CAPTURE

LIFE Capture

2nd International Congress on PFAS in Paris

2023-06-14

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- Alessandro Tucci

LIFE CAPTURE

Co-funded by the European Union

Combining novel Analytical protocols for PFAS contamination with Technologies for sustainable Remediation

DURATION

2022-10-01 – 2027-09-30

CONSORTIUM

ABO NV (ABO)

GreenSoil International BV (GS)

Politecnico di Milano (POLIMI)

Universita' Degli Studi Di Milano-Bicocca (UNIMIB)

IFLUX BVBA (iFLUX)

VIACQUA spa (VIACQUA)

Sveriges Lantbruksuniversitet (SLU)

SGS Belgium NV (SGS)

OBJECTIVES

4 main objectives

1 Sampling and analytical techniques

2 Monitoring framework

3 Remediation technologies

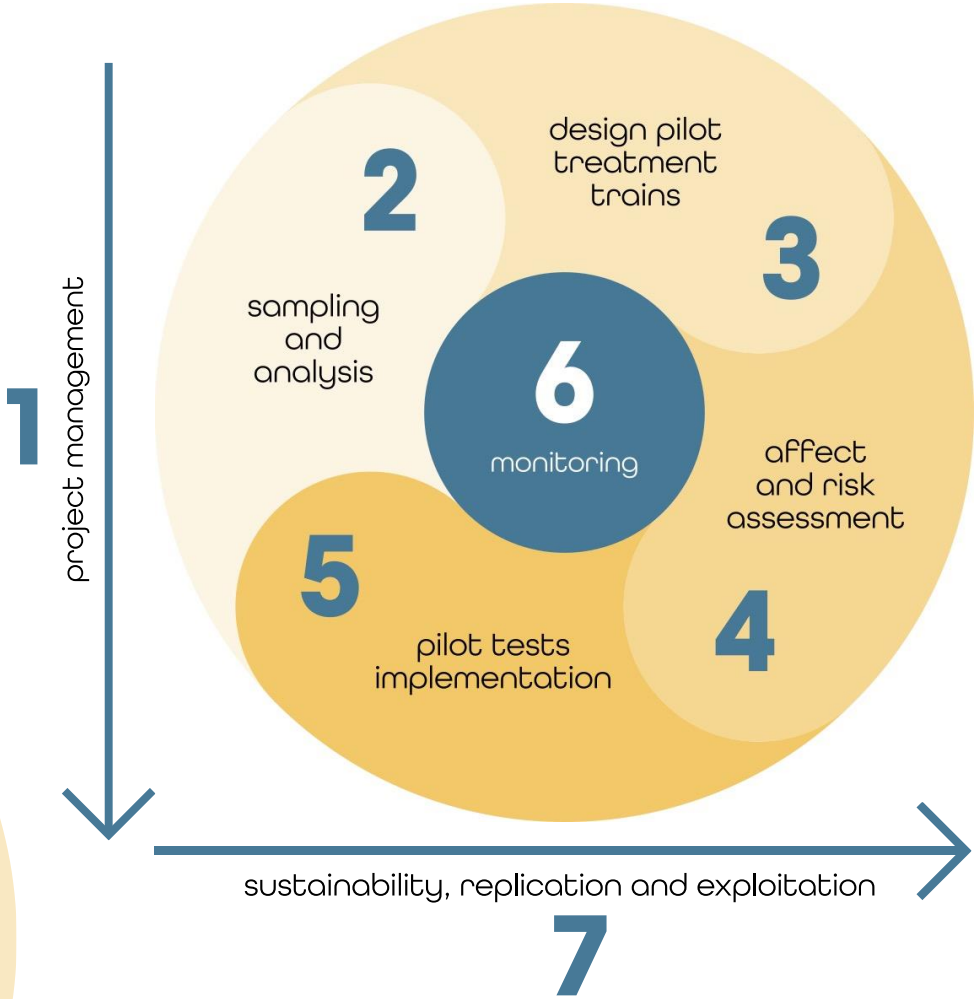
4 Effect and risk assessment

EXPECTED RESULTS AND IMPACTS

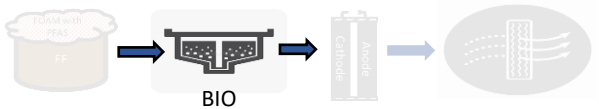
- 4 sites will be (partially) remediated during projects
- Other replication sites in the following years

