ULTIMATE

WATER SMART INDUSTRIAL SYMBIOSIS

CS9 Kalundborg

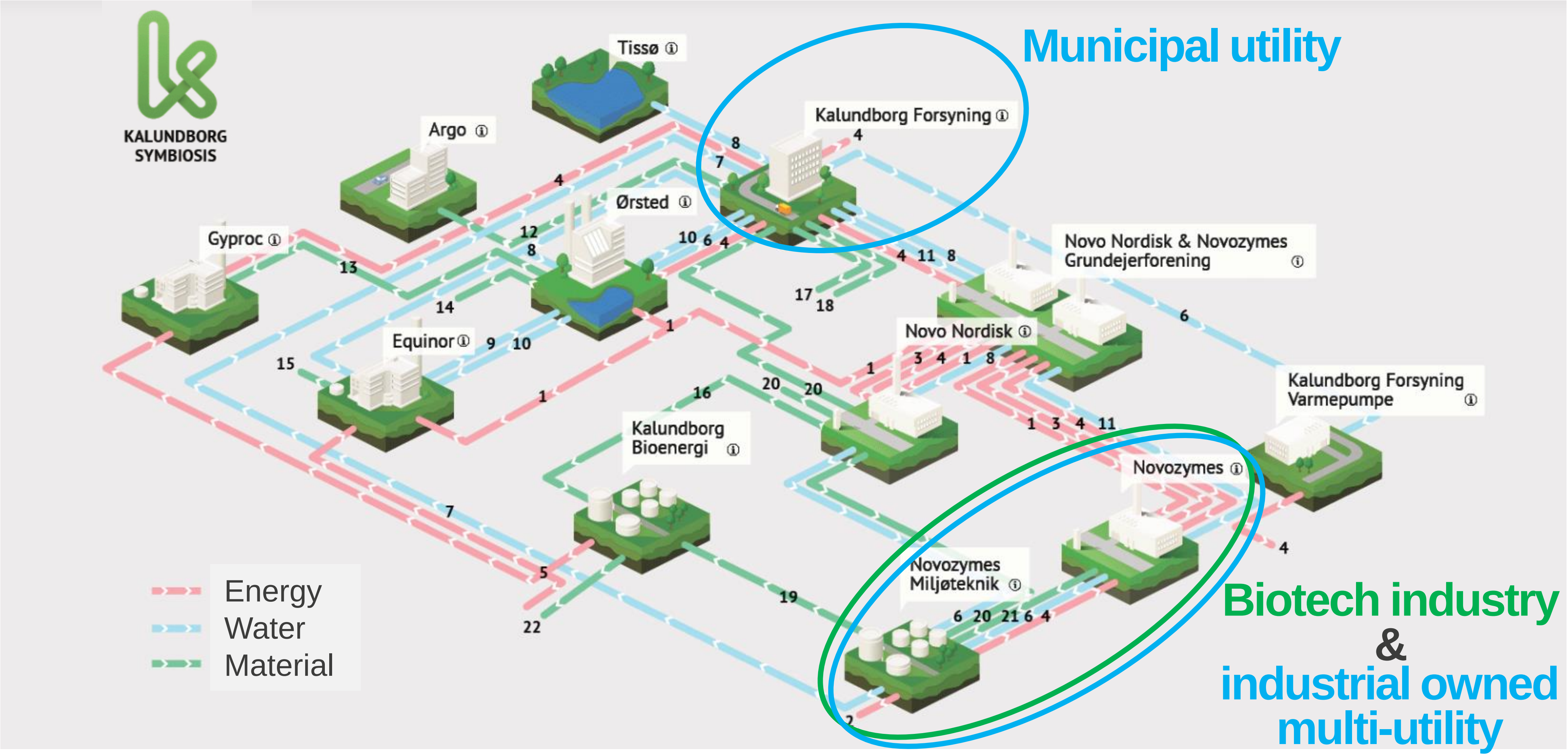
Ultra-tight UF in fit-for-purpose water treatment systems in the biochemical industry

