GRUPPO CAP
LA TUA ACQUA IN BUONE MANI

PerformWater2030: A contribution to knoledge and control for Contaminant of Emerging Concern (CECs) in urban areas

12 Giugno 2018
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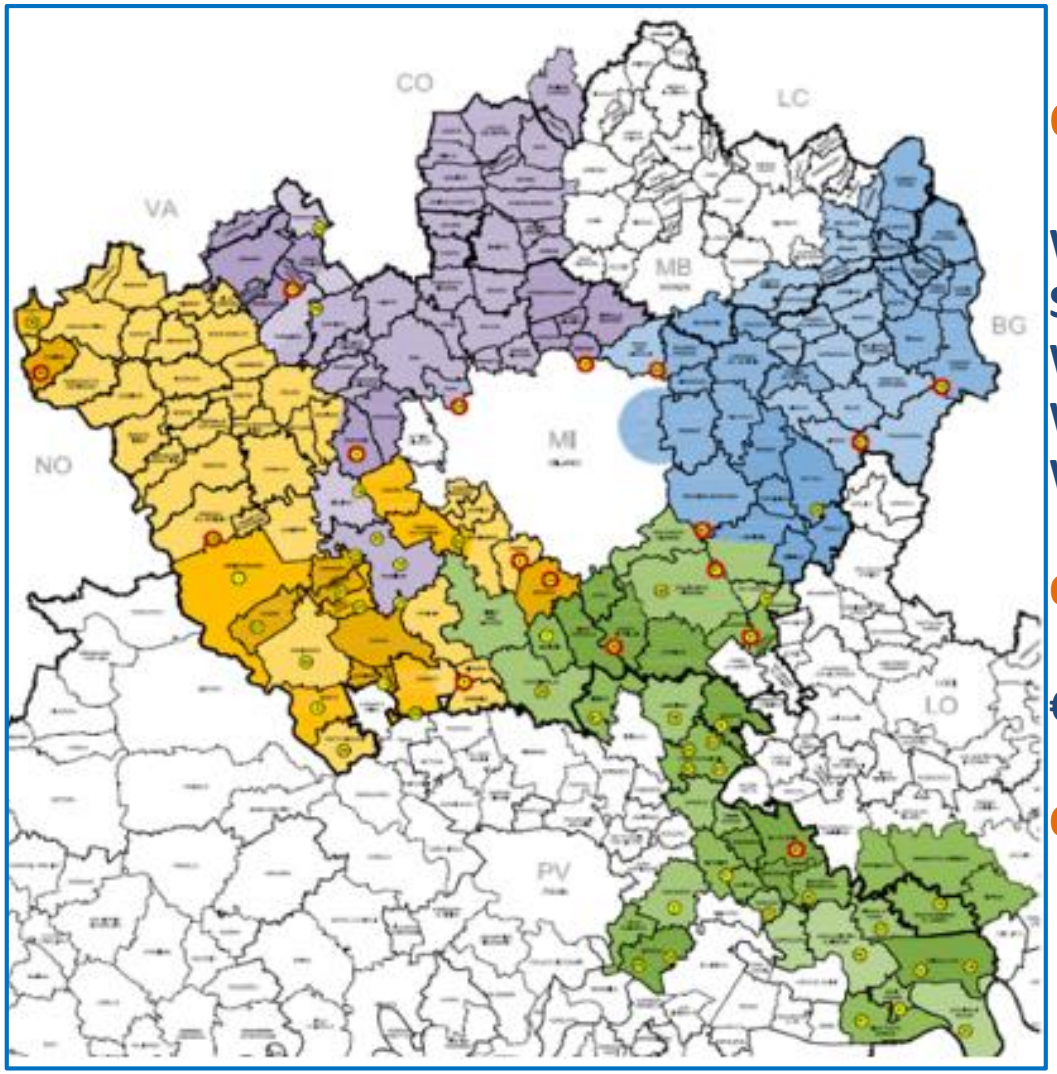
Gruppo Cap

SERVIZIO IDRICO INTEGRATO

SUMMARY

- CAP GROUP WATER UTILITY
- PerFORM WATER 2030: the project
- PerFORM WATER 2030: Contaminant of Emerging Concern in urban areas and waste water plants