- Volume of contaminated soil and groundwater treated
- Mass of PFAS removed

- CO_2 reduction in comparison with classical methods
- Employment generated & stakeholders informed


1
project management
2
sampling and analysis
design pilot treatment trains
3
6
monitoring
affect and risk assessment
4
5
pilot tests implementation
sustainability, replication and exploitation
7

1st step: Preliminary testing of the effect of PFAS on activated sludge process



1° step objective: Preliminary assessment of the potential toxicity of PFAS on activated sludge by lab-scale testing of COD removal efficiency with growing concentrations of PFAS

EXPERIMENTAL PLAN:

1 - Blank period: AS plant fed on primary clarified urban sewage (21 days)

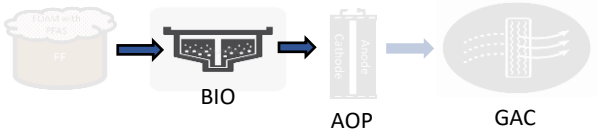
2 – 1st dose: AS plant fed on primary clarified urban sewage spiked with PFAS in order to obtain a concentration comparable to the lower concentration expected in the foam from SFF (21 days)

3 – 2nd dose: AS plant fed on primary clarified urban sewage spiked with a dose of PFAS double than the lower concentration expected in the foam from SFF (21 days)

….growing doses till 50% decrease of COD removal efficiency

Aqueous film-forming foams (AFFFs) were chosen for spiking urban sewage as they are one of the most important sources of PFAS pollution in soils and waters within Life CAPTURE project

Characterization of the tested Aqueous film-forming foam (AFFF)



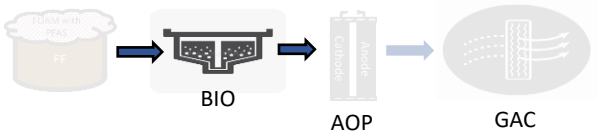
Perfluorinated alkyl compounds (PFAS)	**mg/kg**
4:2-fluorotelomer sulfonate (4:2-FTS)	0.013
6:2-fluorotelomer sulfonate (6:2-FTS)	8.274
8:2-fluorotelomer sulfonate (8:2-FTS)	< 0.010
Perfluorobutanoic acid (PFBA)	0.046
Perfluoropentanoic acid (PFPEA)	0.011
Perfluorobutanesulfonic acid (PFBS)	< 0.010
Perfluoroesanoic acid (PFHXA)	0.132
Perfluoroeptanoic acid (PFHPA)	< 0.010
Perfluoroesansulfonic acid (PFHXS)	< 0.010

AQUEOUS FILM-FORMING FOAMS (AFFFS) CHARACTERIZATION

Lab-scale plants

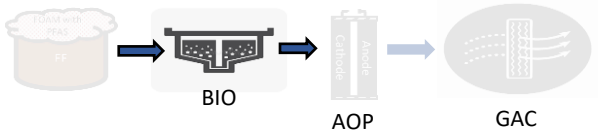
For the preliminary evaluation of the inhibiting effect of PFASs on activated sludge

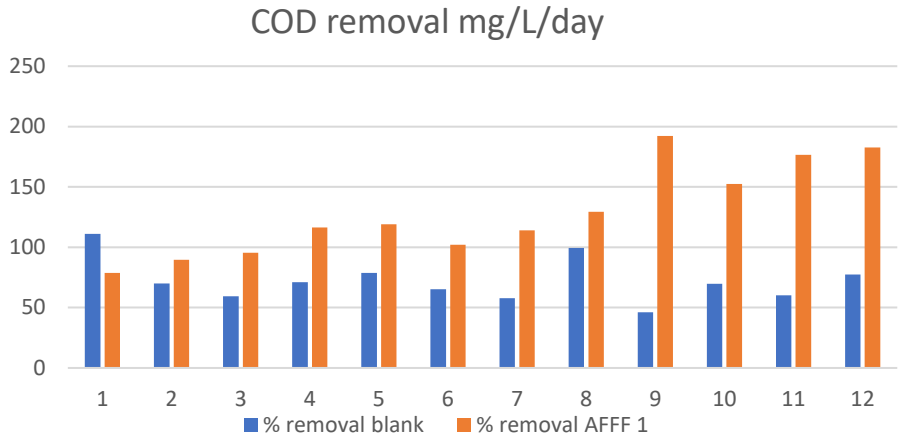
- Duplicate trials
- Total volume: 4.5 L, working volume: 2 L
- Mixing by magnetic stirring and air bubbling
- Continuous monitoring of DO, pH and temperature by probes
- Sludge inoculum from a municipal WWTP
- Semicontinuous feeding, HRT 18 h
- Daily sludge recirculation to keep TSS = 1.5-2 g/L in the mixed liquor
- 1st dose: 5 mL AFFF/L sewage
- 2nd dose: 10 mL AFFF/L sewage

