

Gruppo CAP's case study on the TFA challenge: treatment technologies and pilots testing

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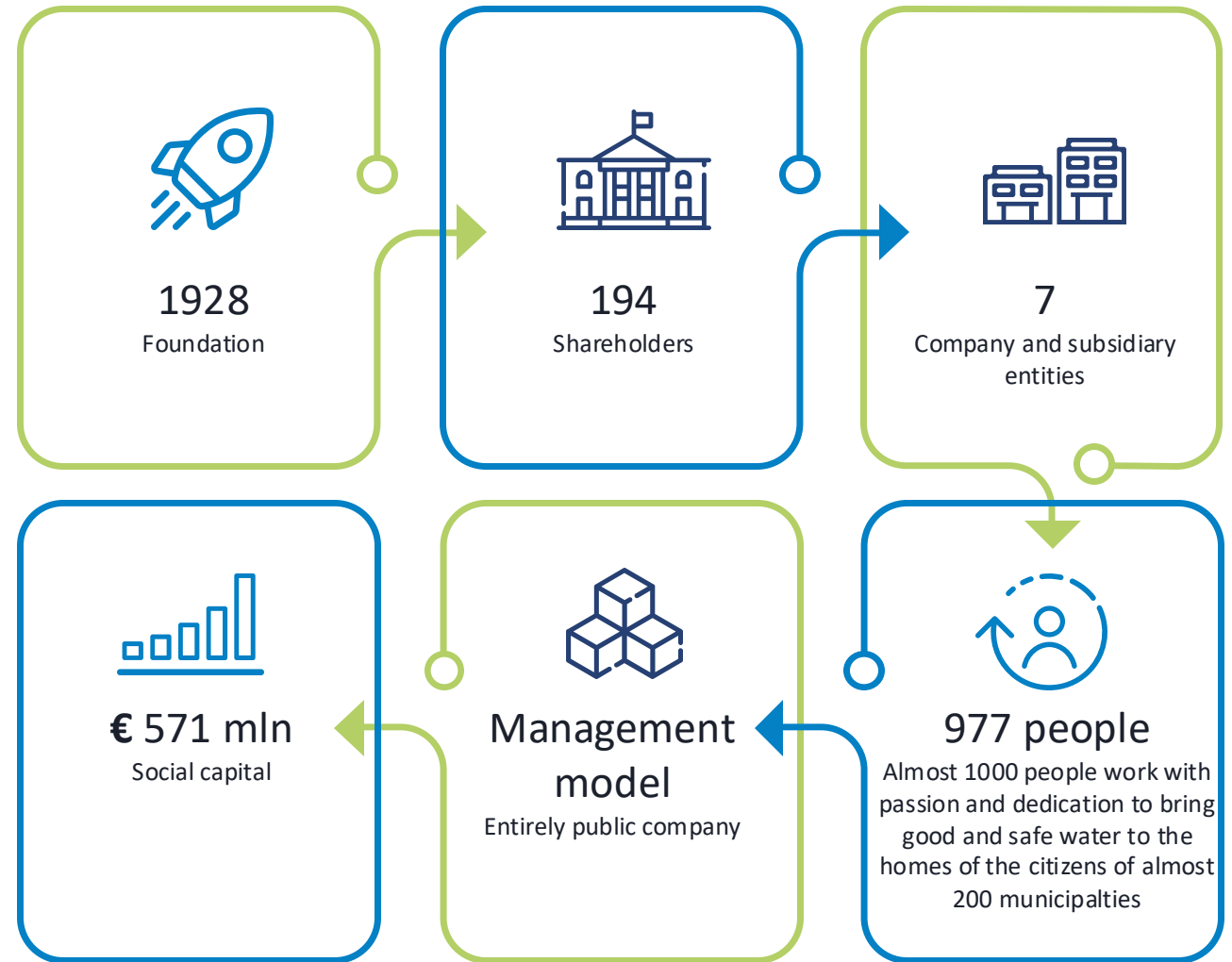


