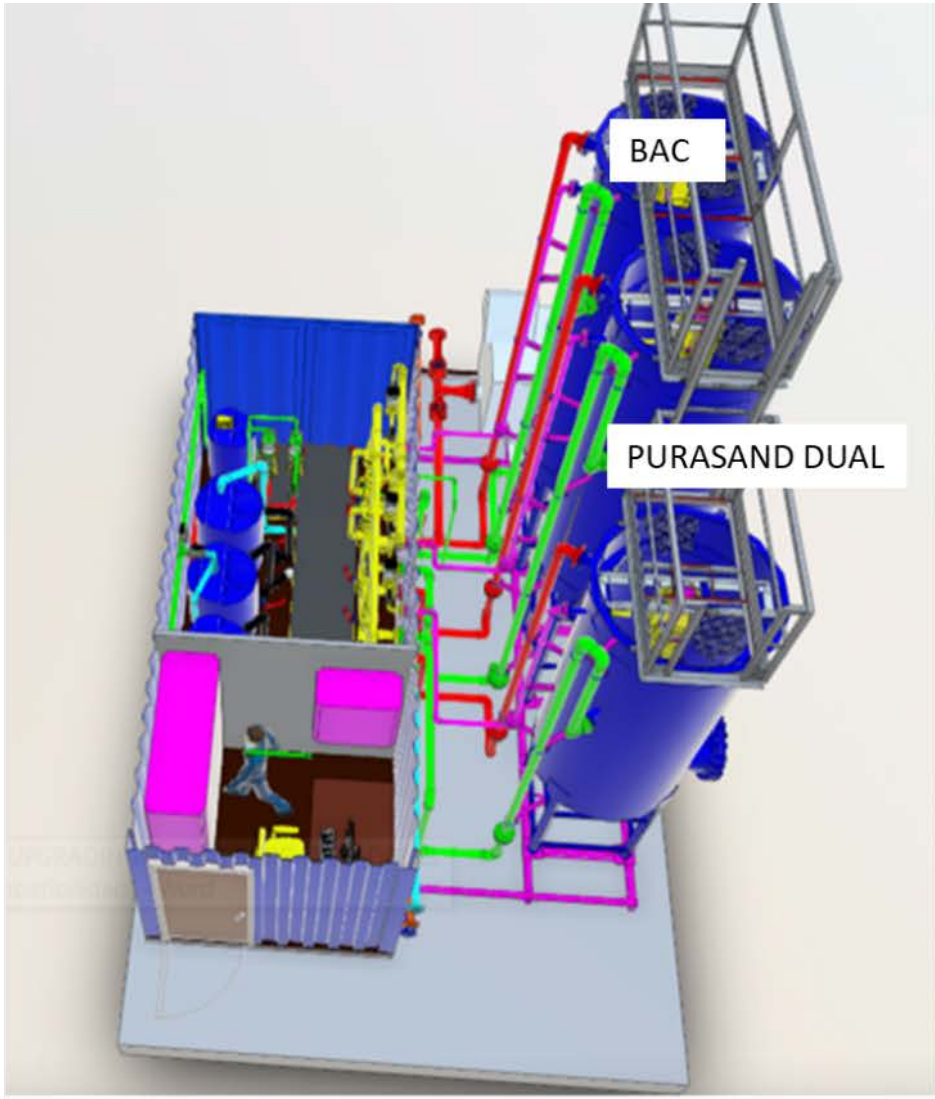
FILTRATON-BIOFILTRATION MODULE