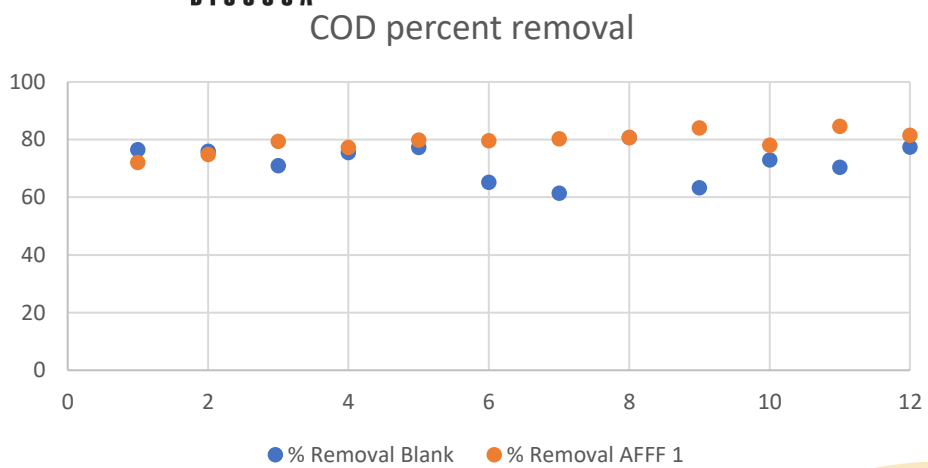


LAB SCALE TESTING

First results







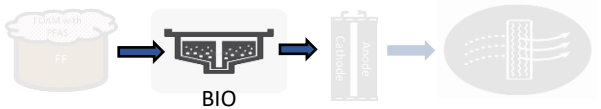
In the blank period COD removal rate: 46-111 mg COD/L/day

In the blank period COD % removal: 60-77%

With 5 mL/L AFFF COD % removal: 79-192 mg COD/L/day

With 5 mL/L AFFF COD % removal: 72-84%

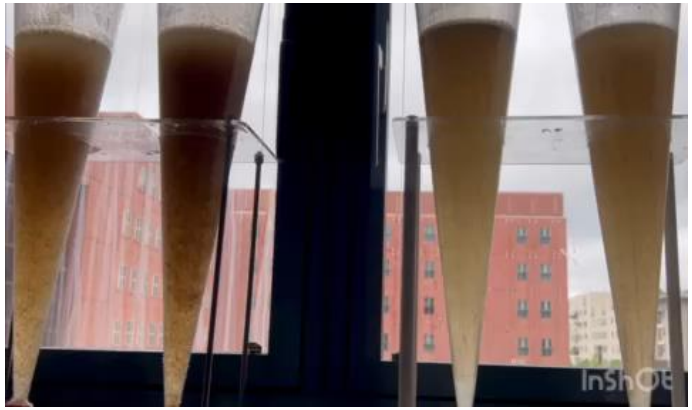
In the presence of AFFF COD removal increased as well as COD in the influent



5 mL/L AFFF contributed about 60 mg/L to the influent COD.

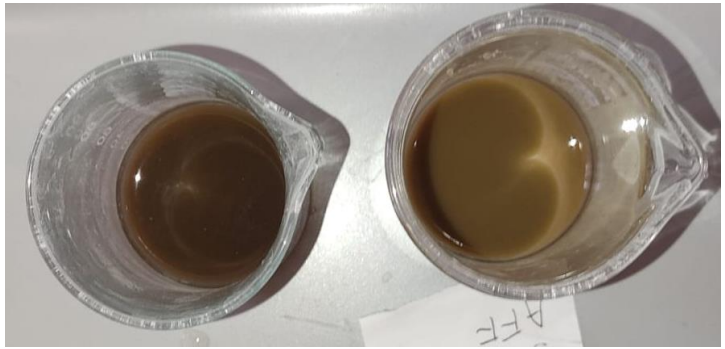
The average COD in the effluent was 31 mg/L, and it was 27 mg/L in the blank period.