Leo Vredenbregt

PENTAIR X-FLOW

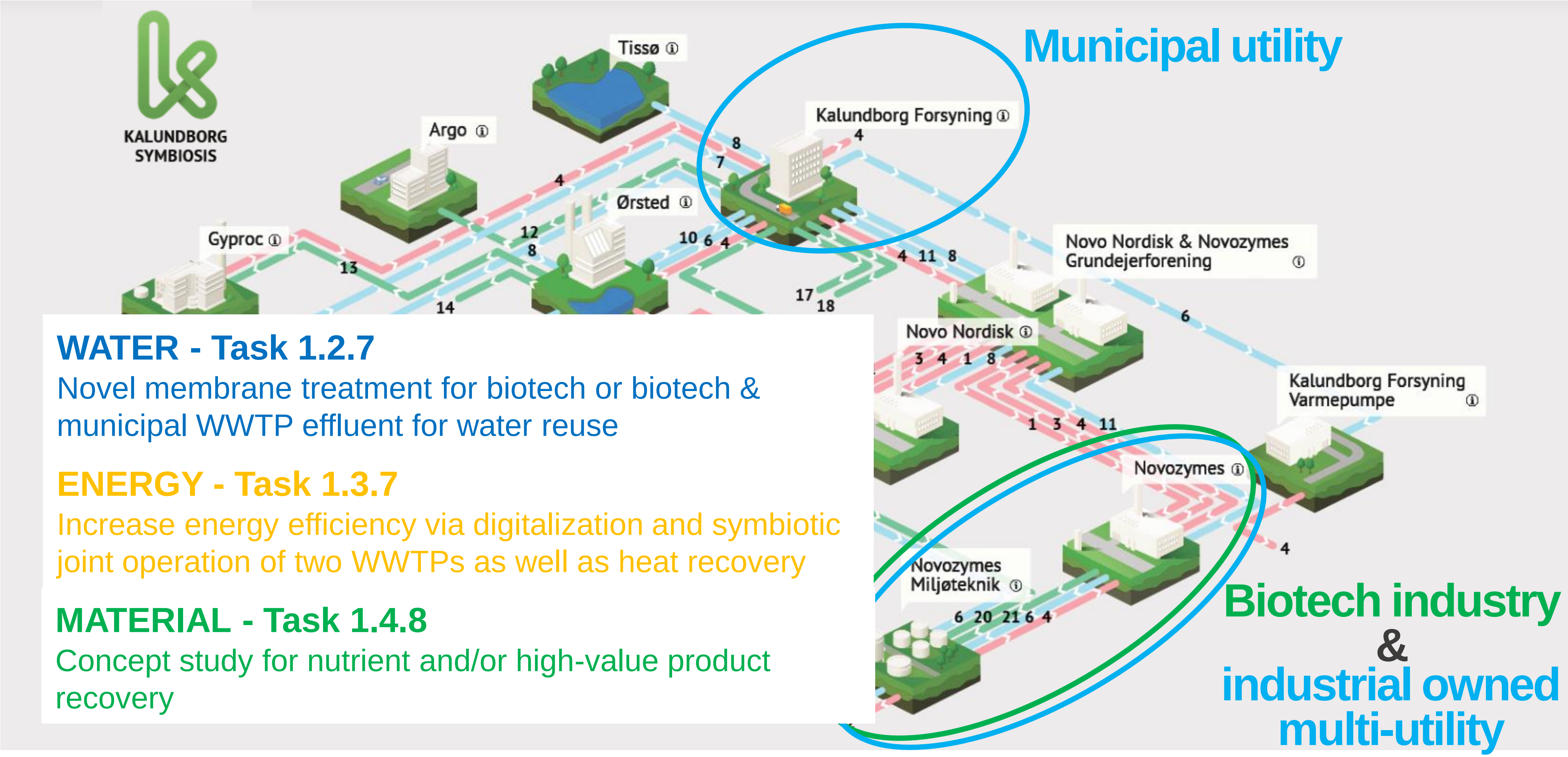
CTG Membranes meeting: 25 November 2020

Kalundborg Symbiosis since 1972:



The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869318

Kalundborg Symbiosis since 1972:



WATER - Task 1.2.7
Novel membrane treatment for biotech or biotech & municipal WWTP effluent for water reuse