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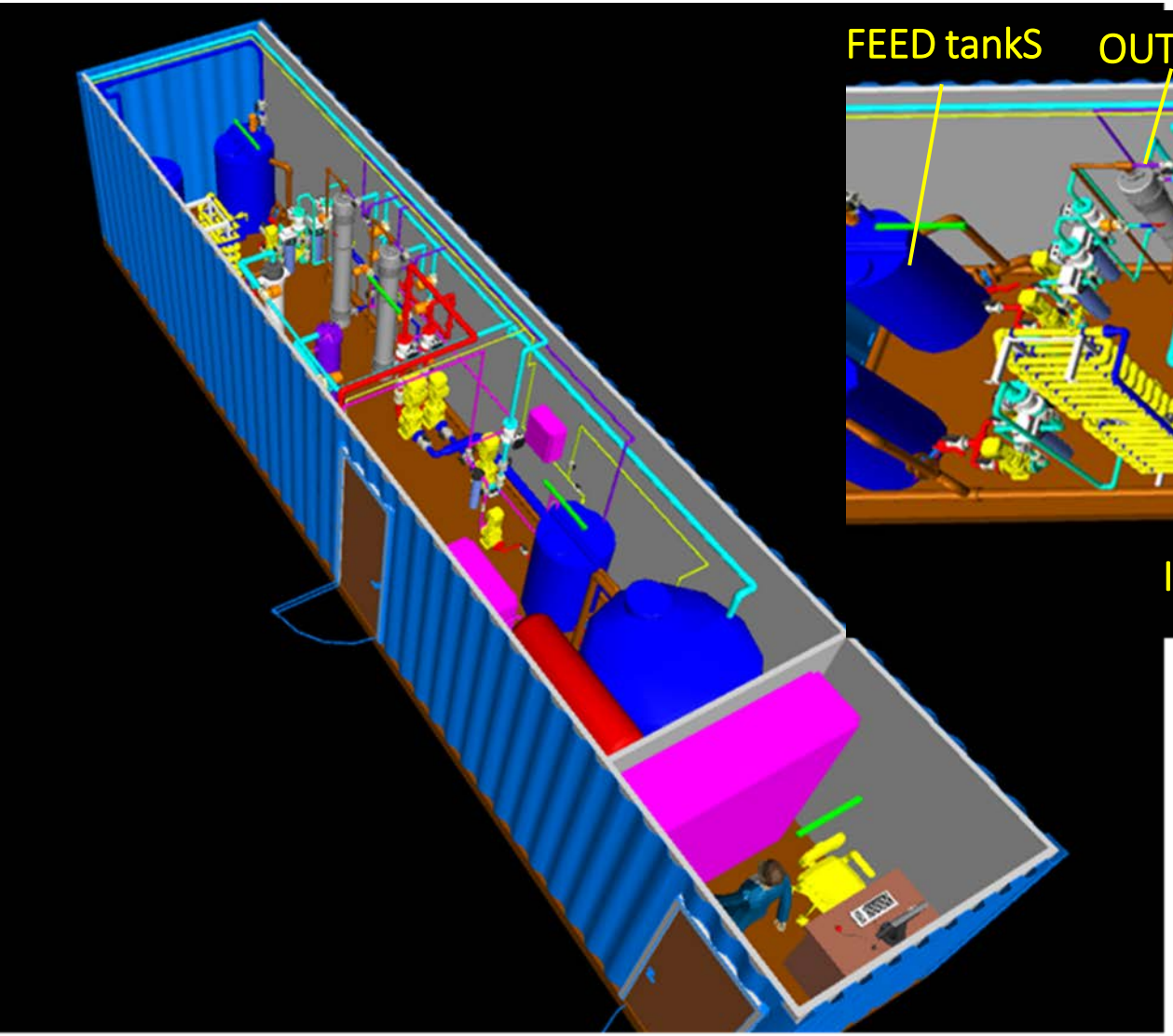
