



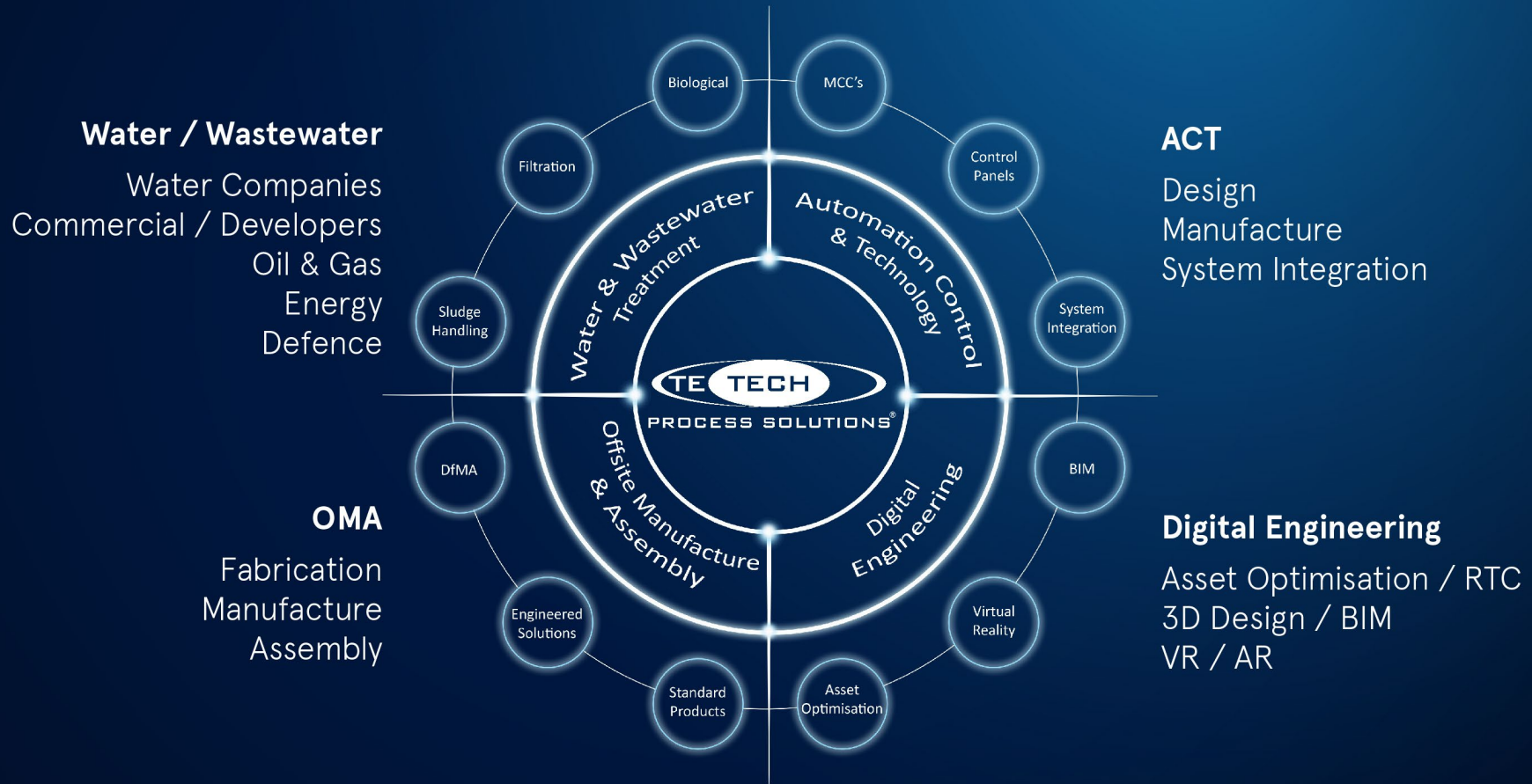
Treatment of emerging contaminants – An evaluation of the te-ion™ non-thermal plasma based oxidation process.

Ben Hazard, Process Engineer

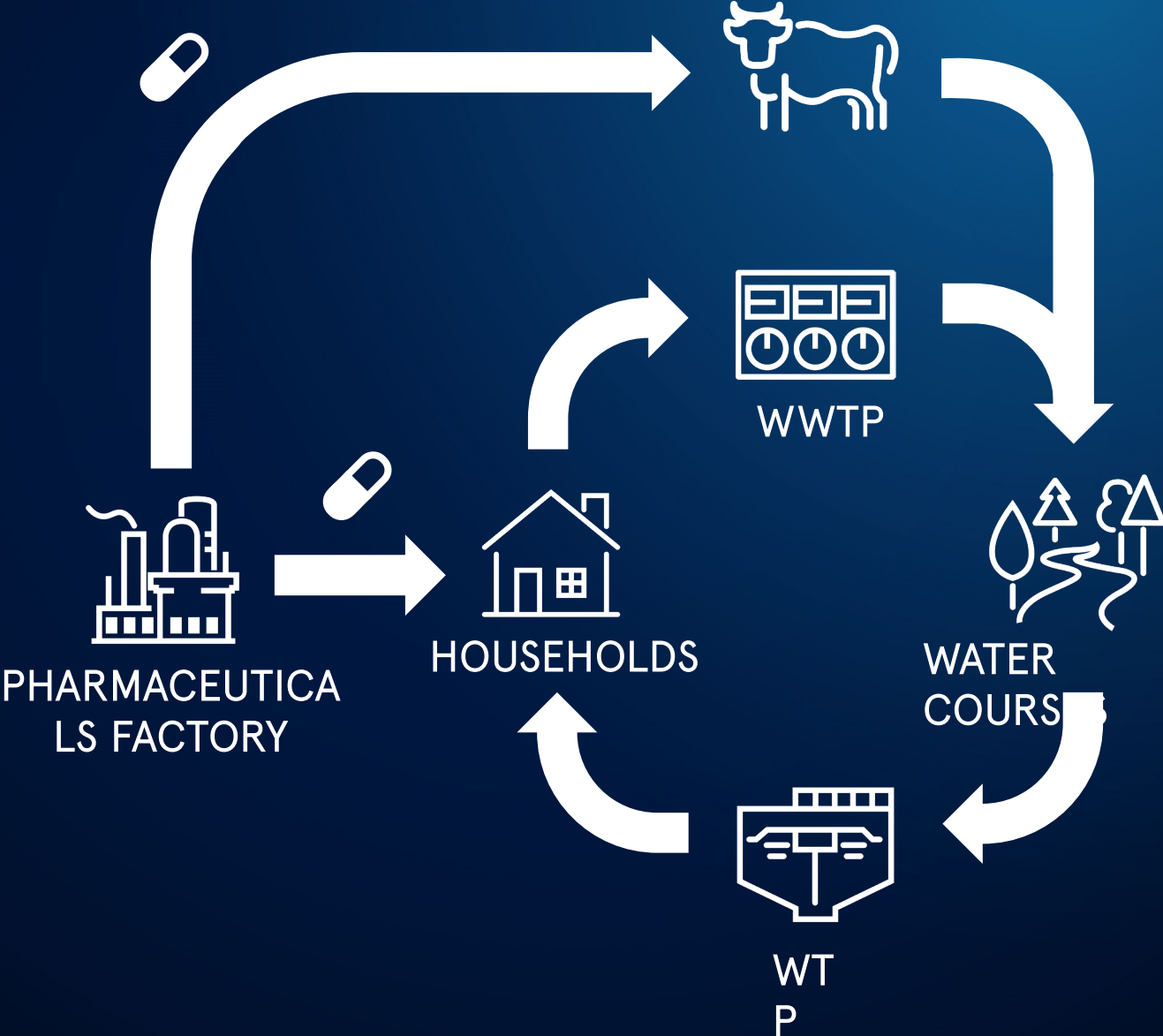
12/07/2022



# Company Overview

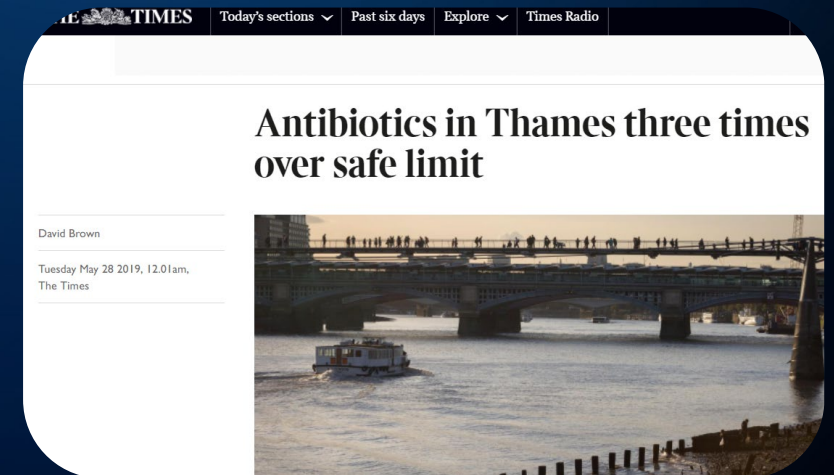


# Pharmaceuticals – what’s the problem?



# Pharmaceuticals – what’s the problem?

- Damage to aquatic life
- Antimicrobial Resistance (AMR)