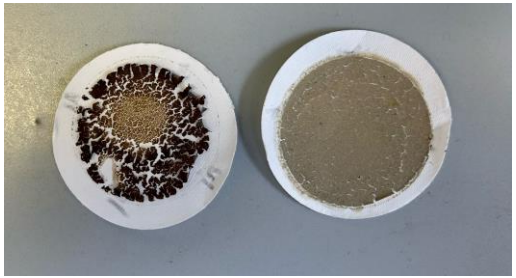
The system was able to remove part of the components of AFFF, other than PFAS



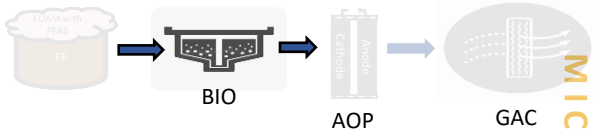
However, differences in colour and settling time of the sludge were observed. After the addition of AFFF, the sludge was paler and its settling time increased, with sludge tending to float

Without AFFF **5 mL/L AFFF**





BIO (…in progress)



Analysis of the microbial community in the activated sludge

MICROBIAL COMMUNITY CHARACTERIZATION

- Analysis of community composition by Next-generation sequencing (NGS):
- Bacterial community → 16S rRNA gene
- Fungi community → ITS1

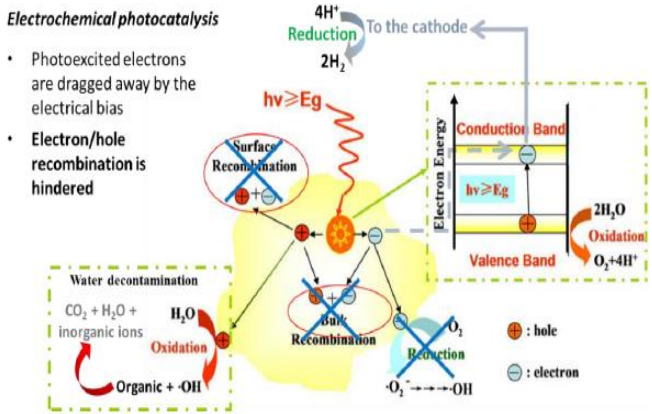
Quantification of cell abundance (qPCR):

- Bacterial → 16S rRNA gene
- Fungi → ITS1

MICROBIAL COMMUNITY CHARACTERIZATION

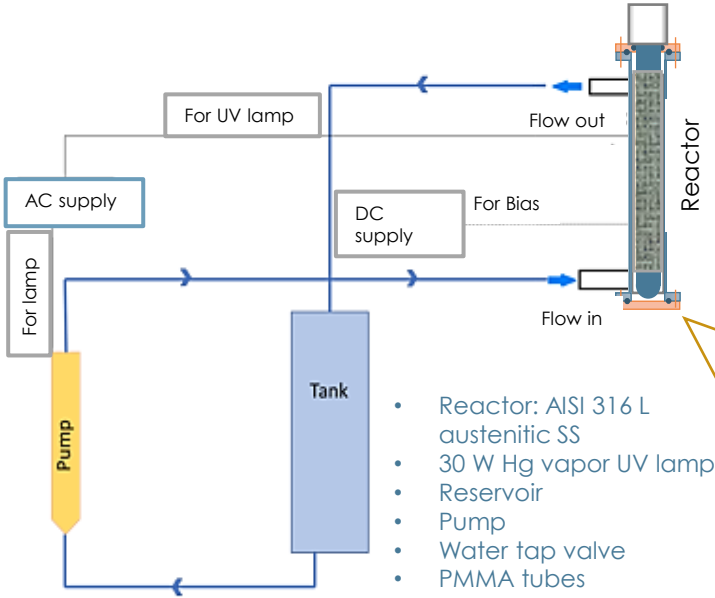
2nd step: Photoelectrocatalytic treatment of groundwater