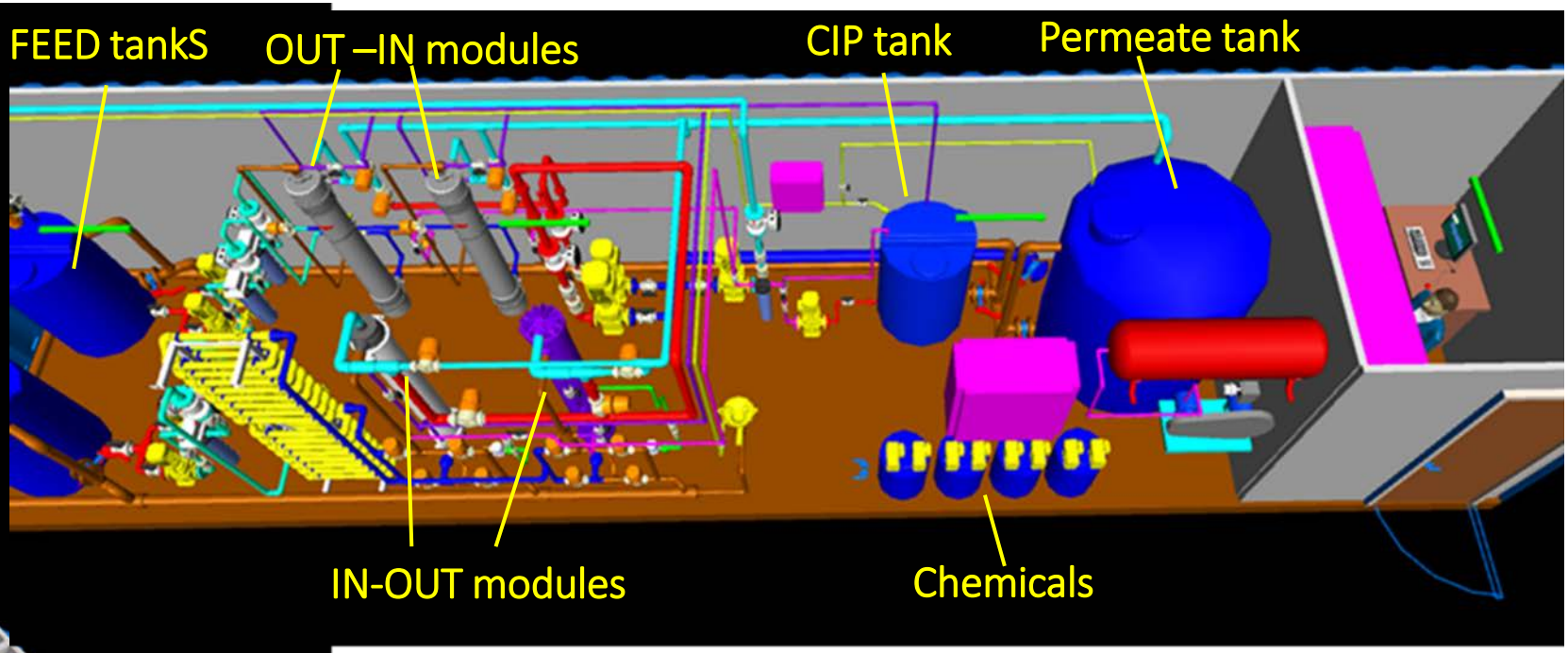
MULTIMEMBRANE UF MODULE