ENERGY - Task 1.3.7
Increase energy efficiency via digitalization and symbiotic joint operation of two WWTPs as well as heat recovery

MATERIAL - Task 1.4.8
Concept study for nutrient and/or high-value product recovery

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WATER - Task 1.2.7

Novel membrane treatment for biotech or biotech & municipal WWTP effluent for water reuse

Partners:

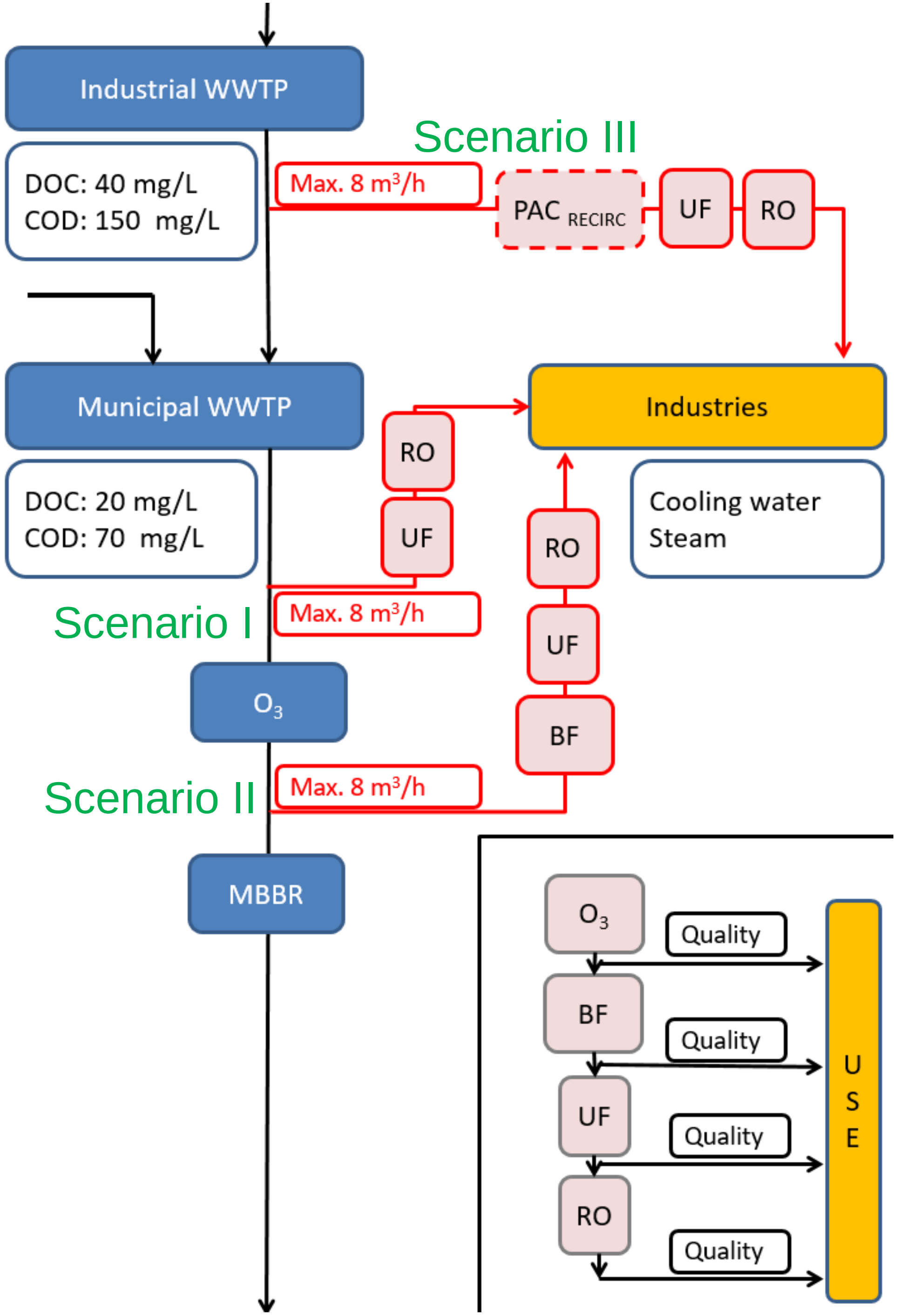
KALUNDBORG FORSYNING
novozymes Rethink Tomorrow
PENTAIR X-FLOW
KOMPETENZZENTRUM Wasser Berlin