# Regulation

## Water Framework Directive

- Priority Substance List
- Substance Watch List

Watch list of substances for Union-wide monitoring as set out in Article 8b of Directive 2008/105/EC

Name of substance/group of substances	CAS number (1)	EU number (2)	Indicative analytical method (3)	Maximum acceptable method detection limit (ng/l)
Metaflumizone	139968-49-3	604-167-6	LLE-LC-MS-MS or SPE-LC-MS-MS	65
Amoxicillin	26787-78-0	248-003-8	SPE-LC-MS-MS	78
Ciprofloxacin	85721-33-1	617-751-0	SPE-LC-MS-MS	89
Sulfamethoxazole (4)	723-46-6	211-963-3	SPE-LC-MS-MS	100
Trimethoprim (5)	738-70-5	212-006-2	SPE-LC-MS-MS	100

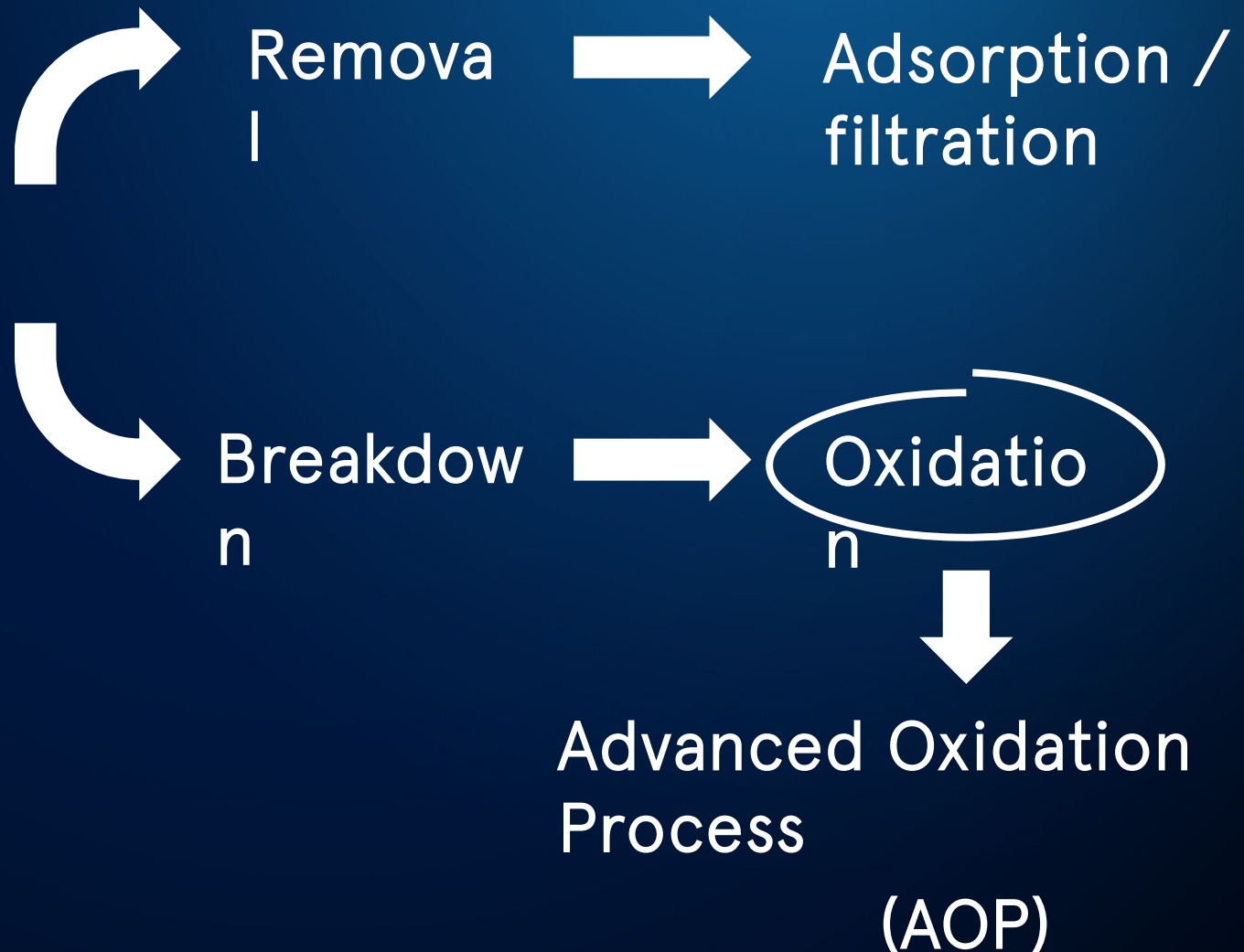
## Chemical Investigations Programme

- Data from CIP2 suggest that some painkillers, antibiotics, and hormones are of potential concern.



# What's the solution?

Pharmaceuticals  
Treatment



# Non-thermal Plasma

## (NTP) – Plasma

- 4<sup>th</sup> State of matter
- Generated from gas
- Mostly made up of charged particles → ions, electrons, and radicals