PAC+COAGULANT+O_3 DOSING TO IMPROVE FOULING/PERMEABILITY/CHEMICALS CLEANING

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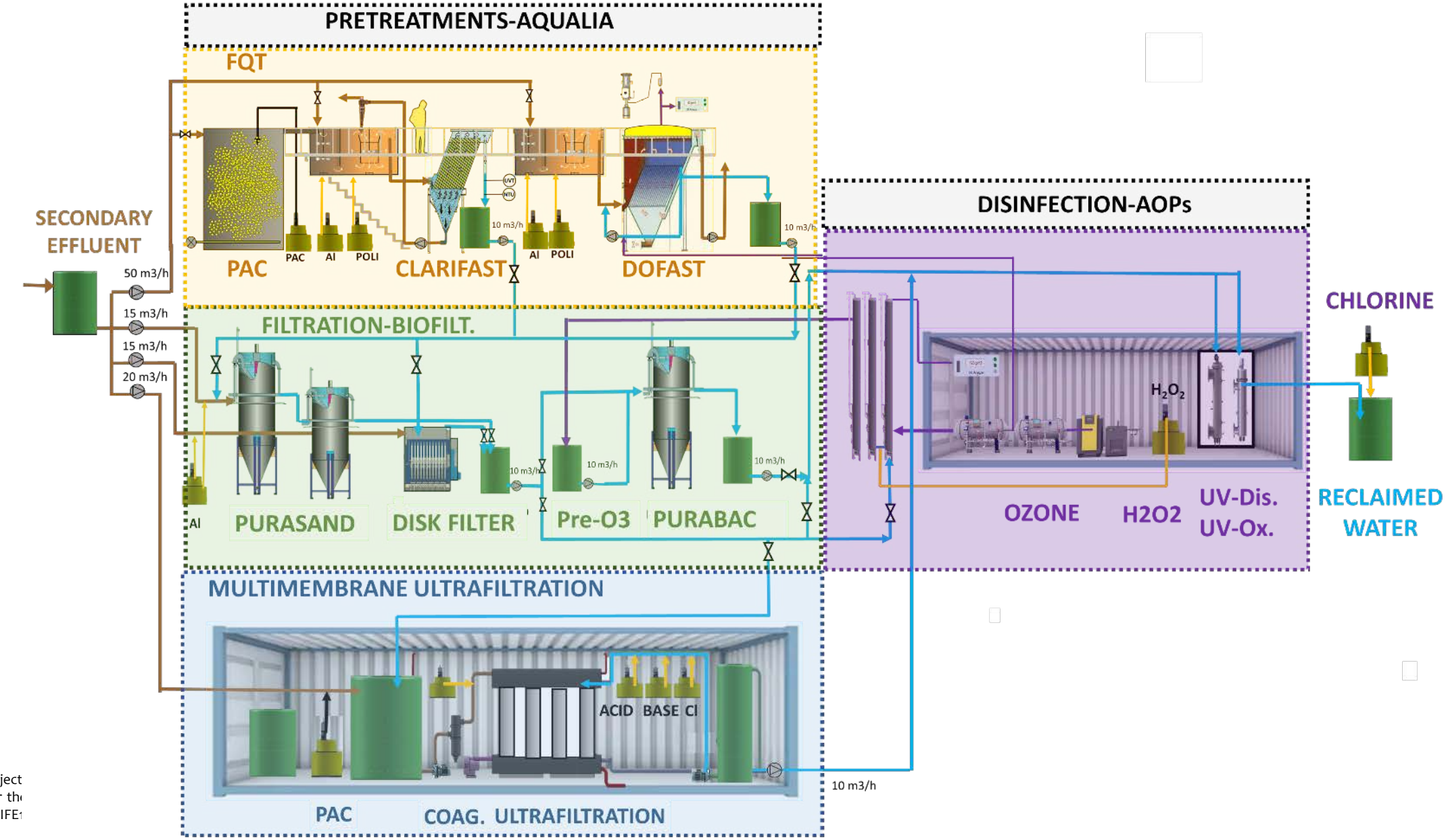
PROCESS FOR LARGE-MEDIUM WWTPs



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European Union under th
Grant Agreement no. LIFE

Technology options

	PAC	COAG.	FLOC	CLARIFAST	DOFAST	PURASAND	DISK FILTER	OZONE	BAC	UF	UV dis.	UV Ox.	Cl
1	O/X	X	X	X			X				X		X
2	O/X	X	X	X			X	X	X		X	X	X
3		O/X				X					X		X
4		O/X				X		X	X		X	X	X
5	O/X	X	X		X	X					X		X
6		O/X					X				X		X
7	O/X	O/X								X	X		X
8	O/X	O/X				X				X	X		X