OBJECTIVE:

Production of fit-for-purpose water via:

→ novel (ultra tight) ultra-filtration membrane combined with

→ pre-treatment for wastewater with high-non-degradable organic matter



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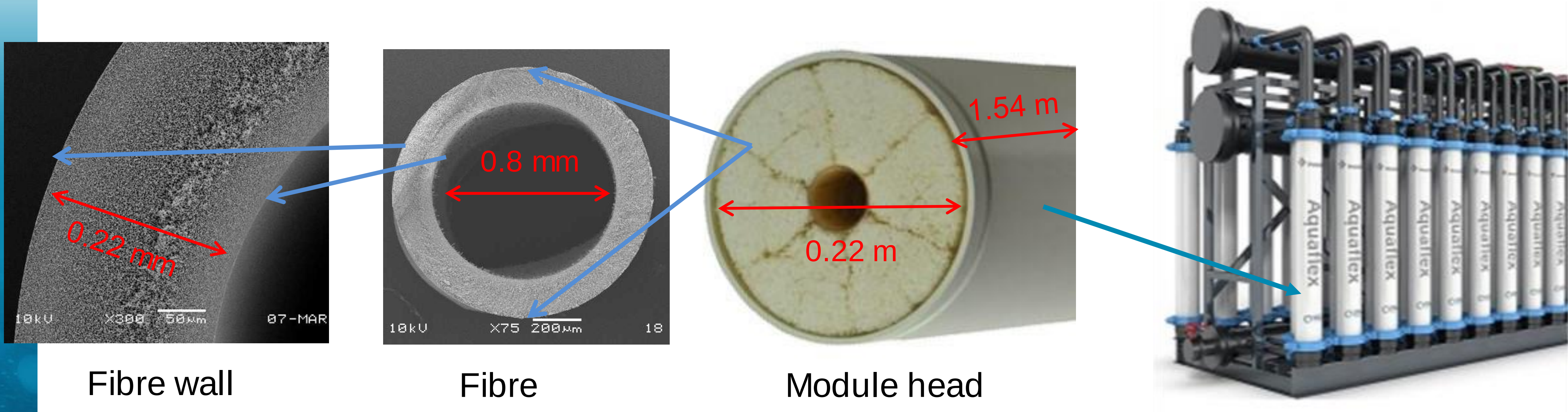
Hollow Fiber Ultrafiltration

PENTAIR X-FLOW

- Hollow fibers: 0.8 mm internal diameter
- Filtration: inside out
- Material: polyvinylpyrrolidone / polyethersulfone
- Module: 0.22 / 1.5 m (diameter / length), 64 / 75 m^2
- > 99.99% virus removal (NSF61 & NSF41)