CAP GROUP



Our Service

WATER NETWORK: 6483 Km
SEWAGE NETWORK: 6808 Km
WELLS FOR DRINKING WATER: 782
WATER PURIFICATION PLANTS: 294
WASTE WATER TREATMENTS PLANTS: 61

Our Investments 2017-2020

€536 MILIONS

Our Investments in R&D 2017

€1 MILION

LOMBARDY INNOVATION CALL – *Accordi per la Ricerca e l'Innovazione*

REALIZZATO CON IL SOSTEGNO DI

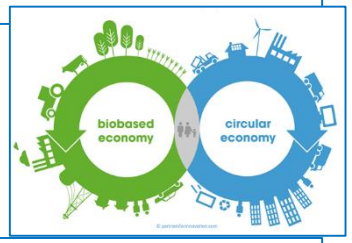
UNIONE EUROPEA
Fondo europeo di sviluppo regionale

Regione Lombardia

fesr

POR FESR 2014-2020 / INNOVAZIONE E COMPETITIVITÀ

In the framework of the European Regional Development Fund 2014-2020, Lombardy Region has opened an Innovation Call, *Accordi per la Ricerca e l'Innovazione*, allocating 106,7 M€ funds for 32 innovation projects in different fields of study which include ECO-INDUSTRY.



GRUPPO CAP presented the innovation project PerFORM WATER 2030 with 9 M€ associated budget

PerFORM WATER 2030: PARTNERS

The strategic partnership is composed by

- 8 industrial companies

with an important role in the eco-industry field, in addition to the project Coordinator Gruppo CAP, and

- 2 Universities and 1 Research Institutes

as essential support for all the experimentations and which will closely collaborate with the industrial partners.

PROJECT COORDINATOR: Gruppo CAP

SCIENTIFIC PROJECT MANAGEMENT: Politecnico di Milano

PROJECT MANAGEMENT SUPPORT: Fondazione Politecnico

INDUSTRIAL PARTNERS:

- GENEGIS GI
- HyDEP
- MMI IDRO
- PASSAVANT
- SEAM ENGENEERING
- SIAD
- VEOLIA
- VOMM

UNIVERSITIES AND RESEARCH INSTITUTES PARTNERS:

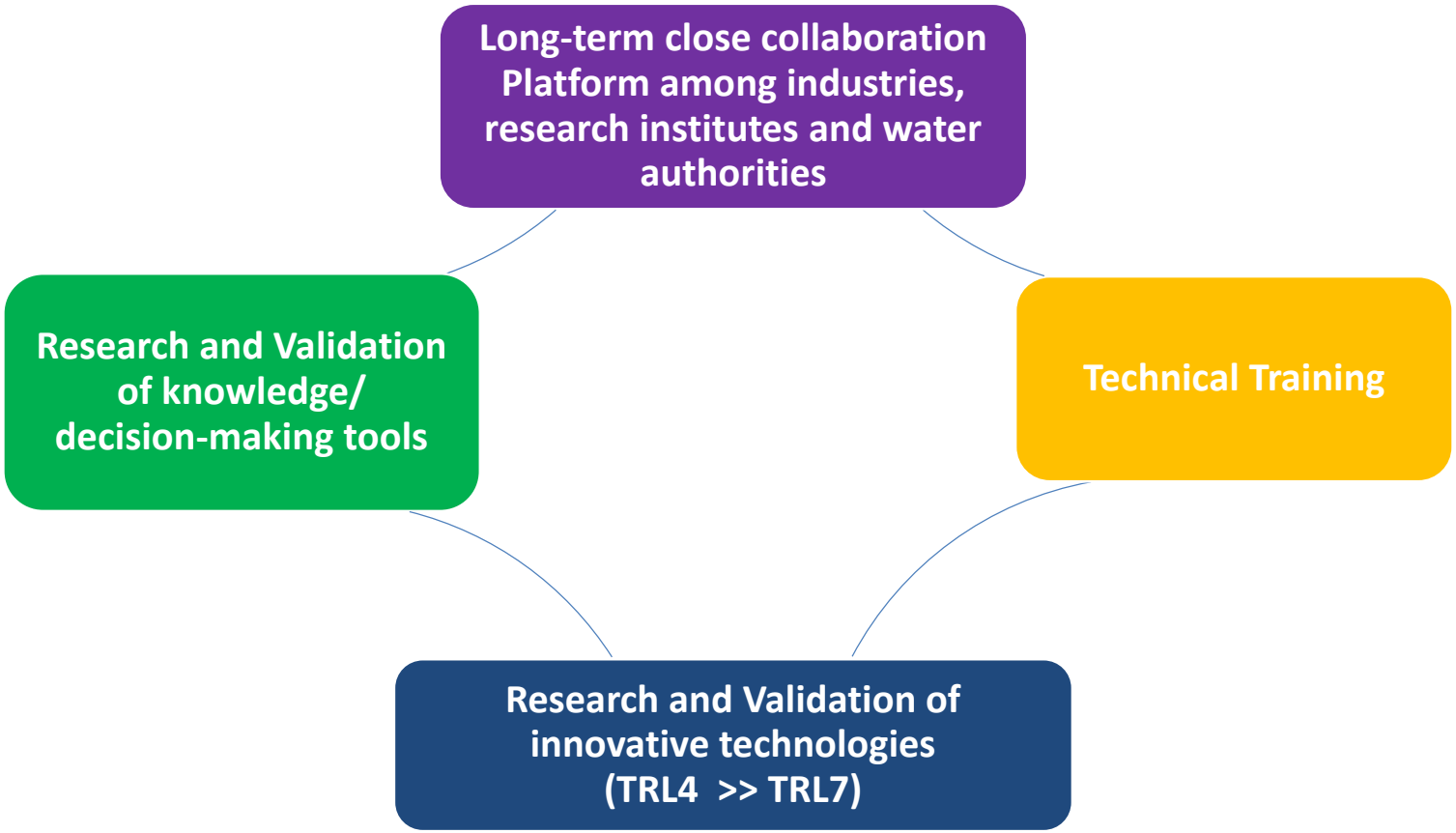
- Politecnico di Milano
- Università degli Studi Milano Bicocca
- Istituto di Ricerca sulle Acque Consiglio Nazionale delle Ricerche

PerFORM WATER 2030: RATIONALE

***P**latform **F**or*	**Platform: a way to bring together different stakeholders to identify solutions to common problems or to achieve common goals**
Integrated	**Integration of knowledge, know how and interests as real-added value for innovation**
***O**peration*	**Optimized and innovative ideas for plant operations solutions**
***R**esearch and*	**Research: crucial step for innovation demonstration**
***M**anagement of*	**For future public water innovation managers**
*Public **Water***	**Water: the essential resource**
*towards **2030***	**Towards 2030 European Circular Economy scenario**

PerFORM WATER 2030: MAIN FEATURES

Experimental Development ⟷ **Industrial Research**



PerFORM WATER 2030: MAIN FEATURES

- The project started in January 2018 and will be lasting until July 2020; **it has also the ambitious goal to create a long-term experimental platform;**
- The main purpose is **to redesign the current water infrastructure into a broad natural and engineered system increasing water resource efficiency and circularity;**
- This purpose will be achieved creating **a diffused platform within GRUPPO CAP plants for research, development and validation of innovative technologies, processes and knowledge/decision-making tools**, in order to assure an increasingly efficient management of the Integrated Water Service;
- The project activities will create **an industrial symbiosis example** among the industrial partners, Universities, Research Institutes and the territory;
- This platform will be **a unique example not only in Lombardy but also throughout Italy**.