About us

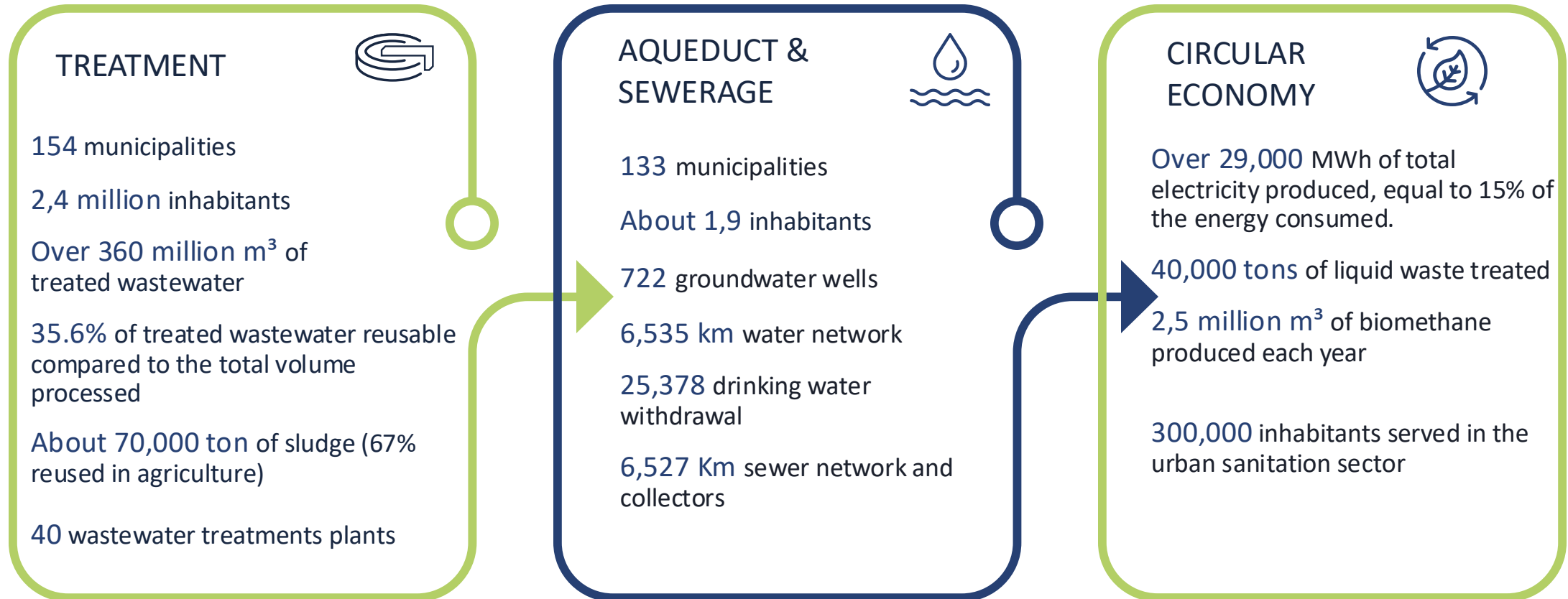
Gruppo CAP is the public company that manages the **Integrated Water Service of the Metropolitan City of Milan** and plays a key role in the development and innovation of Lombardy's water infrastructure.

Thanks to a system of shareholdings, business networks and joint ventures, Gruppo CAP is also active in the fields of waste treatment, bioenergy, green energy and circular economy.

We're becoming a true **green utility** by operating across markets that are complementary to the water sector and essential to the planet's sustainable development, helping them move toward sustainability and a circular economy. In terms of size and assets, Gruppo CAP ranks among the most important single-utility companies on the national scene.



What we do



Regulatory framework: D.Lgs. 102/2025: New Limit on TFA

New limit 01/2026

ADDITION OF 6 NEW CONGENERS

PFAS	sum	limit
The sum limit for PFAS has remained unchanged at 0.1 µg/l.		
Addition of new congeners		
Development of a new analytical method		
Lowering of the LOQ		
The current limit of quantification (LOQ) of 0.01 µg/l is to be lowered to 0.001 µg/l		

New limit 01/2026

SUM 4 PFAS < 0,02 µg/l

PFOA,
PFOS,
PFNA
PFHxS

New limit 01/2027

TFA < 10 µg/l

Fluorinated compound of the PFAS family, TFA (trifluoroacetic acid) is derived also from the degradation of other PFAS. The limit is set at 10 µg/l. This requires the development of a new analytical method, distinct from that used for PFAS, which will double the current analysis times, and subsequent mandatory accreditation from 2026.

TFA: trifluoroacetic acid

Trifluoroacetic acid (TFA) is a synthetic organofluorine compound with the chemical formula $\text{CF}_3\text{CO}_2\text{H}$.

It belongs to the subclass of per- and polyfluoroalkyl substances (PFASs) known as ultrashort-chain perfluoroalkyl acids (C2).

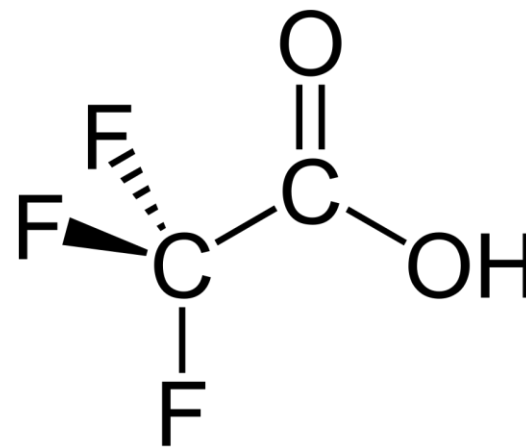
TFA is not produced biologically or abiotically and is commonly used in organic chemistry for various purposes (pharmaceutical, pesticides..)