Fibre wall

Fibre

Module head

Skid with modules

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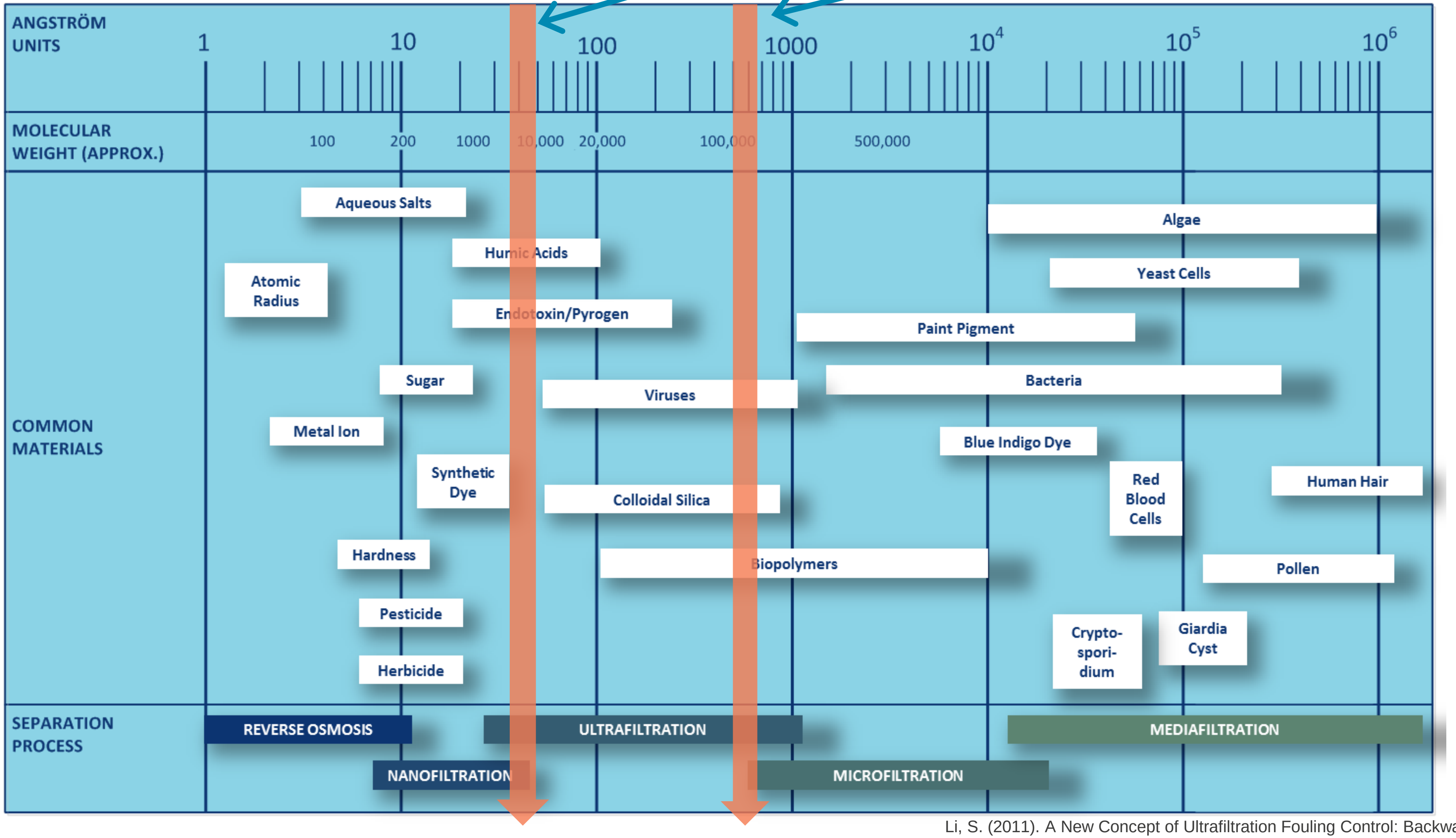
The Filtration Spectrum

Novel (ultra tight) UF membrane (~4 kDa)

Conventional UF (MWCO 150 kDa)