Photoelectrocatalysis (PEC)

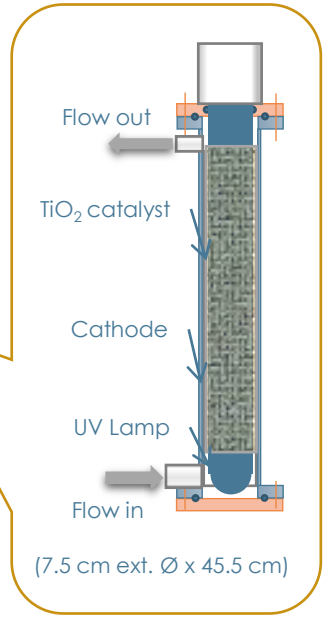


- Photoexcited electrons are **dragged away** by the **electrical bias**
- Electron/hole **recombination** is **hindered**

Semi-batch System

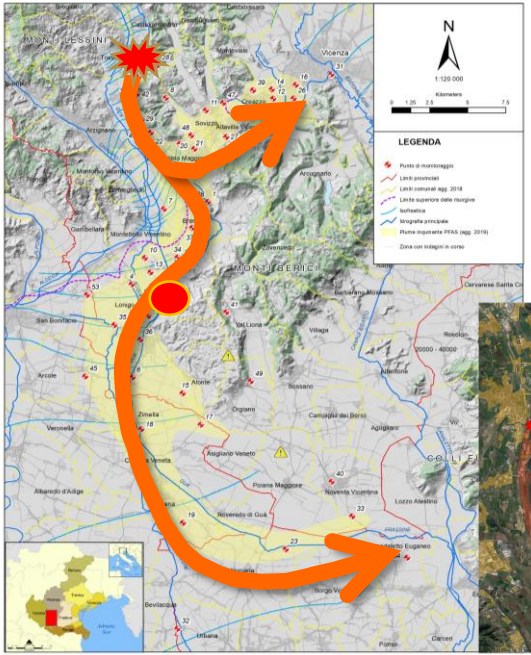


- Reactor: AISI 316 L austenitic SS
- 30 W Hg vapor UV lamp
- Reservoir
- Pump
- Water tap valve
- PMMA tubes



Characterization of the tested Veneto groundwater

	Chemicals	Acronym	Concentration [ng/L]
Perfluorocarboxylic Acids (PFCA)	Perfluorobutanoic Acid	PFBA	515
	Perfluoropentanoic Acid	PFPeA	155
	Perfluoroesanoic Acid	PFHxA	154
	Perfluoroeptanoic Acid	PFHpA	43
	Perfluoroottanoic Acid	PFOA	690
Perfluorosulfonic Acids (PFSA)	Perfluorobutsulfonic Acid	PFBS	488
	Perfluoroesasulfonic Acid	PFHxS	42
	Perfluoroeptasulfonic Acid	PFHpS	6
	Perfluoroottsulfonic Acid	PFOS	45



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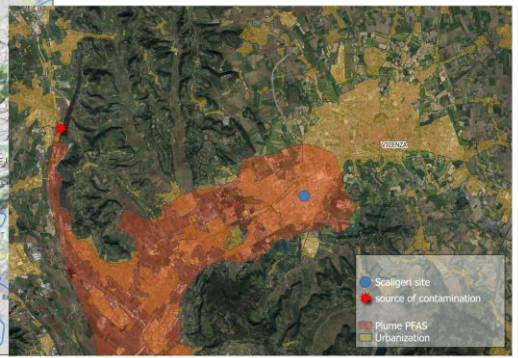

- **Total PFAS** concentration: **2138 ng/L**
- Presence of untargeted **fluorinated or non-fluorinated compounds**