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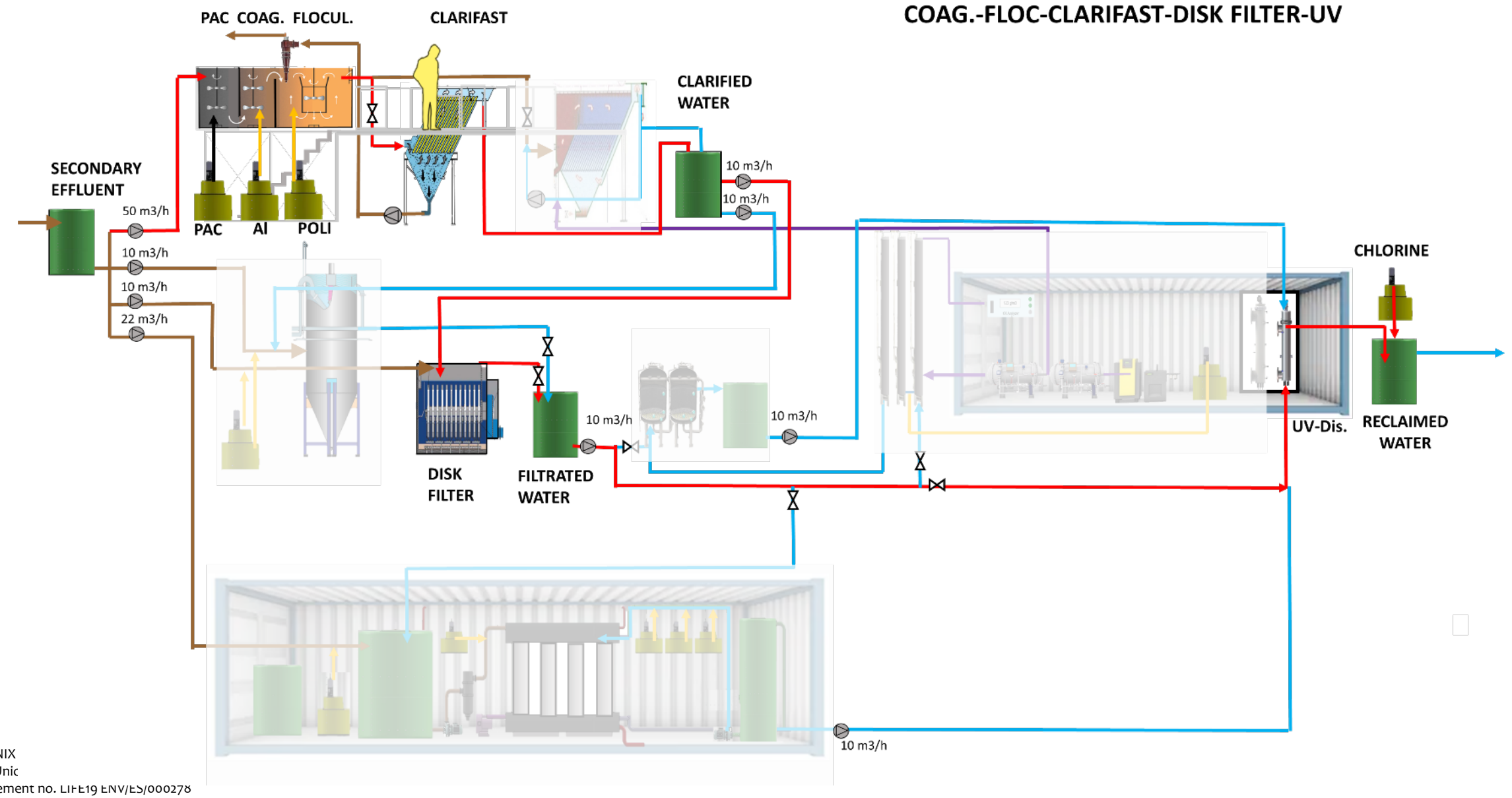
Option 1