It is the most abundant PFAS found in the environment.

Could be produced also by the degradation of longer chain PFAS.

Highly polar, strongly acidic

Potentially toxic (recently discussed by ECHA)



Two cases of TFA contamination documented to date in Europe:

Saldrines, France, 2024: Discharge from a Solvay production site manufacturing fluorinated refrigerants, polymers, pharmaceuticals and pesticides, with TFA concentrations of 7.6 mg/L in surface waters near the site, which was subsequently closed in 2024.

Neckar River, Germany, 2020: TFA concentrations of up to 0.1 mg/L in surface water due to discharges from a Solvay production site.

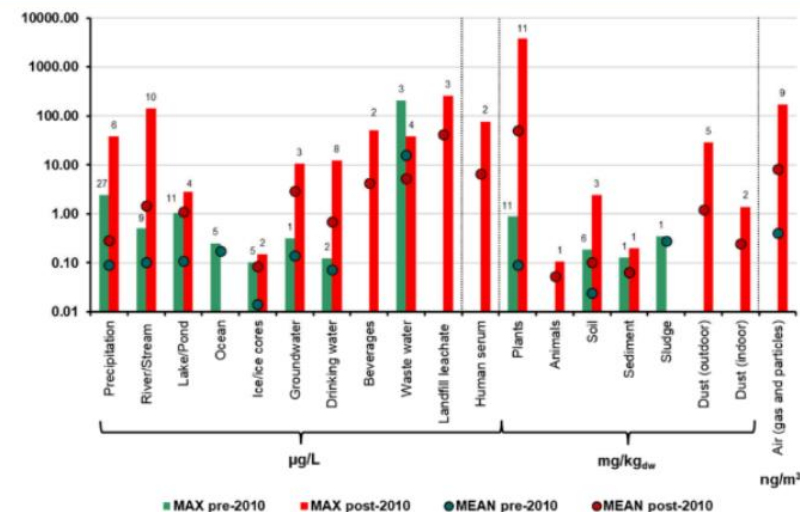
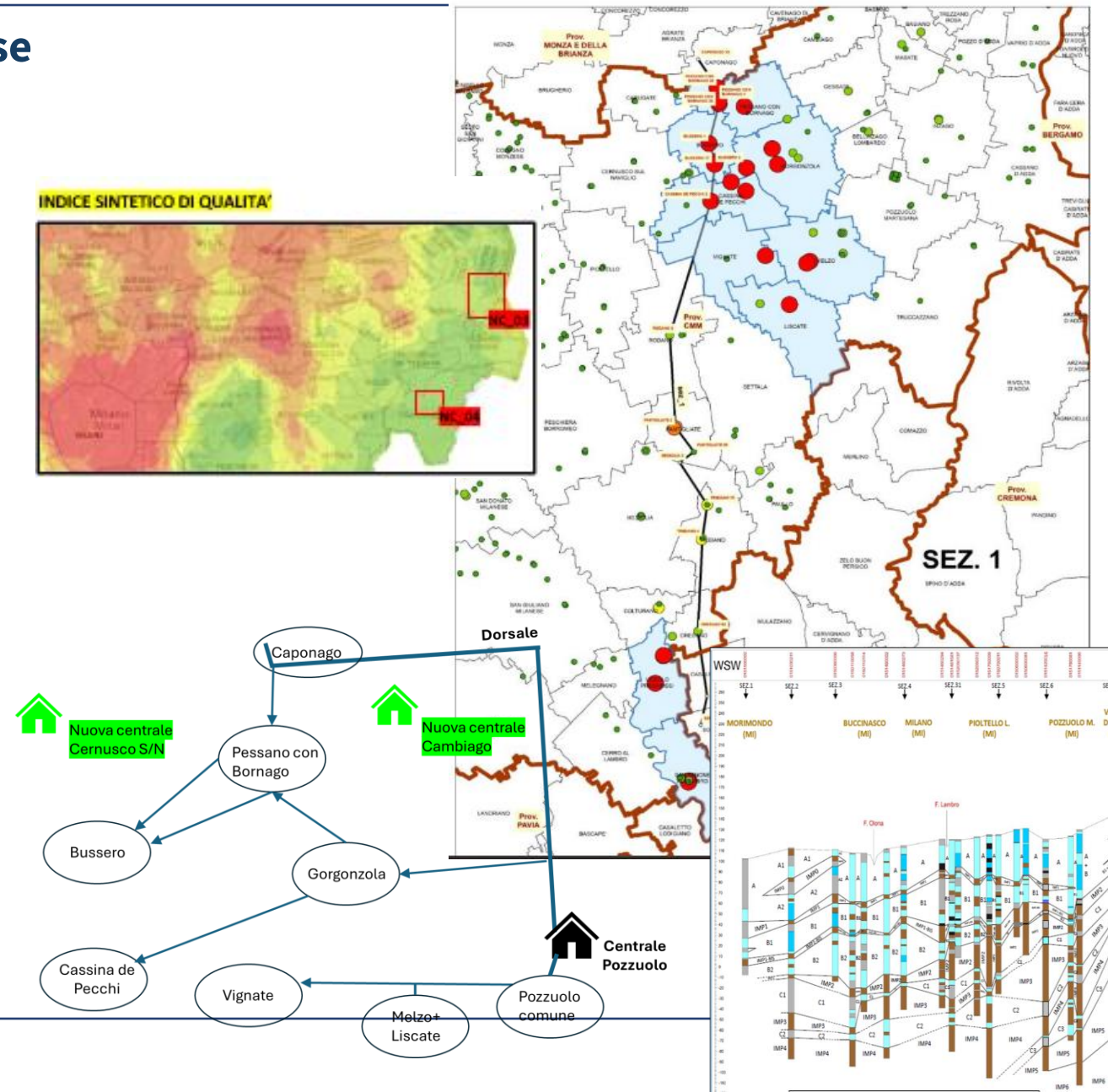