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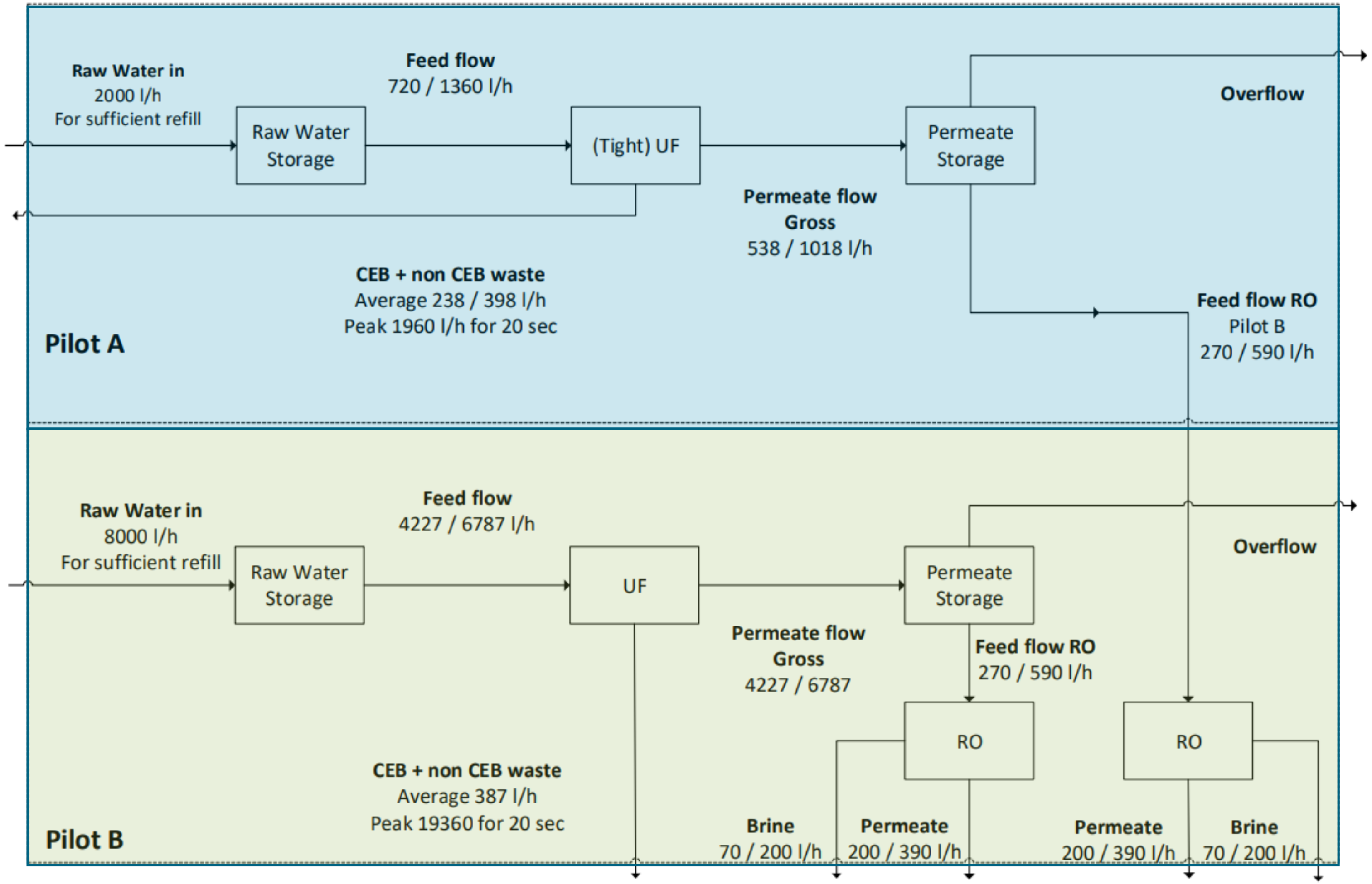
Schematic setup pilot plants



- Pilot A:

20 ft container with new tight UF

- Pilot B:

40 ft container with conventional UF and 2 small RO-units

Each RO-unit receives permeate from one of the UF-processes

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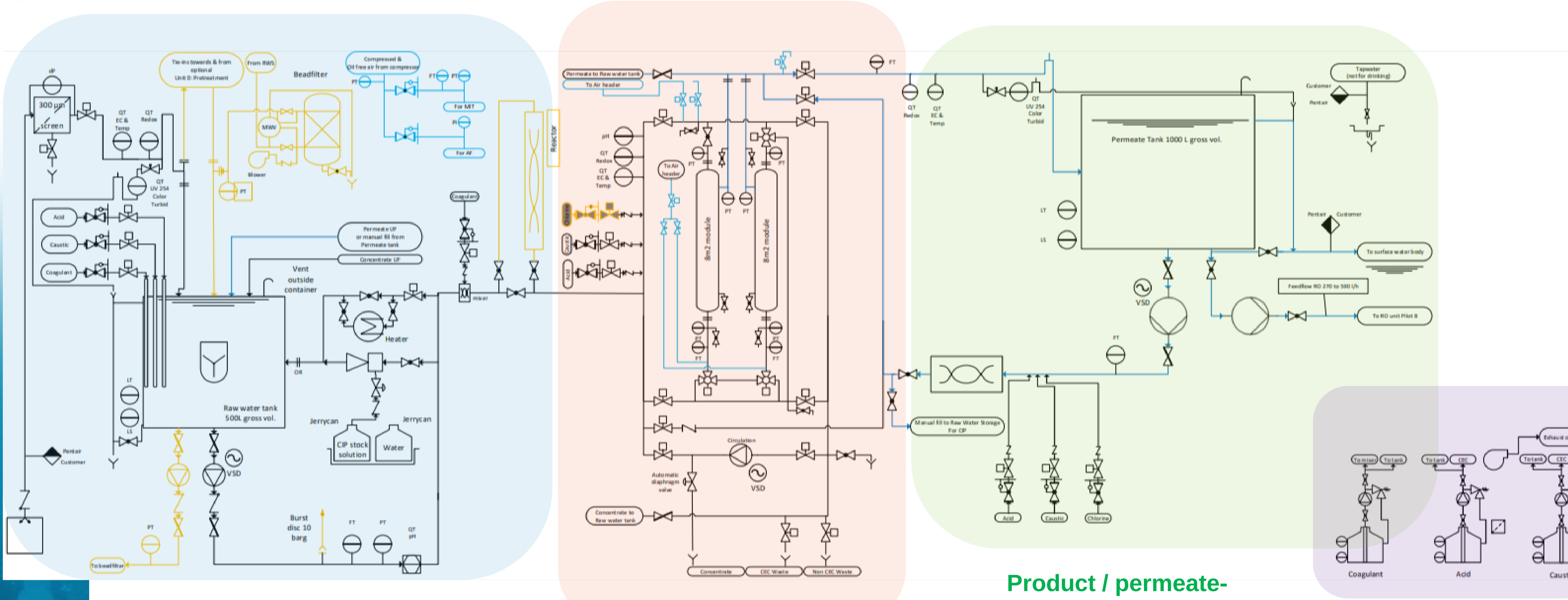
Flow diagram pilot A (tight UF)



Feed-section

Membrane-section

Product / permeate-section

Chemical cabinet

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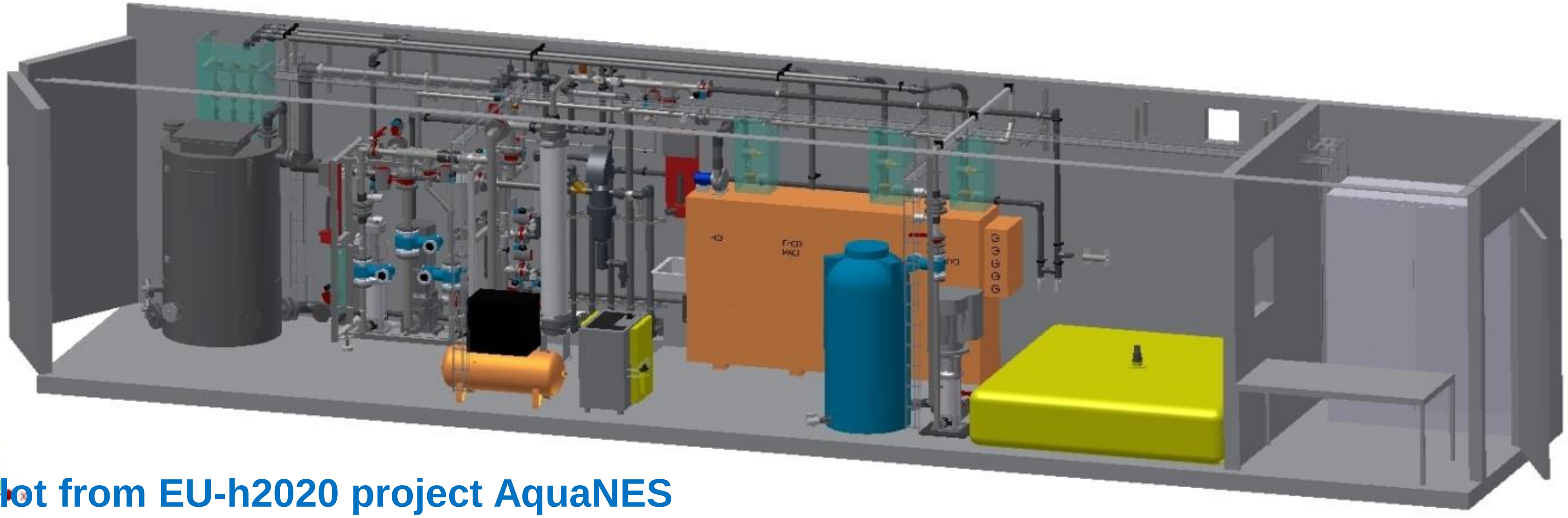
Pilot B from previous EU-h2020 project will be refurbished