PerFORM WATER 2030: MAIN FEATURES

- Furthermore, the experimental activities will be part of **real-life living labs within a user-centered and open-innovation ecosystem**. It will be valorized the concept that **co-creation and co-participation approaches in deployment, testing, replication and upscaling of innovative technologies represent a real-added value towards the realization of attuned solutions where water plays a central role**;

- A **training center** will be created for water processes managers, students and operators who will be able to witness and test functioning innovative processes.

*The overall objective is therefore to **demonstrate a new business model in which water utilities will not only provide drinking water and treat used water, but also supply valuable resources, provide technology and become partners of industry, cities and citizens in finding water management solutions at different scales and for different purposes**.*

PerFORM WATER 2030 WORK PACKAGES

- The project cover **4 main thematic areas**, besides those associated with technical and scientific management and dissemination and transfer of results;

- It focus on **different study activities and pilots** (TRL 4 to 7) implementation.

The specific themes which will be addressed deal with the current challenges of the water management systems regarding the paradigm shift towards a sustainable and circular water-smart society.

PerFORM WATER 2030 WORK PACKAGES

WP WATER: *5 main objectives -9 related tasks–**5 pilot plants** -4 research activities*

- Cold Anammox process
- Emerging contaminants
- Emissions in the atmosphere
- Drinking water quality monitoring
- Water supply network optimization
- Measurements in sewer systems and modeling activities

WP MATERIALS AND ENERGY RECOVERY *5 main objectives -6 related tasks–**5 pilot plants** - 1 research activity*

- Recovery of water, material and energy resources
- Biogas upgrade
- Anaerobic Digestion optimization

WP SLUDGE: *4 main objectives -4 related tasks–**2 pilot plants** -2 research activities*

- Reduction of extra sludge production
- Sludge thermal valorization
- Modeling activities

WP ECONOMIC SUSTAINABILITY AND SOCIAL ACCEPTABILITY OF NEW TECHNOLOGIES: *3 main objectives -3 related tasks-4 research activities*

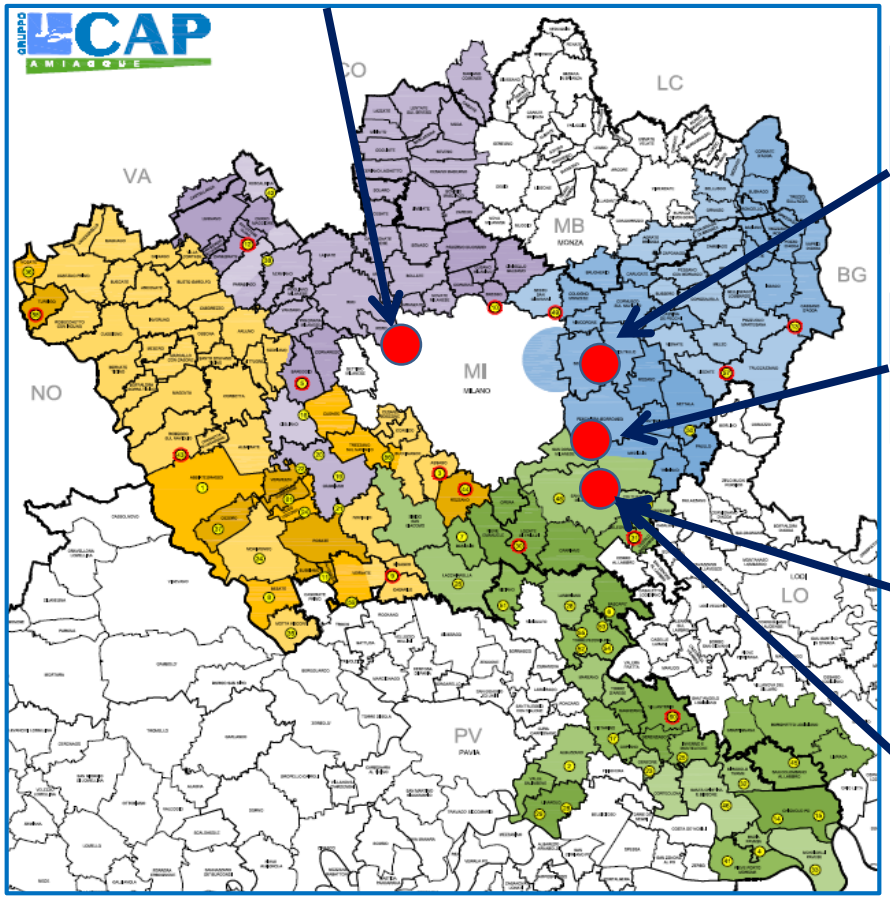
- Stakeholders engagement
- Advanced costs and tariffs analysis
- Operation & Maintenance