### Non-thermal

- Plasma generated at ambient temperature

## What is it?



# Non-thermal Plasma (NTP) –



## Current Applications

Medical

- Wound disinfection
- Cancer treatment
- Infection treatment

Food

- Preservation
- Sterilisation

Air Purification

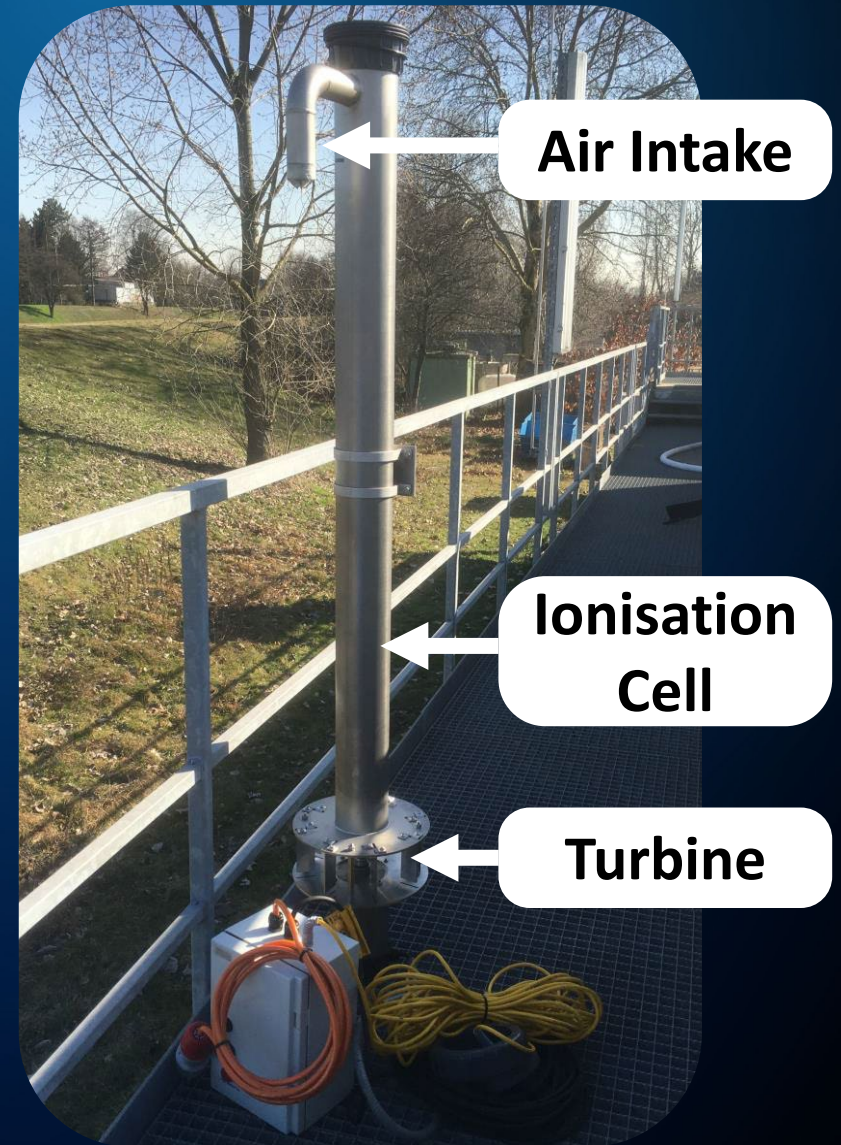
Textiles



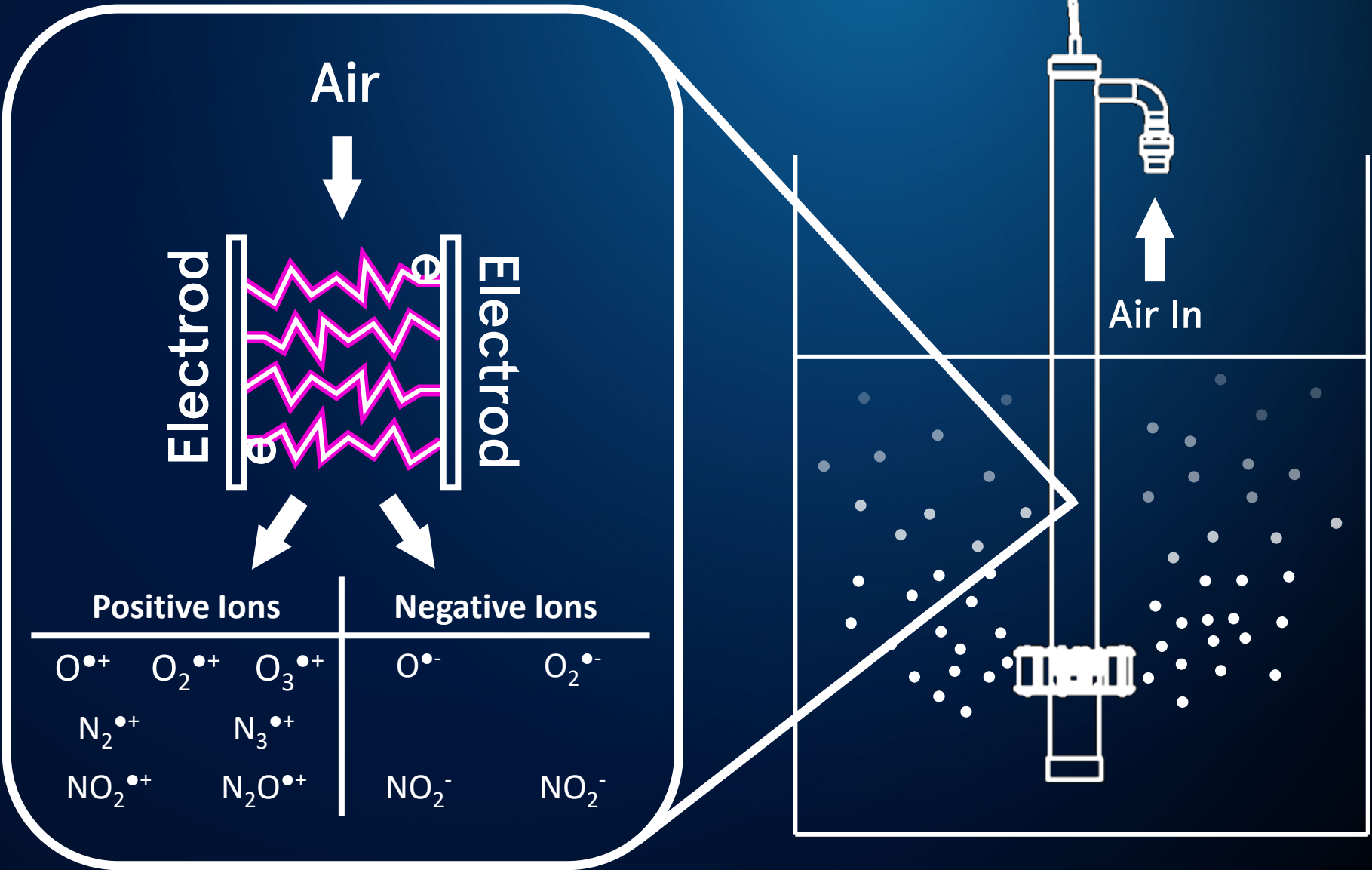


# te-ion™ Process

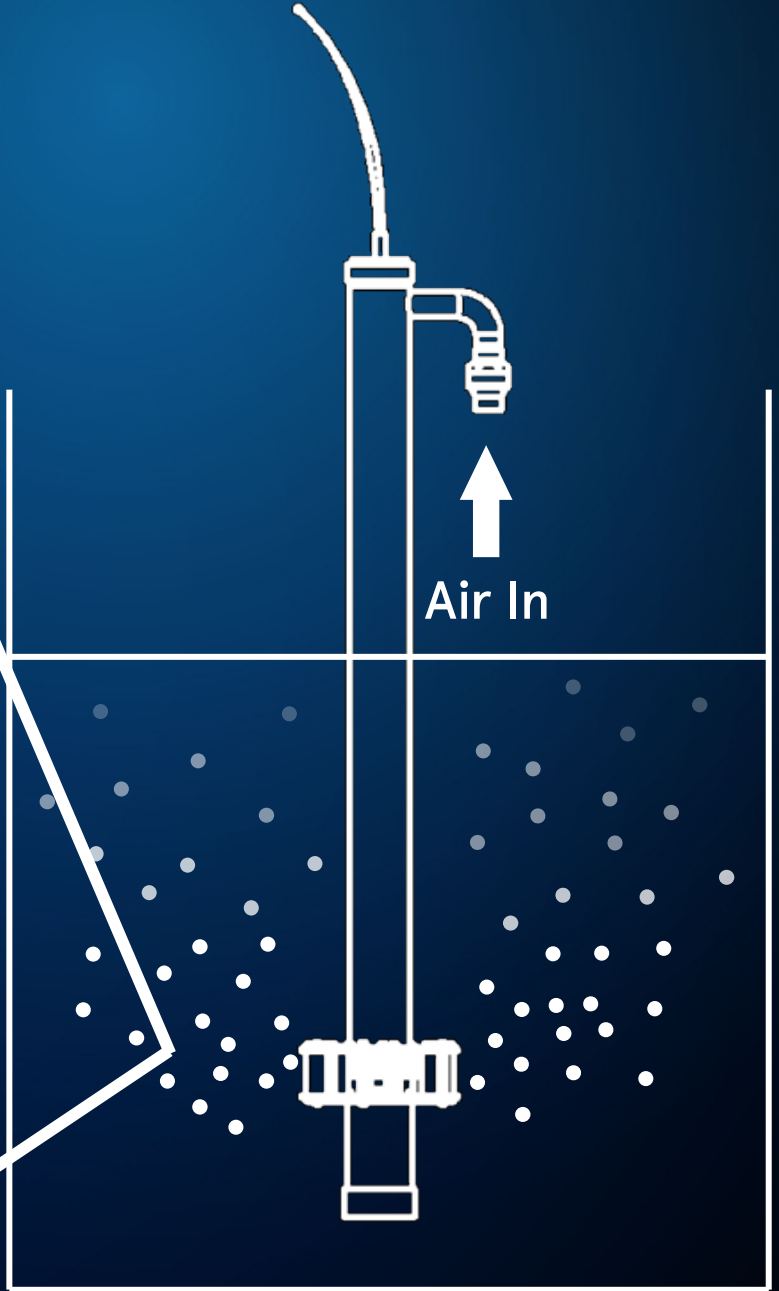
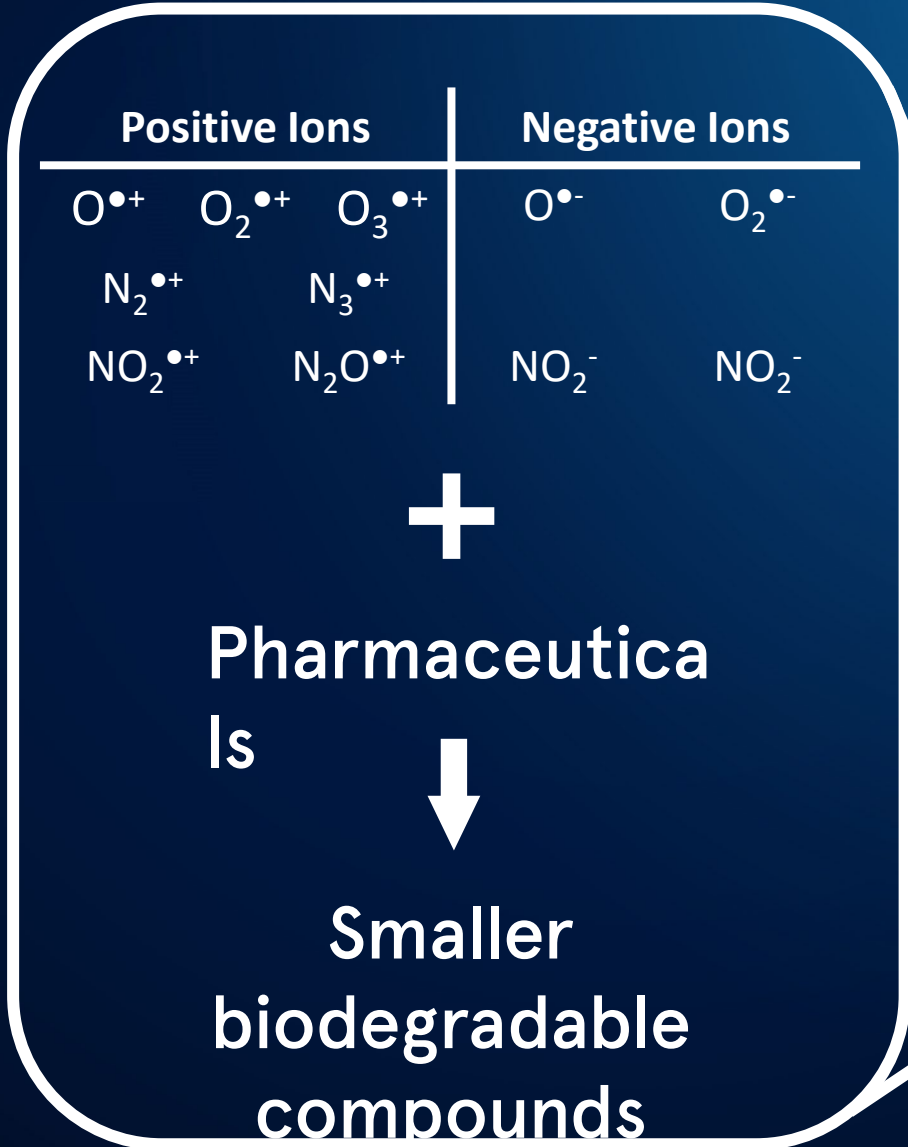
*Utilising non-thermal plasma for water and wastewater treatment*