Pilot from EU-h2020 project AquaNES

Containerized (40 feet)

Remote controlled

Full-scale NF or UF module (40-75 m^2)

Variable process settings

Simulation of one full-scale filtration stage

Feed: 0.5 – 6 m^3/h

Panorama-tour: http://showcase24.eu/pano/bwb-tiefwerder.html

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KPI's proposed (for Task 1.2.7)

KPI proposed	Parameter to be determined
Water yield & reduction of fresh water through reuse of treated wastewater	Inlet and outlet flowrate of the system Recoveries (UF, RO)
Water quality	Removal of specific compounds. Physicochemical and microbiological parameters from inlet and outlet; emerging organic pollutant; nutrient removal (or recovery)
Other parameters to be determined	
Energy consumption	Energy used for the treatment per m^3 obtained Energy used per kg of pollutant removal
Reagents & materials required	Amounts of reagents used for treatment or materials (flocculant, etc.) per m^3 produced and kg of pollutant removed
Wastes produced	Sludge generated (kg per m^3 produced) and brines (m^3 per m^3 produced)

WATER - Task 1.2.7

Parameters to be determined in detail (to be discussed!)

- Physicochemical parameters (temperature, pH, conductivity, O_2, ORP, turbidity, suspended solids/ TDS, UV absorption (254nm), colour (436nm), DOC, TOC, COD, Fe, Mn, hardness, carbonate hardness, Ca, Mg, CO_2, HCO_3, acid capacity, base capacity, total alkalinity, Al, Ba, Cl, K, Na, SiO_2, Sr, F, B, SO_4 – only a selection continuously!)
- Microbiological parameters (pathogenic bacteria, viruses and parasites (e.g. *E. Coli*, *Enterococcus*, somatic coliphages, *Clostridium perfringens* spores/spore-forming sulphate reducing bacteria)), Emerging organic pollutants (depending on existing pollutants)
- Nutrients (NH_4, NO_3, PO_4, TP, BOD_5)
- Performance parameter (flow, pressure, temperature, intervals backwash, chemical cleaning, CIP's)

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Planning for testing water reuse (Task 1.2.7)

		2020							2021												2022												2023												2024				
		6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Internal milestones: pilot plant		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
UFs (novel & commercial), RO designed	X-Flow																																																
UF's & RO's constructed	X-Flow																																																
Commissioning pilots	X-Flow																																																
Transport, installation & commiss. on site	X-Flow																																																
Support pilot process operation	X-Flow																																																
Discussion & support: pilot plant design	all																																																
Preparation of periphery for plant imple-mentation (pipes, electricity, etc)	KAL																																																
Pilot plant implemented and operational	KAL																																																
Scenario I: UF&RO – pilot operation	KAL																																																
Scenario I (UF-RO) - evaluation	KWB																																																
Biofilter (BF): tendering for rental	KAL																																																
Preparation of periphery for plant imple-mentation for scenario II	KAL																																																
Scenario II: O3/BF-UF&RO – pilot operation	KAL																																																
Scenario II (O3-BF-UF-RO) - evaluation	KWB																																																
PAC unit tendering	Novo																																																
Preparation of periphery for plant imple-mentation for scenario III	KAL																																																
Scenario III: PAC - UF&RO – pilot operation	KAL																																																
Scenario III ([w/&w/o PAC]-UF-RO) - evaluation	KWB																																																
Comparison of Scenarios	KWB																																																

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Summerizing some high lights

The project will deliver:

- Insight in the performance of the novel ultra-tight UF membrane (with challenging WWTP effluents)
- Insight in quality of produced water
- Effectiveness of novel UF in protecting the RO is compared with conventional UF
- KPI's will be available to assess the (economic) feasibility for the water treatment steps

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