PerFORM WATER 2030 CAP DEMO SITES

BRESSO WWTP

2 PILOT PLANTS

...An Innovation Green Ring around Milan...



***SALA AZZURRA* RESEARCH AND INNOVATION CENTER - SEGRATE**

4 RESEARCH ACTIVITIES

PESCHIERA BORROMEO WWTP

1 PILOT PLANT

SAN GIULIANO OVEST WWTP

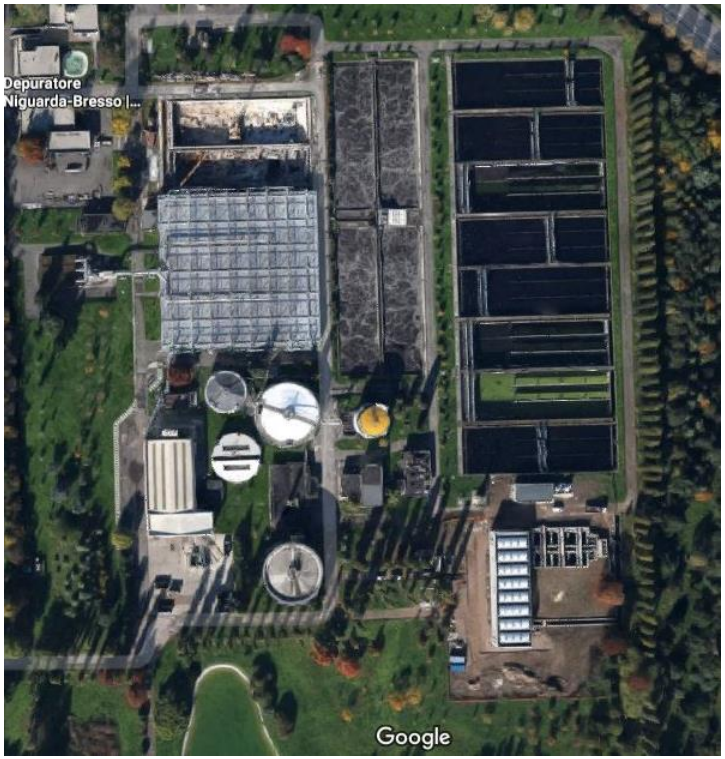
8 PILOT PLANTS

SAN GIULIANO EST WWTP

1 PILOT PLANT

PerFORM WATER 2030: BRESSO WWTP

Pilot-scale testing



A.E. = 220.000

WATER LINE

- Mechanical pre-treatment (screening, grit/oil removal)
- Primary settling with waste sludge recycling
- Activated sludge predenitrification/nitrification reactors
- Secondary settler
- Tertiary treatment (U.V. disinfection)

SLUDGE LINE

- Mesophilic anaerobic digestion
- Centrifuge for sludge thickening

PerFORM WATER 2030: SAN GIULIANO OVEST WWTP

Pilot-scale testing

A.E. = 30.000

WATER LINE

- Mechanical pretreatment (screening, grit/oil removal)
- Primary settling with extra sludge recycling
- Activated sludge pre-denitrification/nitrification reactors
- Secondary settlers
- Filtration
- U.V. disinfection

SLUDGE LINE

- Sludge thickening
- Mesophilic anaerobic digestion (2 digesters)
- Sludge dewatering (belt filter presses)
- Sludge thermal drying