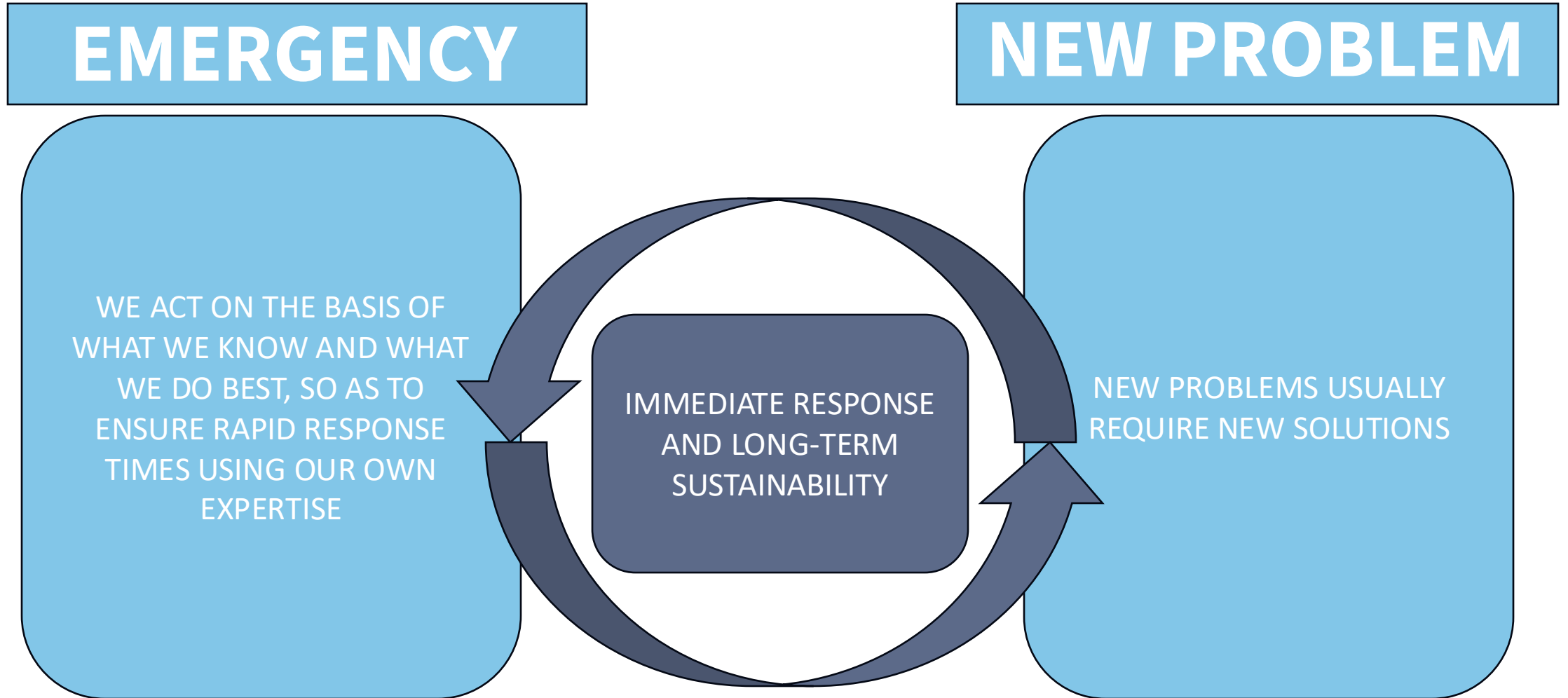
Figure 1. Comparison of TFA concentrations detected in different media summarized as before 2010 (green) and after 2010 (in red). Reported values of maximum concentrations found in the literature review are shown as vertical bars and mean values of reported monitoring means and medians are shown with overlapping dots. Numbers indicating the number of summarized individual data points are shown above the corresponding bars. In cases of either green or red bars and dots missing, data were not available for the given media and/or time frame. For air concentrations before 2010 only two studies were available, one of which reported only mean measured concentrations (see [Table S1](#) for the full data set and [Figure S3](#) for air data presented as concentrations from individual studies).