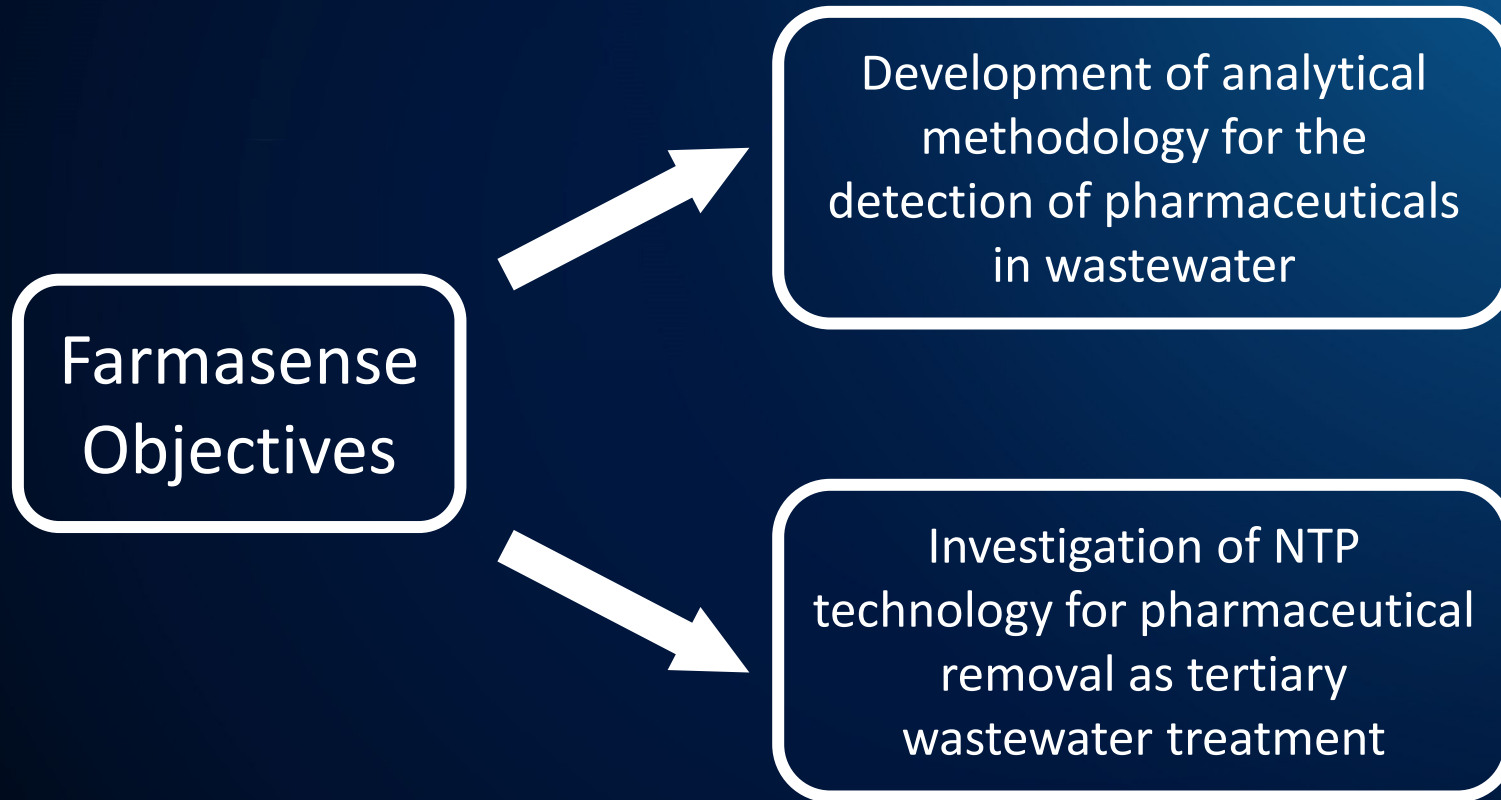
# te-ion™ Process – how does it work?



# te-ion™ Process – how does it work?



# Pilot Trials – Farmasense Project, Portugal

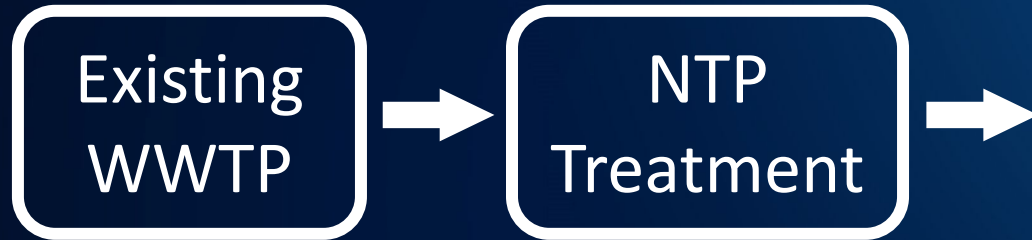


## Partners

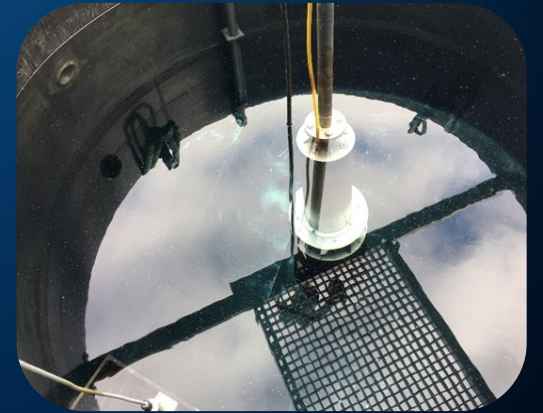


# Pilot Trials – Farmasense Project, Portugal

Trial 1:

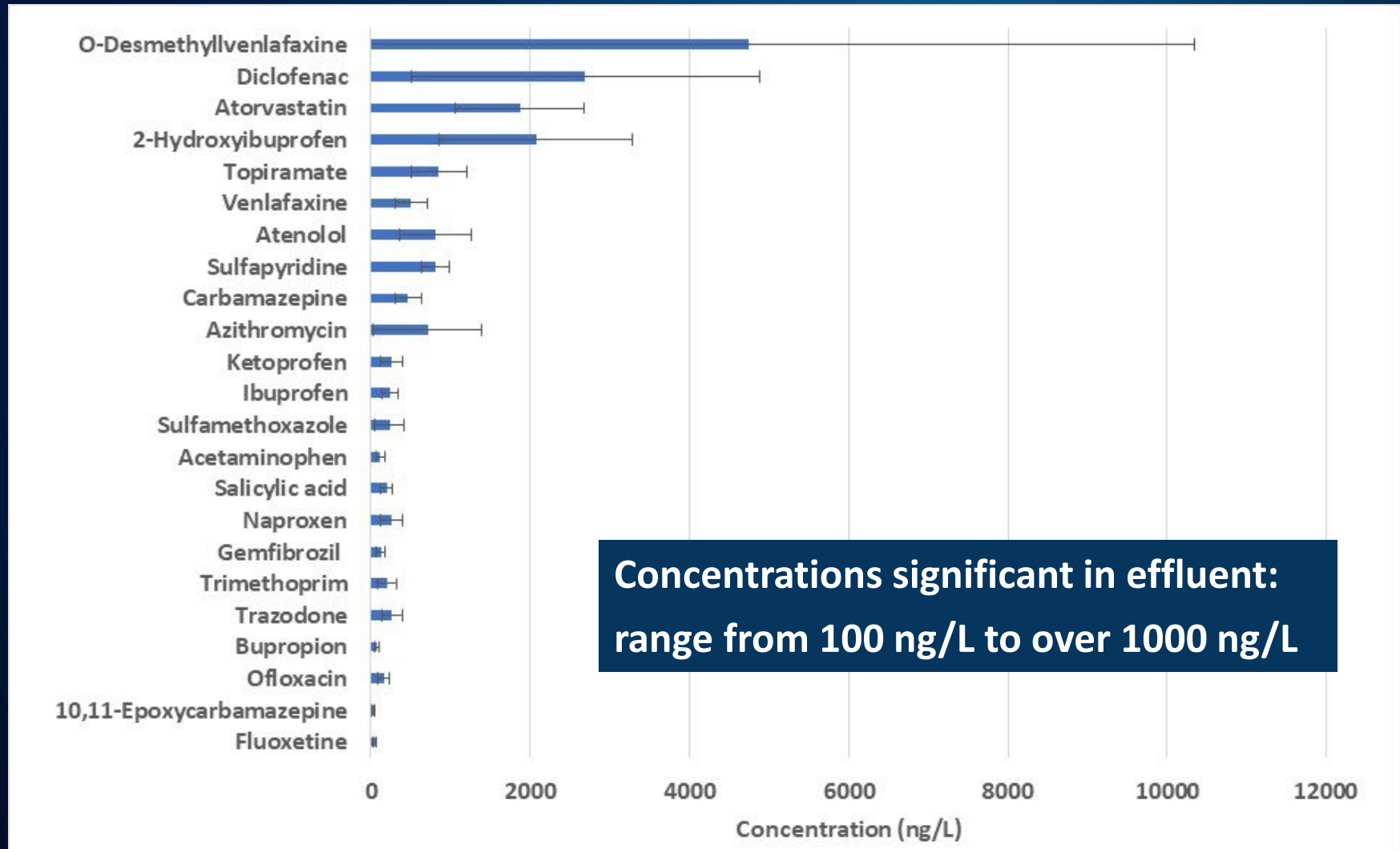


Trial 2:



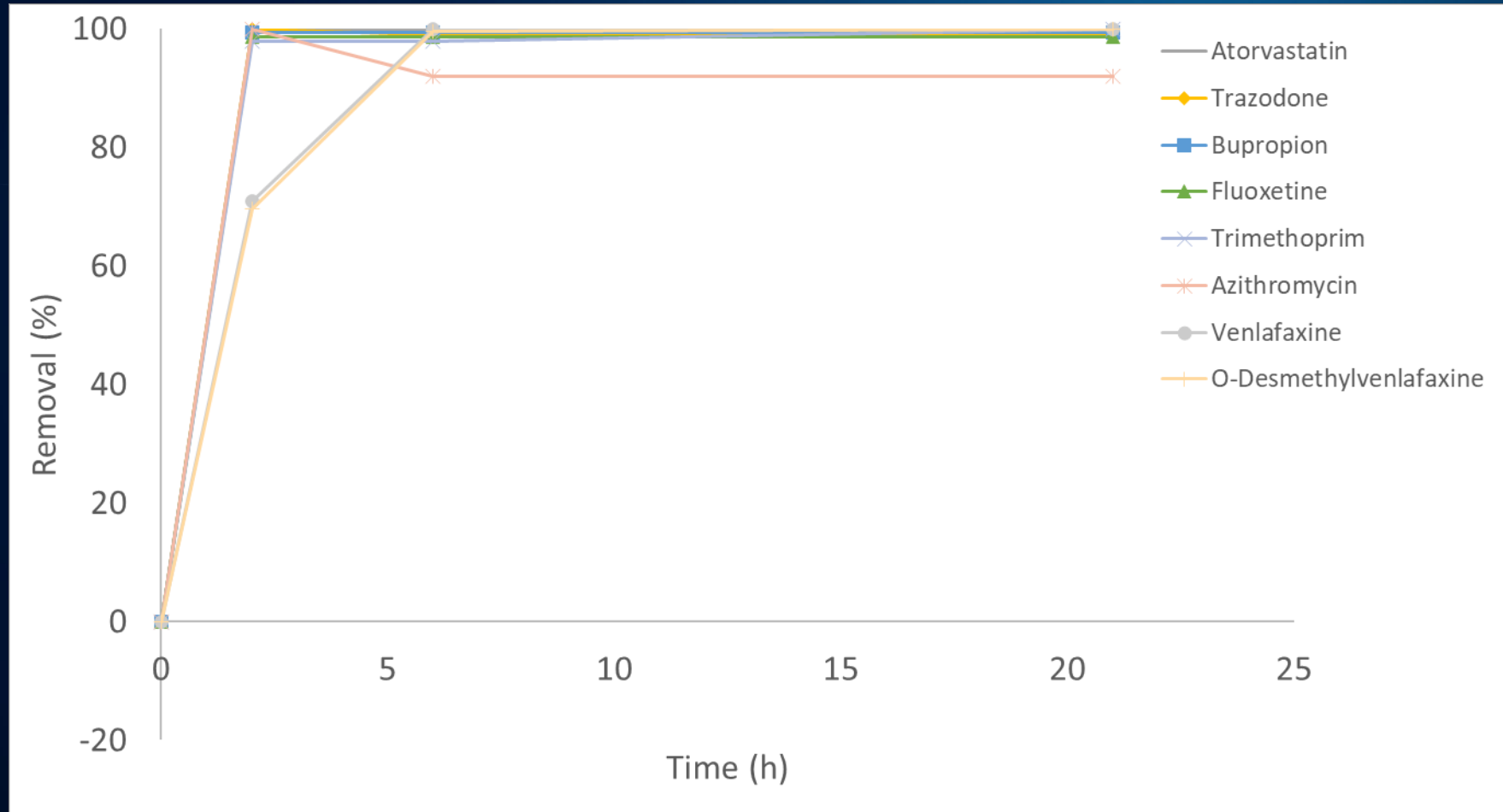
# Pilot Trials – Farmasense Project,

Portugal  
Effluent characterisation by UHPLC-MS/MS, > 20 substances detected:

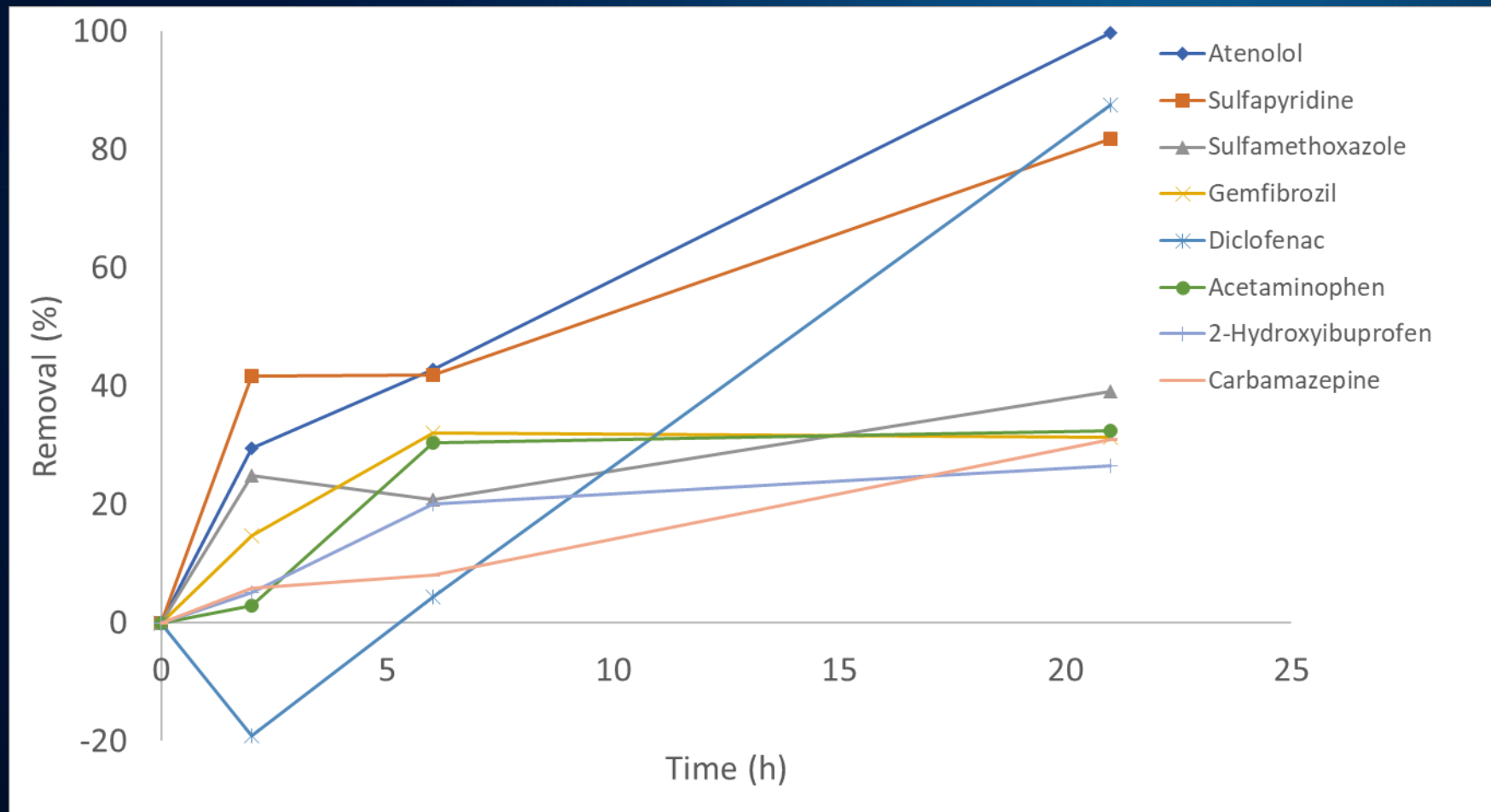


# Pilot Trials – Farmasense Project,

Portugal Only:

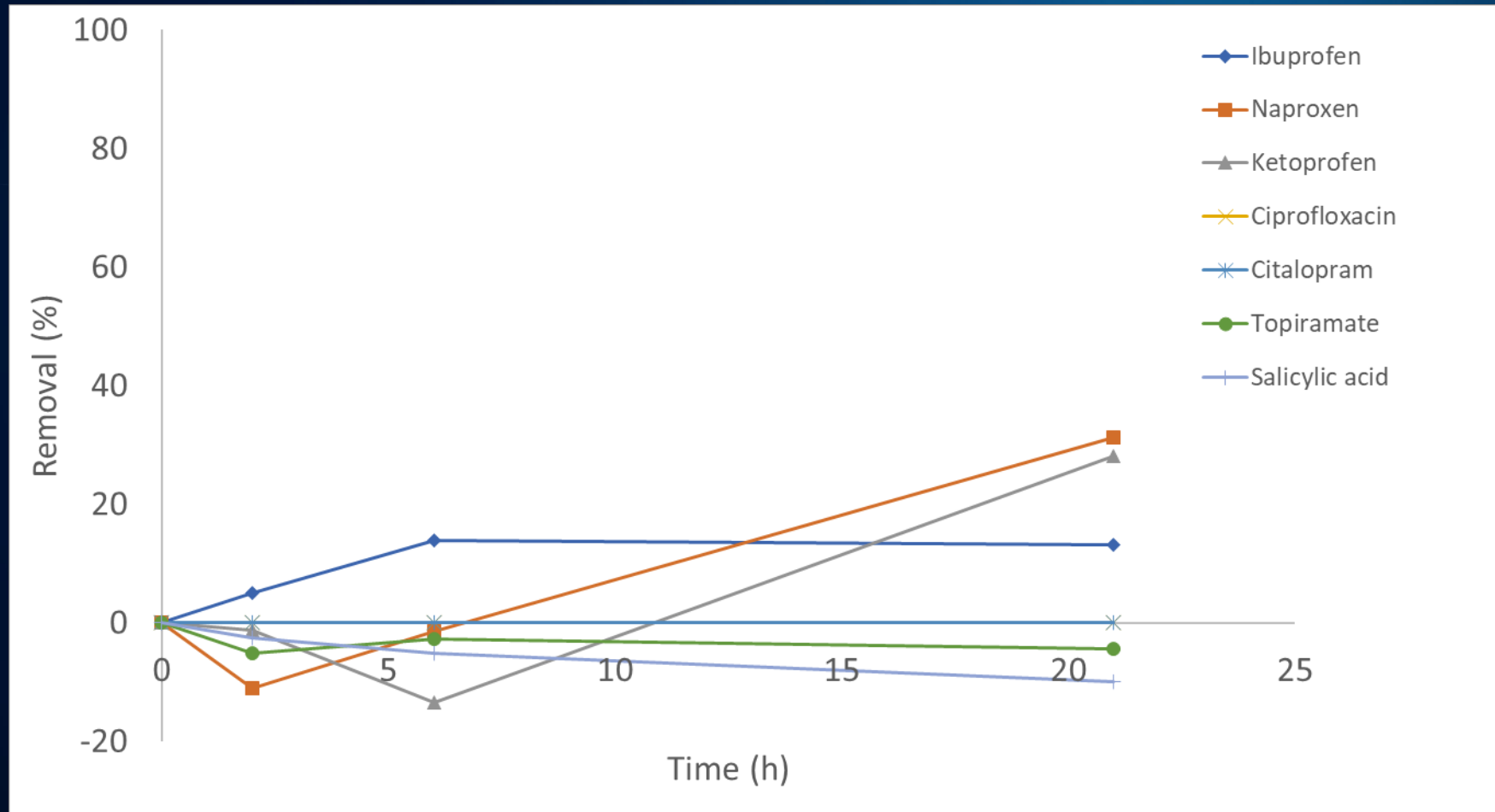


# Pilot Trials – Farmasense Project, Portugal Only:

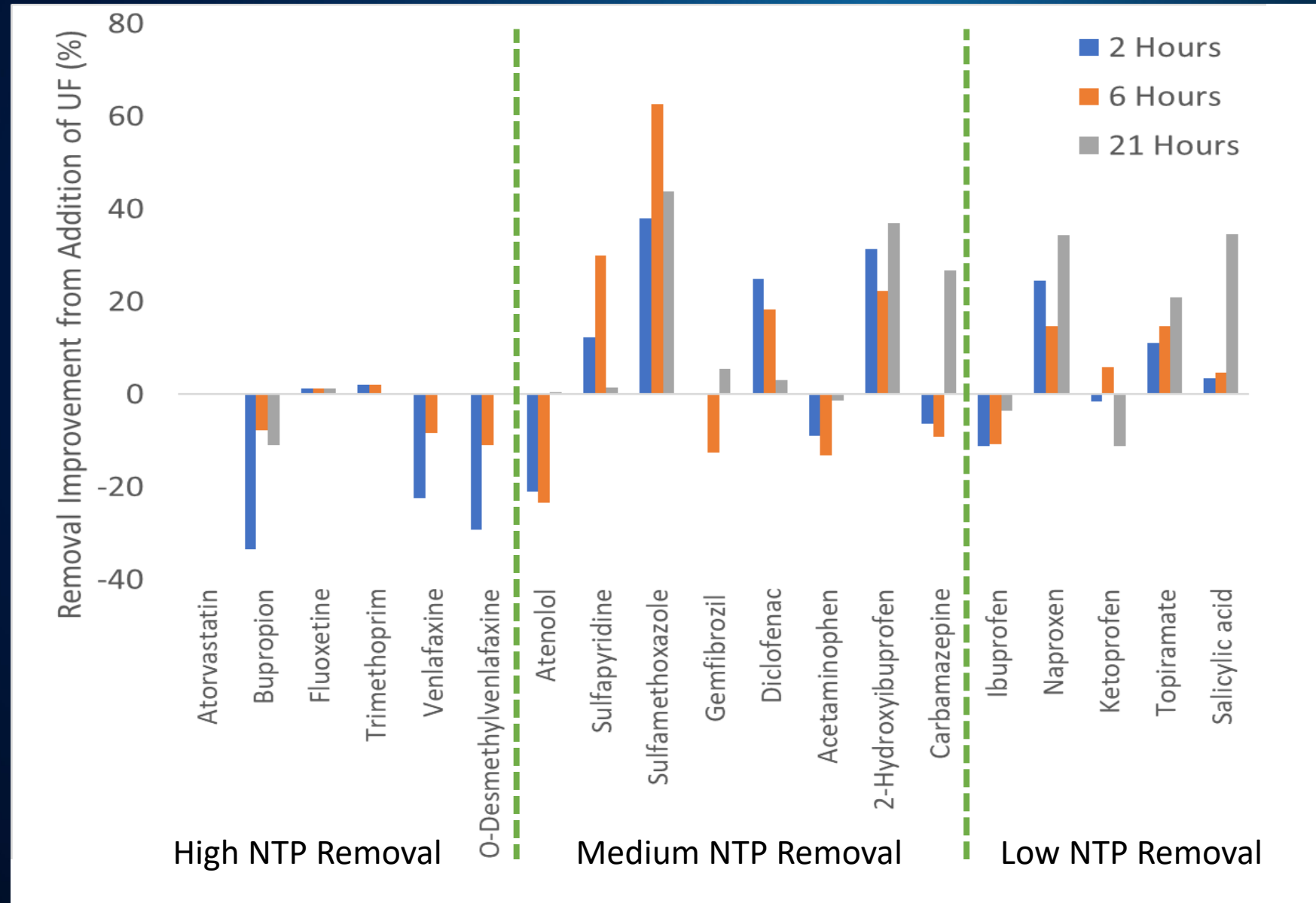




# Pilot Trials – Farmasense Project, Portugal Only:



# Pilot Trials – Farmasense Project, Portugal



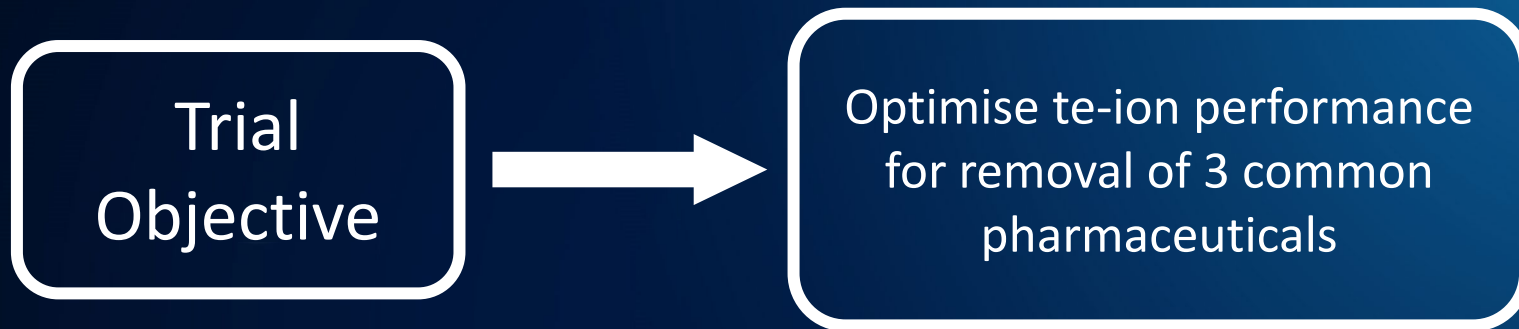
# Pilot Trials – Farmasense Project,

## Portugal Conclusions:

1. NTP shows good potential for treatment of pharmaceutical compounds present in real effluent from WWTP.
2. Different pharmaceuticals respond differently to NTP treatment.
3. NTP + UF treatment generally improved overall removal, but only for compounds that showed medium to low removal from NTP alone.
4. Pilot trials will continue to optimise NTP treatment to improve removal performance of the more difficult to remove pharmaceuticals.



# Pilot Trials – Bad Reichenhall, Germany

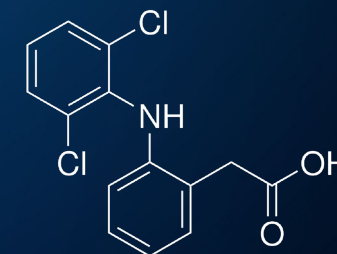


## Operating Parameters:

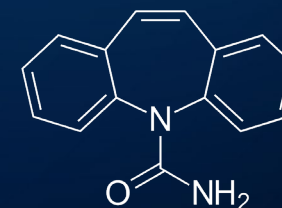
1. With or without UF pre-treatment.
2. Plasma flowrate.
3. Plasma frequency → ozone production

## Pharmaceuticals

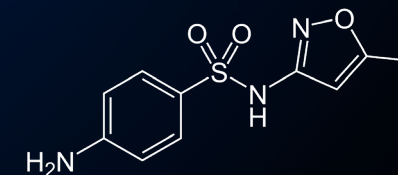
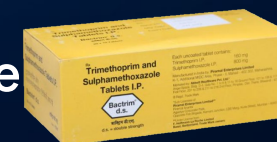
1. Diclofenac