PFAS degradation by PEC

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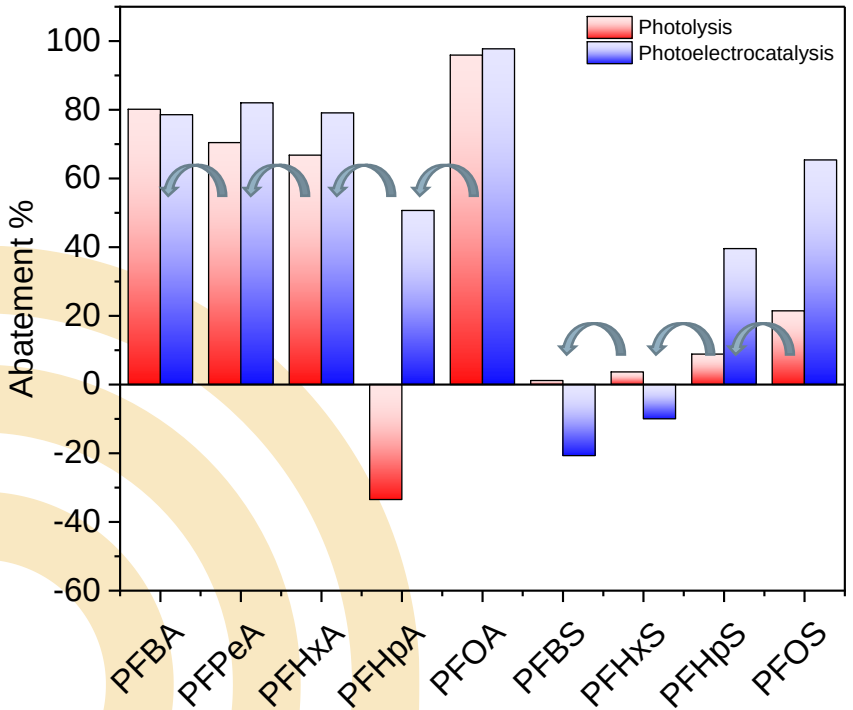
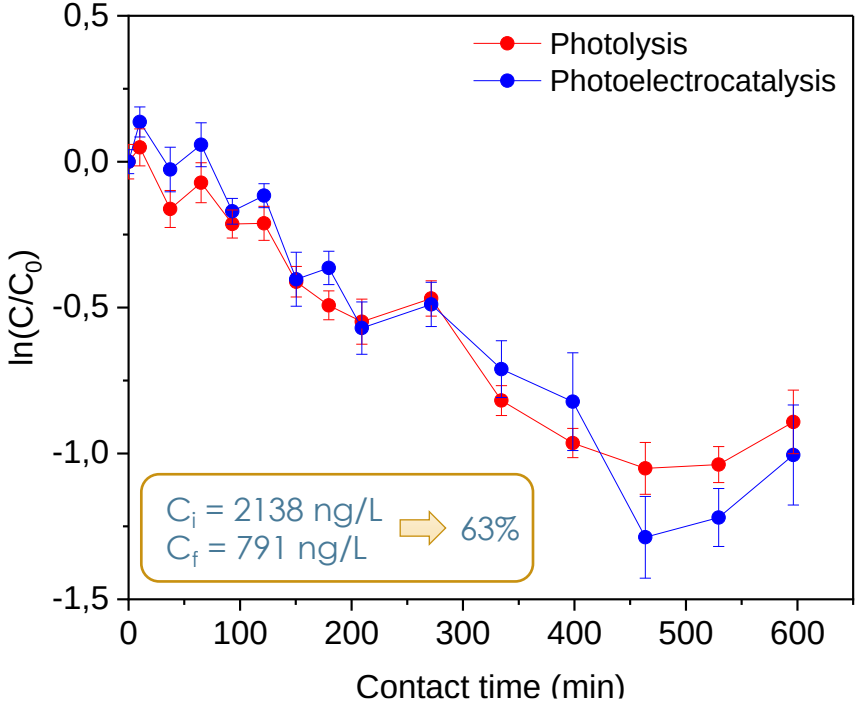
PFAS Abatement % (600 min)