TFA contamination plume and emergency response

- June 2025: finalization of the in-house laboratory method
 - Start of field sampling
 - Discovery of a significant contamination plume affecting nine municipalities and compromising a large part of the water supply
- Activation of the crisis management team
- Network management to close contaminated wells and minimize exposure
 - Hydrogeological modelling:
 - Study of plumes and possible sources
 - Territorial survey to identify areas with good water quality for the construction of wellfields
 - Design and engineering
 - Design of a new wellfield, water mains and connections between municipalities
 - In field surveys
 - Permits
 - Civil engineering works



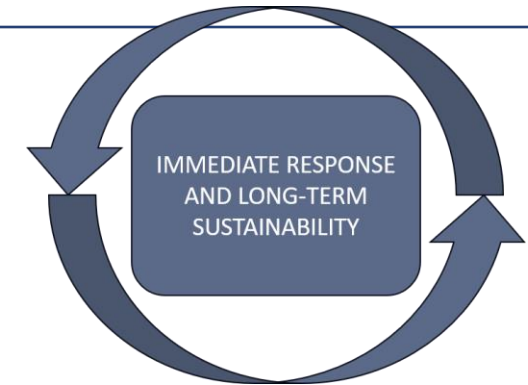
Approach to the emergency and R&D activities



Treatment technologies

Technological scouting

Selection and prioritization based on TRL and applicability



1) ACTIVATED CARBONS



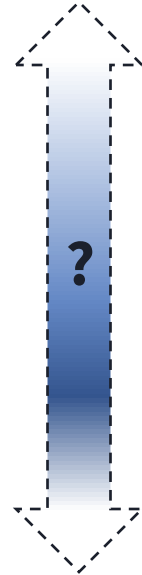
2) IONIC EXCHANGE RESINS



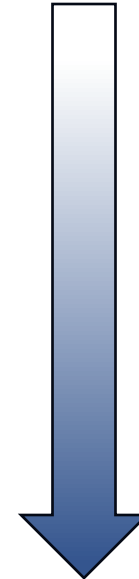
3) NANOFILTRATION / RO MEMBRANES

4) Others??

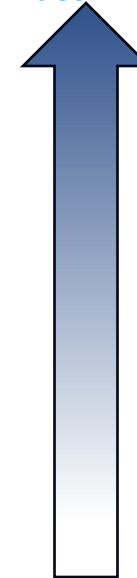
Effectiveness



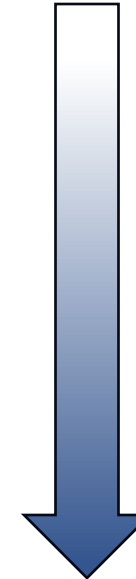
CAPEX



TRL drinking water



System complexity



OPEX



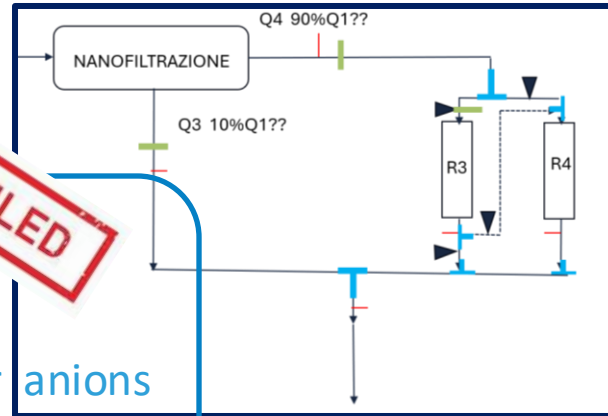
TESTS ON 2 PILOT PLANTS with different configurations and different membranes

01

Objective

Separation of TFA from other anions (NO_3 and SO_4) and downstream resin treatment, followed by mixing of the concentrate with the permeate on the resins: zero discharge and no remineralisation