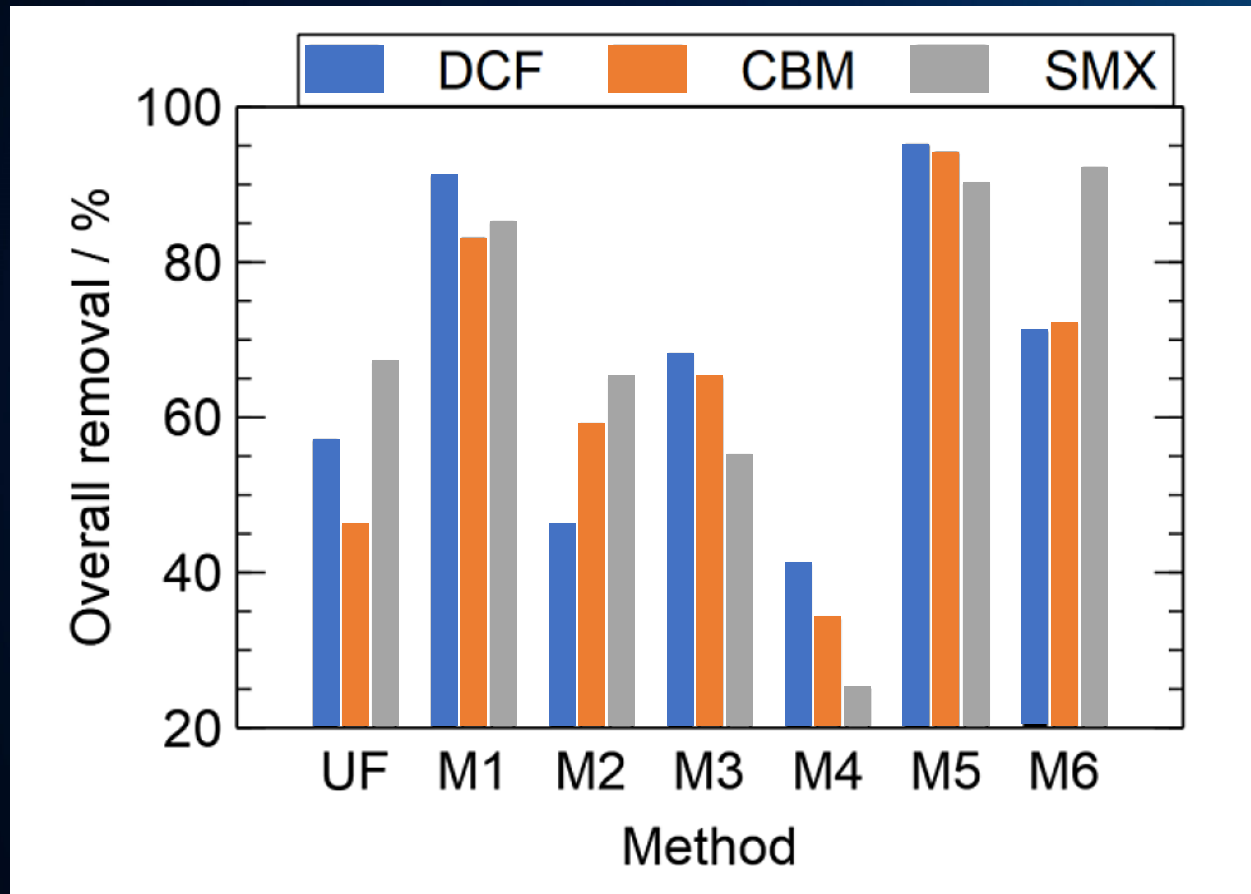
2. Carbamazepine



3. Sulfamethoxazole



# Pilot Trials – Bad Reichenhall, Germany



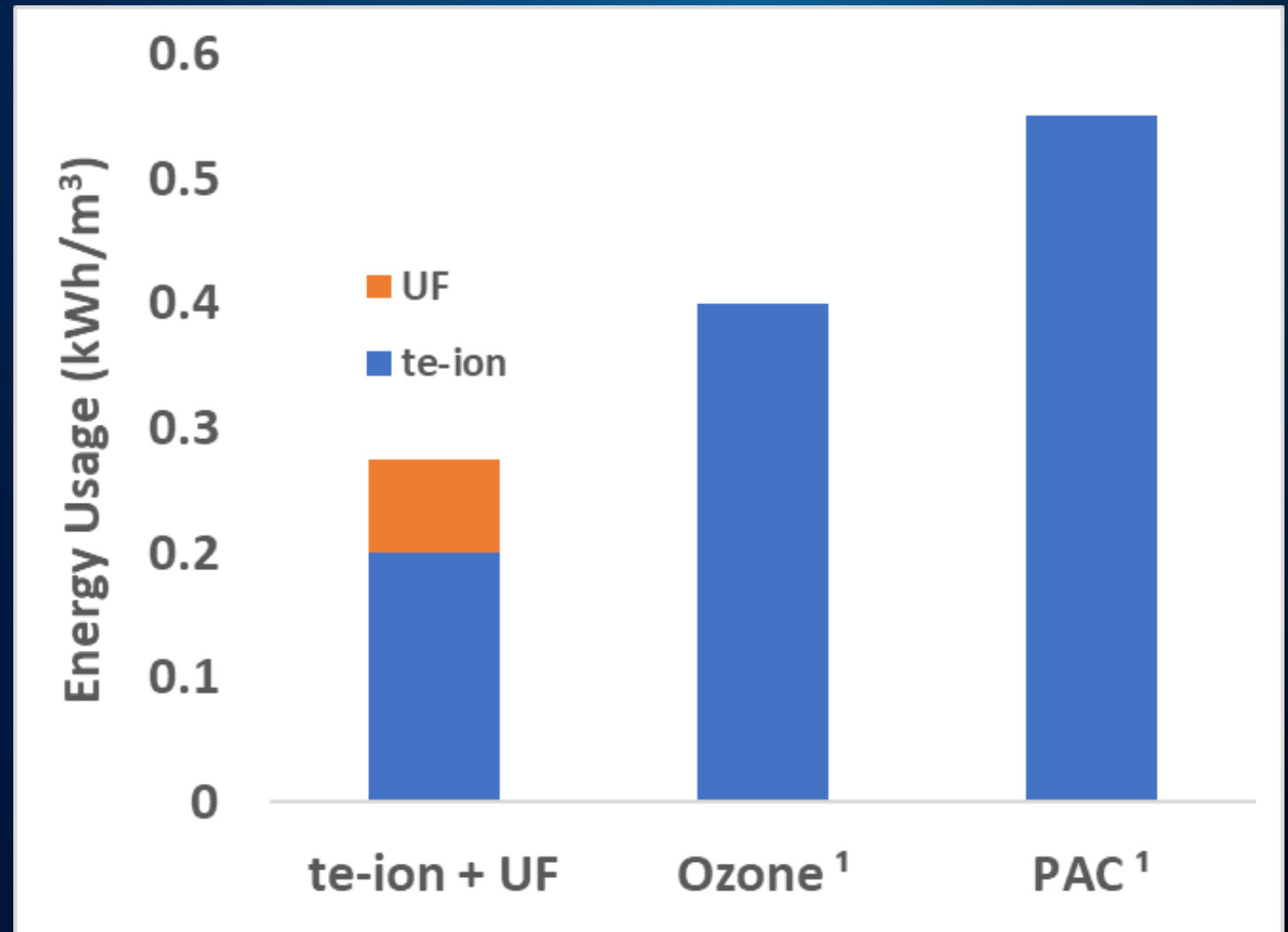
Method	UF	Plasma Flowrate (l/min)	Plasma Frequency (Hz)	Ozone Content in Plasma (ppm)
1	Yes	150	2,000	120
2	Yes	150	500	20
3	No	150	2,000	120
4	No	150	500	20
5	Yes	70	2,000	120
6	Yes	70	500	20



# Pilot Trials – Bad Reichenhall, Germany

## Energy Usage:

Note: the values are for total energy usage which includes production and transport of the resources



# Pilot Trials – Bad Reichenhall, Germany

## Conclusions:

1. Over 90% removal of Diclofenac, Carbamazepine, and Sulfamethoxazole can be achieved with combination of UF and NTP treatment.
2. Addition of UF improves overall pharmaceutical removal performance.
3. A higher plasma frequency and therefore plasma ozone content improves the overall performance of NTP treatment.
4. A lower plasma flowrate improves the overall performance of NTP treatment.



# Other Applications

Other applications of the te-ion™ that have already been tested or are in the pipeline include:

- Wastewater disinfection
- Bulking sludge suppression in activated sludge plants
- Heavy metal removal
- Sludge disintegration to increase biogas yield of AD plants



Before te-ion™ Treatment



After te-ion™ Treatment



*Thank you for listening – any  
questions?*



# Contact us

**Ashton Dewey**

Chief Operating Officer

ashton.dewey@te-tech.co.uk

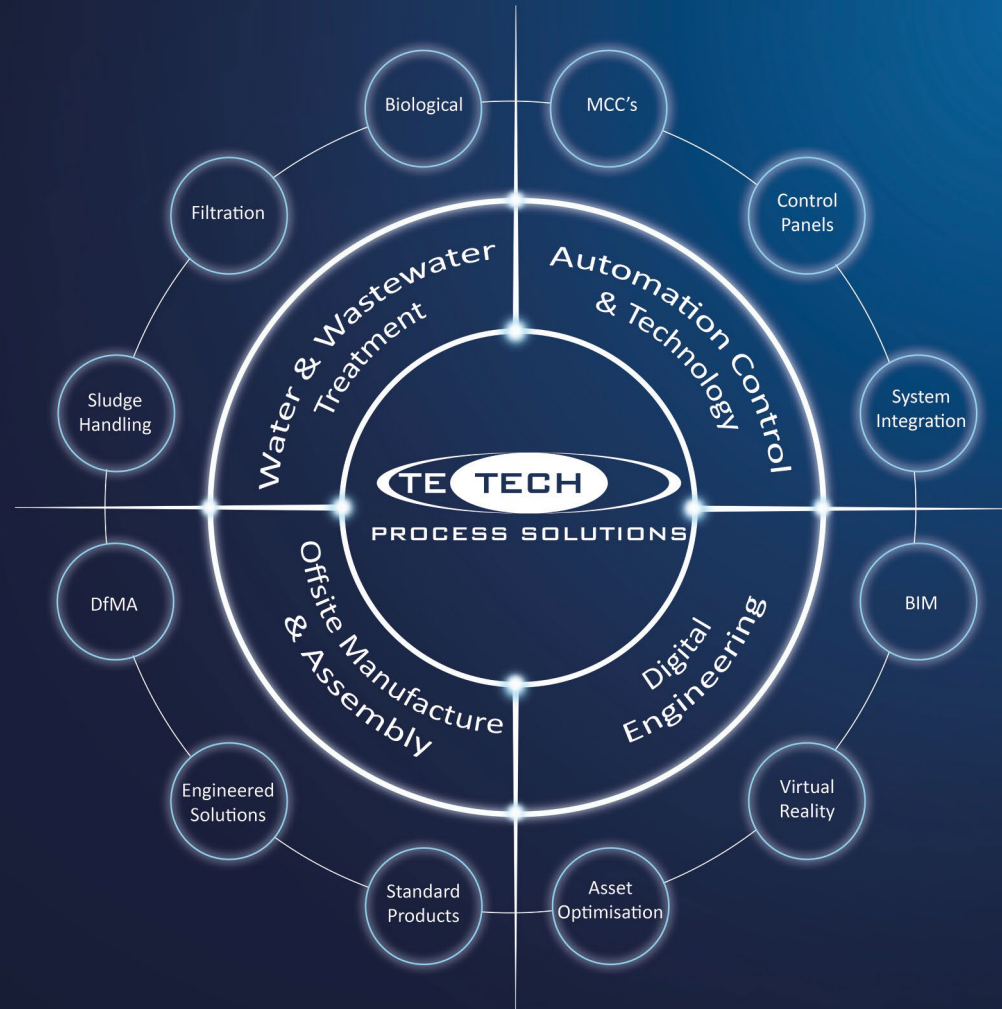
+44 (0) 7865 148589

**Mike Froom**

Business Development Director

mike.froom@te-tech.co.uk

+44 (0) 7831 214913



PROCESS SOLUTIONS<sup>®</sup>  
te-tech.co.uk

2 Contech House, Unit 2 Chapel Lane,  
Rushington Business Park, Southampton SO40 9AH

T: +44 (0) 23 8235 1600

E: enquiries@te-tech.co.uk