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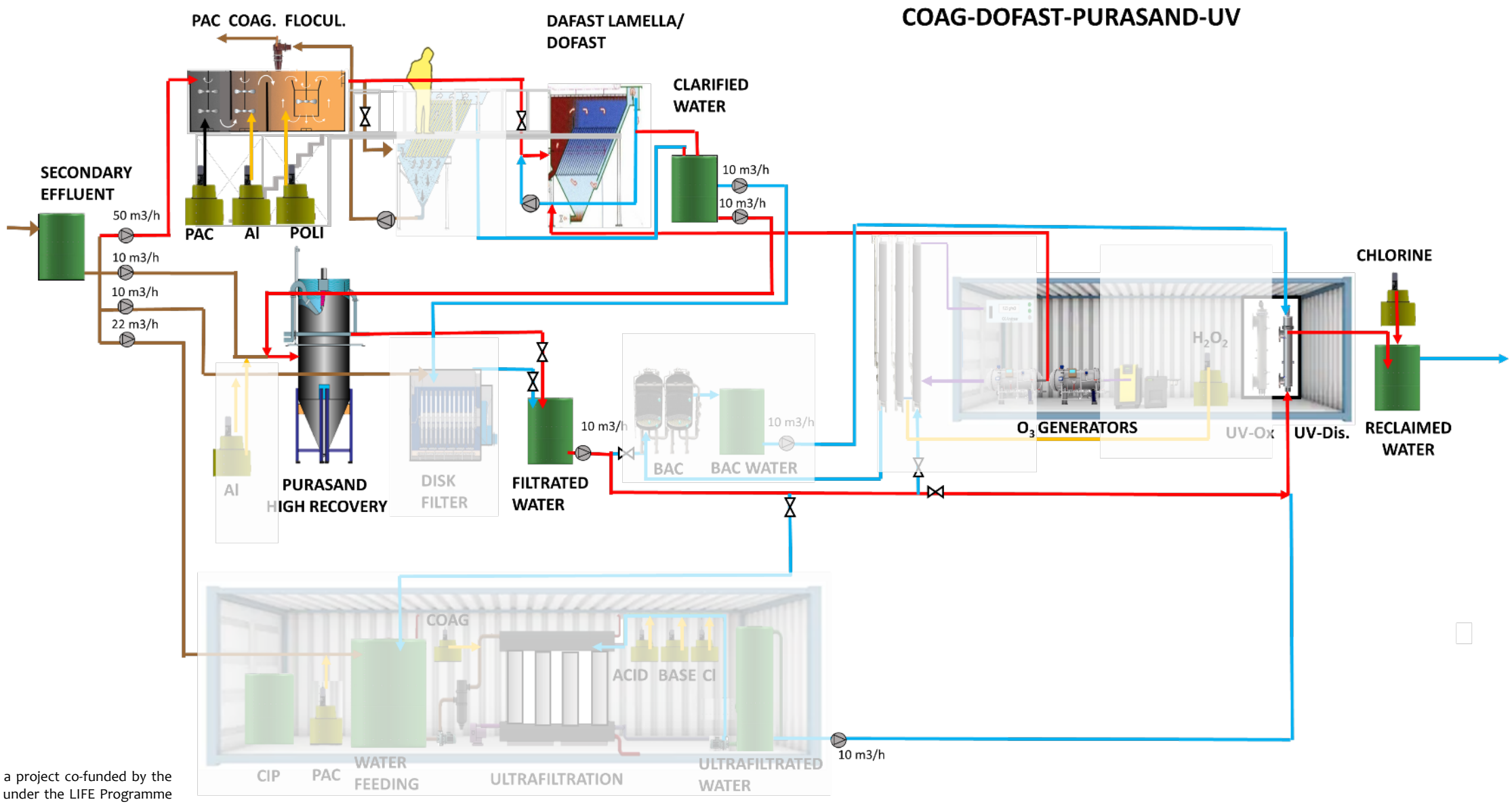
Option 5