- ✓ Good separation of SO_4 ;
- ✗ No separation of TFA and NO_3

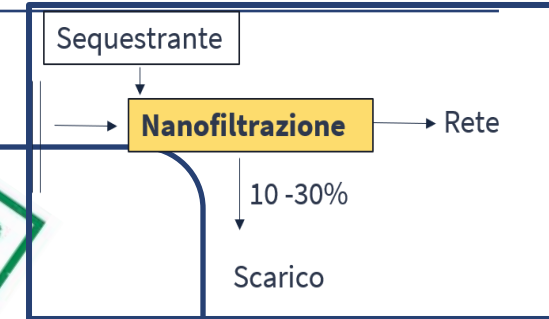


02

Objective

Nanofiltration / osmosis 'pure' testing different membranes using a standard configuration

- Retention of up to 100% TFA.
- Discharge of 10–30% concentrate from the treated stream
- Partial remineralisation or blending required



Effective technological solution with operational/management challenges to be addressed

CAP Ionic exchange resins

LABORATORY



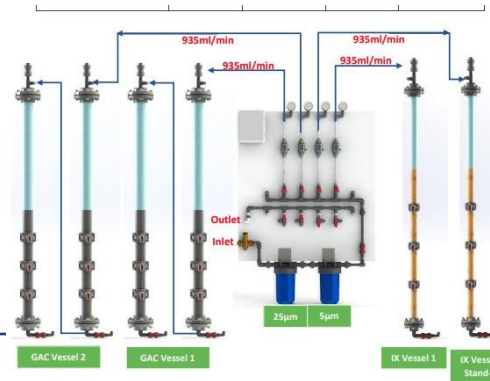
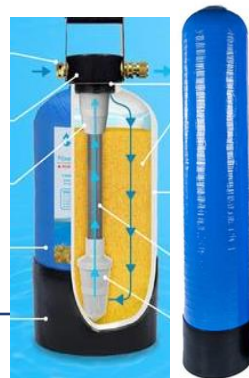
Preliminary absorption tests to select the best resins.

- **RESIN SELECTION:** >15 resins tested, 11 of which were tested on pilot plants;
- **EVALUATION AND OPTIMISATION:** >30 regeneration tests using different resins and under different conditions

PILOT PLANTS



- **4 TEST SITES and TECH**
- **ABSORPTION TESTS:** >50 test campaigns; >1000 samples.
- **CONSOLIDATION AND RESIN SELECTION:** 8 regeneration tests followed by absorption cycles
- **PERFORMANCE EVALUATION** in successive cycles



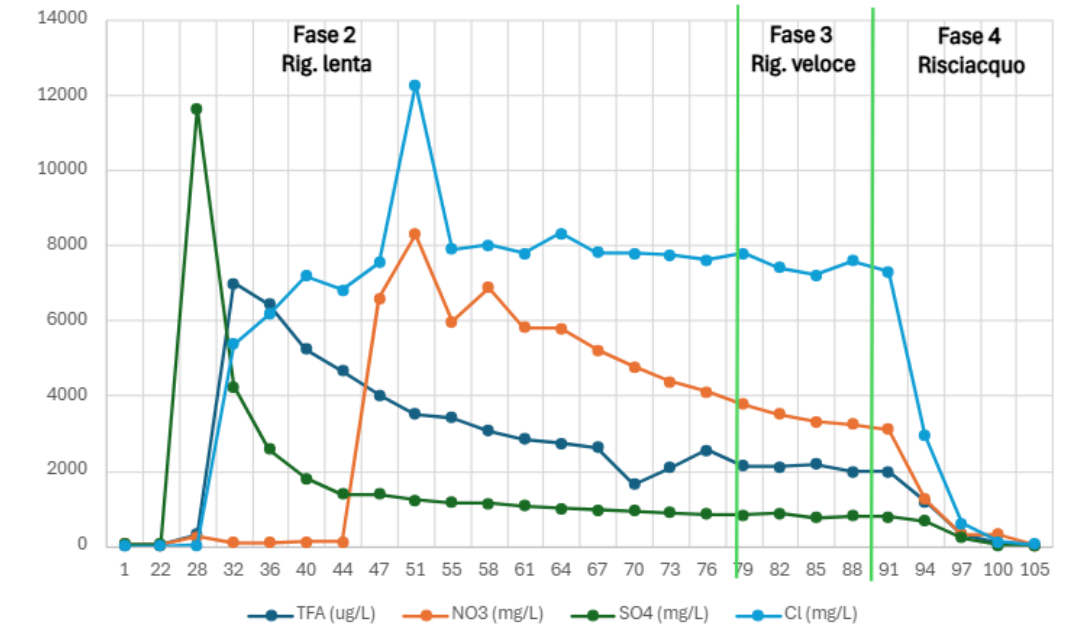
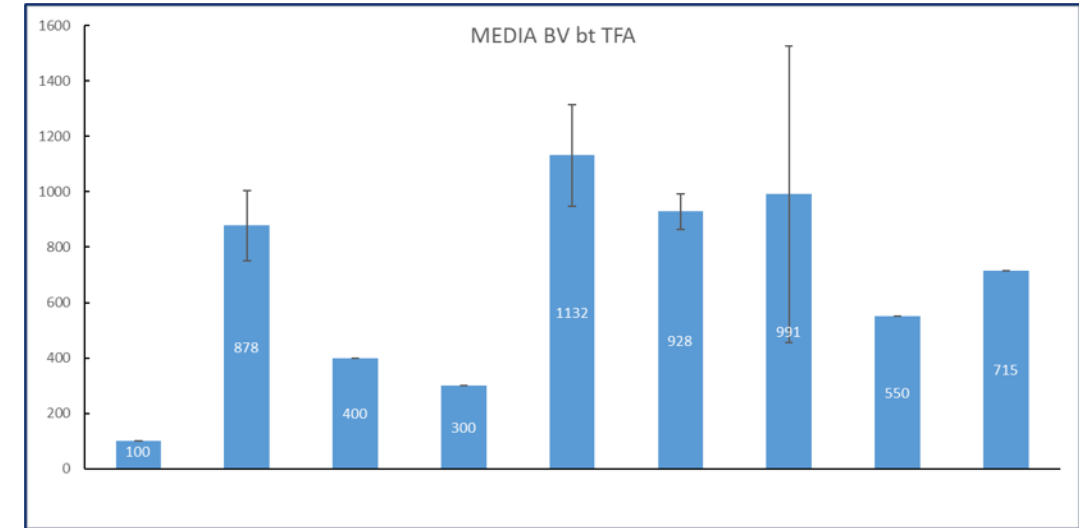
Ionic exchange resins