Perfluoroalkyl subsatnces (PFAS) Degradation



PFAS degradation by PEC

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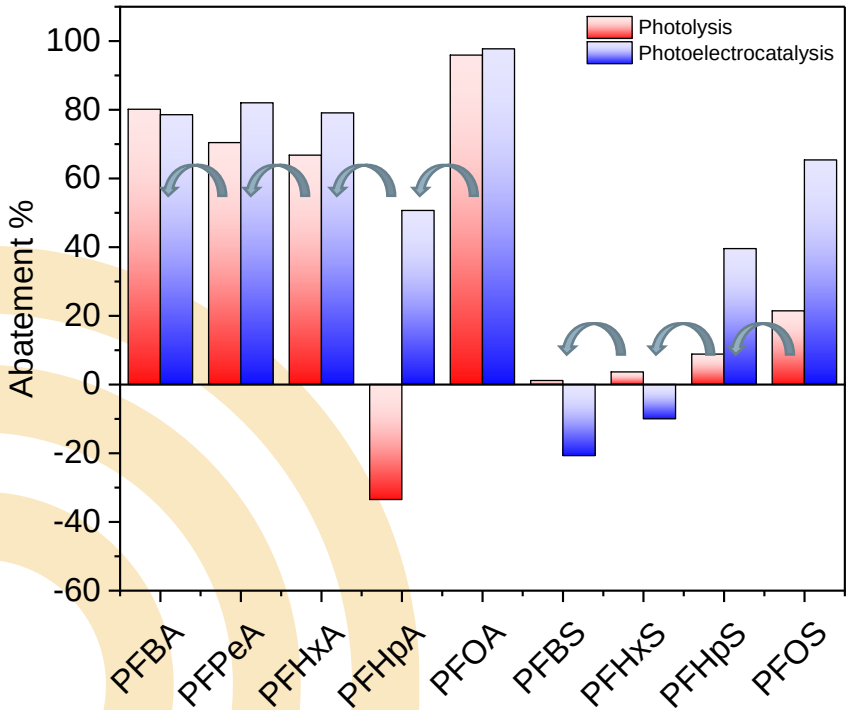
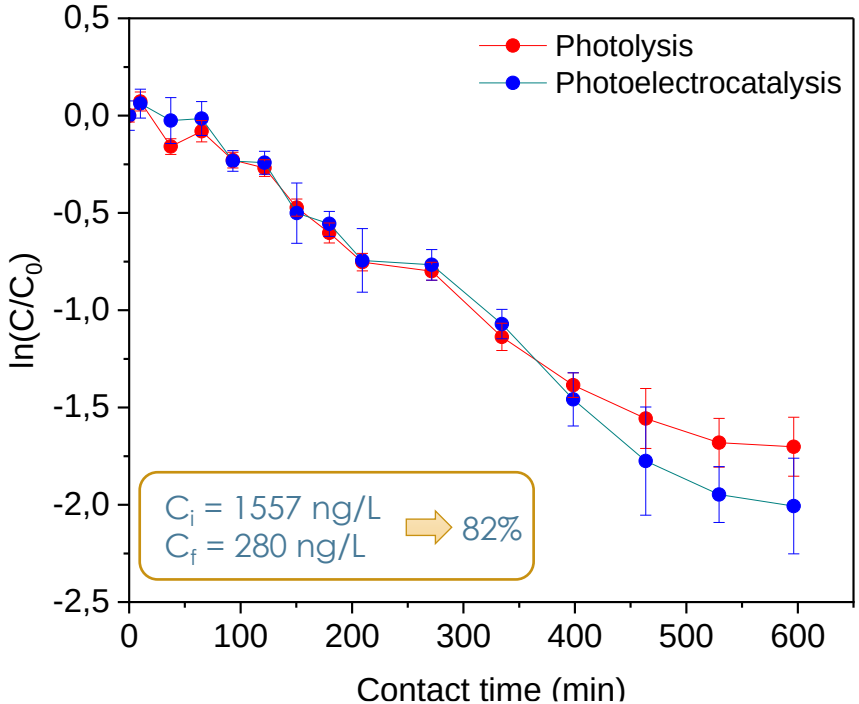
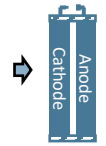
PFAS Abatement % (600 min)



Perfluorocarboxylic Acids (PFCA) Degradation



PFAS degradation by PEC: energy consumption



Electrical energy (KW/h) per order of magnitude (90% of degradation):