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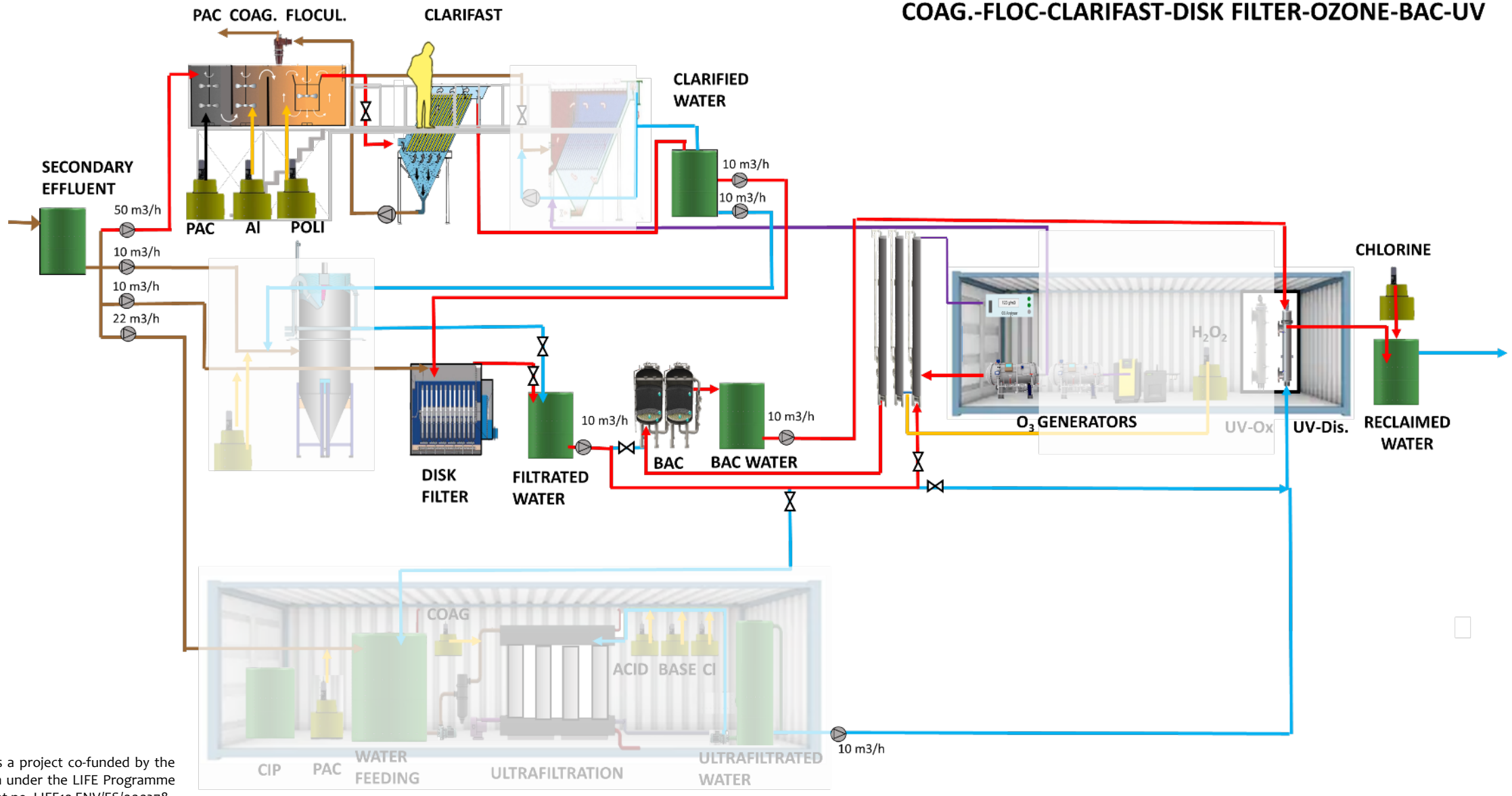
Option 5

COAG.-FLOC-CLARIFAST-DISK FILTER-OZONE-BAC-UV



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FINAL OBJECTIVE : DSS TOOL AND MARKET UPTAKE

LARGE-MEDIUM WWTPs

Influent WW
-Flow
-Contamination

-DATA BASE: Technology options, tests results different locations, area, CAPEX, OPEX
-SOFTWARE WITH SIMULATIONS

	PAC	COAG.	FLOC	CLARIFAST	DOFAST	PURASAND	DISK FILTER	OZONE	BAC	UF	UV dis.	UV Ox.	Cl
1	O/X	X	X	X			X				X		X
2	O/X	X	X	X			X	X	X		X	X	X
3		O/X				X					X		X
4		O/X				X		X	X		X	X	X
5	O/X	X	X		X	X					X		X
6		O/X					X				X		X
7	O/X	O/X								X	X		X
8	O/X	O/X				X				X	X		X

EFFICIENCIES	AREA	CAPEX	OPEX

Select the best tertiary treatment for each situation FOSTERING MARKET UPTAKE

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LIFE PHOENIX Project Overview

Enrique Lara, AQUALIA

Isaac Fernández, CETIM

LIFE PHOENIX
LIFE19 ENV/ES/000278

Innovative cost-effective multibarrier treatments for reusing water for agricultural irrigation

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