❑ **Best resin:** 800-1500 BV before BT → Regeneration needed

❑ **Competition with TFA absorption:** significant for nitrates and partial for sulphates

Several attempts have been made to separate anions, with only partial results so far

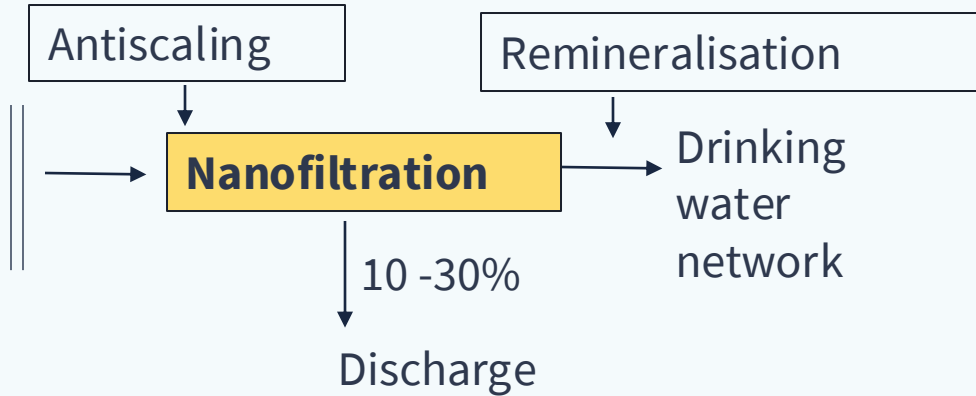
- ❑ The regeneration percentage varies with changes in the NaCl dose and increases with NaOH
- ❑ TFA recovery is lower than that of nitrates
- ❑ Based on observations to date, regeneration ensures that the subsequent operating cycle is of a duration comparable to previous ones
- ❑ Trails of TFA and leaks may be observed after regeneration. This is a point of attention
- ❑ Optimised counter-current regeneration can minimise critical issues



Treatment Technologies

NANOFILTRATION:

TREATMENT OF 50% -100% OF TFA LOAD

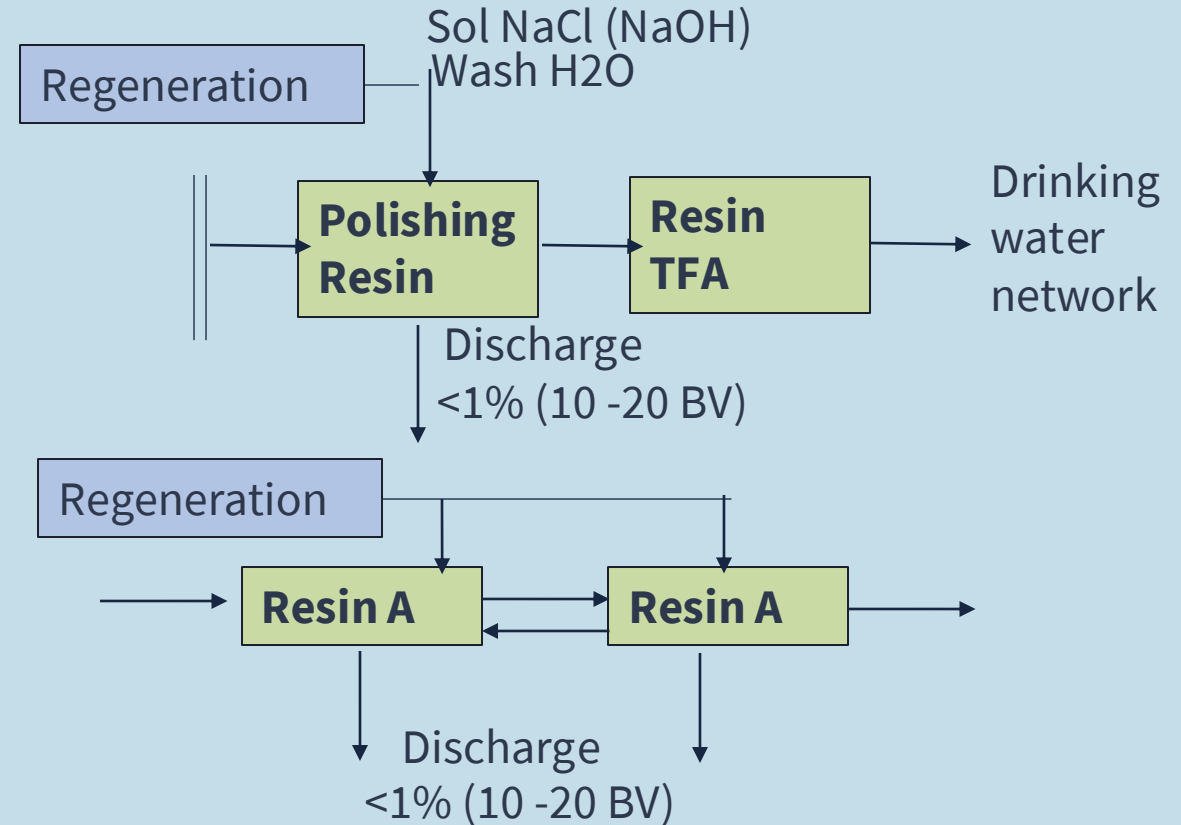


High-volume discharges with medium pollutant concentrations

Blending or remineralisation of the permeate is required

RESIN:

TREATMENT OF 100% OF TFA LOAD

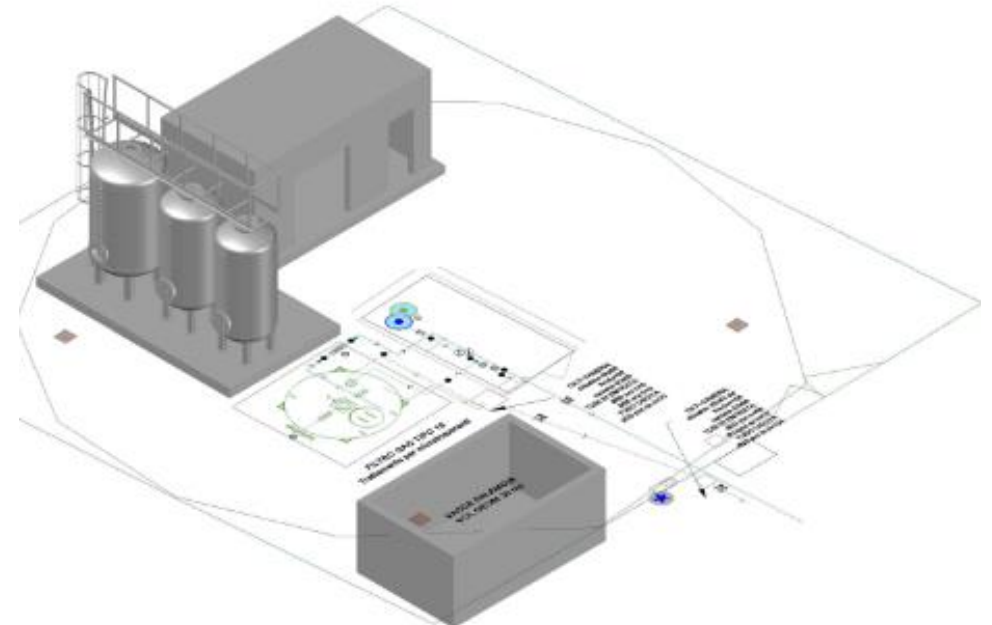


Low Volume, highly concentrated effluents with added reagents

Regeneration: a key step that needs to be optimised

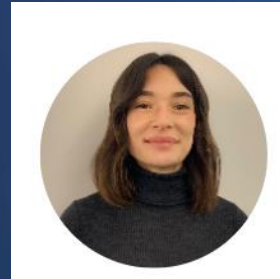
Sizing criteria:

- Startup planned: January 2027**



Grazie per l'attenzione!

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