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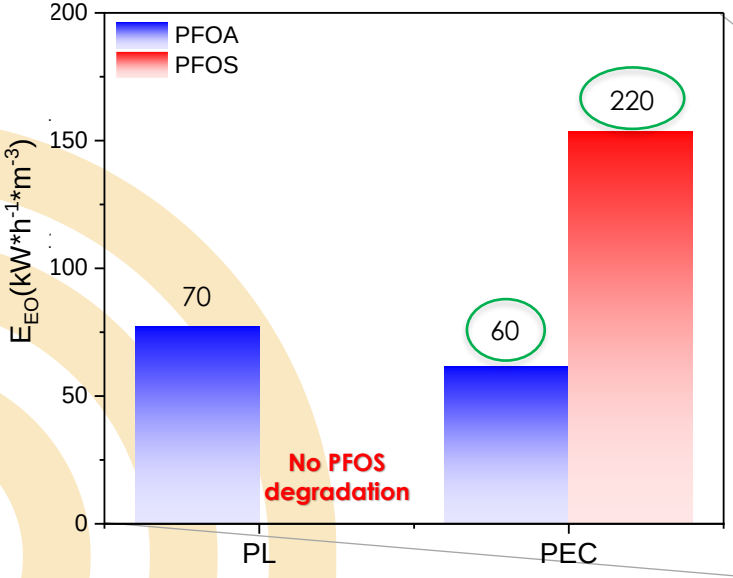
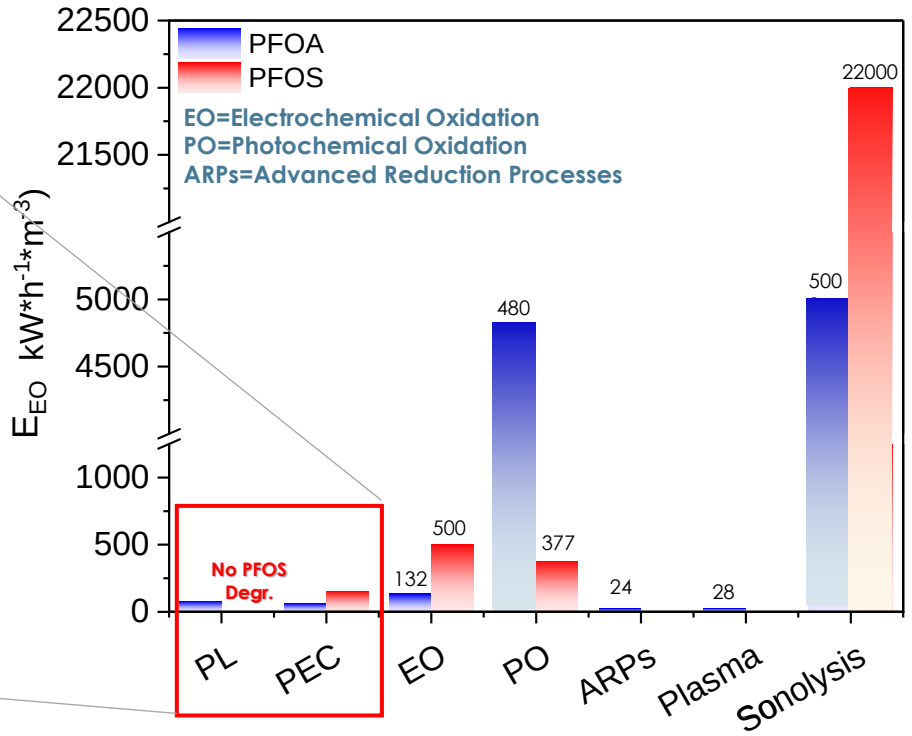
$$E_{EO} = \frac{P_{elec} \cdot t \cdot 1000}{V \cdot 60 \cdot log\frac{c_i}{c_0}}$$





PFAS degradation by PEC: Conclusion

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- Successful degradation of PFAS in Veneto groundwater, -63% of total PFAS in 600 min, -82% of PFCAs in 600 min
- PEC outperformed PL in the degradation of long-chain PFASs, particularly for per-fluorosulfonic acids.
- E_{EO} of PEC comparable (PFOA) or lower (PFOS) than the other laboratory scale AOPs

WEBSITE

https://www.life-capture-pfas.com/

LinkedIn

https://www.linkedin.com/company/93312606/admin/

REMTECH Europe

REMTECH EXPO

An event of Ferrara Expo

RemTech Expo

20th of September 2023

PROPOSED PROGRAM

2:30 - 4:00 pm	6 presentations by the LIFE CAPTURE partners
4:00 - 4:30 pm	Coffee break
4:00 - 4:30 pm	**6 presentations selected based on abstract calls**

Submit your call for asbtract

CAPTURE

THANK YOU

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QUESTIONS?