PerFORM WATER 2030: SAN GIULIANO EST WWTP

Pilot-scale testing

A.E. = 80.000

WATER LINE

- Mechanical pretreatment (screening, grit/oil removal)
- Activated sludge pre-denitrification/nitrification reactors
- Secondary settlers
- Filtration
- Peracetic acid disinfection

SLUDGE LINE

- Sludge thickening
- Aerobic sludge stabilization system
- Sludge dewatering (centrifuges)

PerFORM WATER 2030: PESCHIERA BORROMEO WWTP

Pilot-scale testing

A.E. FIRST WATER TREATMENT LINE = 316.000

- Mechanical pretreatment (screening, grit/oil removal)
- Activated sludge nitrification
- Tertiary treatment: upflow biological filters for denitrification, nitrification and TSS removal
- Secondary settlers
- Peracetic acid disinfection

A.E. SECOND WATER TREATMENT LINE = 250.000

- Mechanical pretreatment (screening)
- Combined lamellar primary settling and grit/oil removal
- Upflow biological filters for denitrification
- Upflow biological filters for carbon and nitrogen removal (BOD/COD removal and ammonia nitrification) and solids filtration (TSS removal)
- U.V. disinfection

SLUDGE LINE

- Sludge thickening
- Mesophilic anaerobic digestion (5 digesters)
- 2 combined heat and power (CHP) units (500 kWel each)
- Sludge dewatering (centrifuges)
- Sludge fertilizers production

PerFORM WATER 2030: PILOT PLANT-CECs REMOVAL

PERFORM WATER 2030 AND CONTAMINANT OF EMERGING CONCERN (CECs)

CODE TASK	TASK	PLANT	GOAL TASK	SUBJECT CATEGORY	PARTNER TASK
WP_A_1	EMERGING MICROPOLLUTANTS REMOVAL: **Actiflo-carb Technology**	San Giuliano EST	This pilot aims at studying and optimizing the operational parameters of emerging micropollutants using **Powdered Activated Carbon (PAC) as adsorption substrate.** The technology is based on a chemico-physical separation process, accelerated with the dosage of microsand and polymer for the **recovery of the powdered carbon**	***WASTE WATER***	VEOLIA Technologies S.P.A. POLIMI - Politecnico di Milano (DICA) IRSA-CNR
WP_A_2	EMERGING MICROPOLLUTANTS REMOVAL: **Advanced oxidation process with ozone and active carbon**	San Giuliano OVEST	This pilot aims at studying and optimizing the operational parameters of a tertiary treatment step for the removal of waste water micropollutants. The tertiary treatment will be based on a **chemical oxidation process with ozone and active carbons adsorption.**		SIAD S.P.A. POLIMI - Politecnico di Milano (DICA) IRSA-CNR
WP_A_3	EMERGING MICROPOLLUTANTS REMOVAL: **Nanoparticles of zero-valent iron encapsulated in microalgal biomass**	Bresso / UNIMIB	The use of **microalgae in nZVI nanoparticles production** and application as sorption elements for micropollutants removal by encapsulation of them inside micro- or nano-carbon spheres through **Hydrothermal Carbonization from algal biomass**		UNIMIB - Università Bicocca (DISAT) SEAM S.R.L IRSA-CNR

PerFORM WATER 2030: STRATEGY FOR CECs REMOVAL

1. • SCREENING CEC's in waste water samples
2. • SELECTION OF TARGET COMPOUNDS for each adopted removal technology
3. • PILOT REMOVAL TRIALS
4. • EVALUATION OF BEST PROCESS CONDITIONS by analytical quantification of target compounds

PerFORM WATER 2030: PILOT PLANT-CECs REMOVAL

Suspect Screening analysis of P&PCP by UHPLC-HRMS

- Water samples

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) by on-line-SPE-UHPLC-MS/MS

- Water samples

Brominated Frame Retardant (BFr) and Personal Care Products (PCPs) in GC-MS

- Water and sludge samples

Trace metals in ICP

- Water and sludge samples

PerFORM WATER 2030: PBDE and PCPs

Five samples of In and Out for each plants (SGO and SGE) during 9 days

APRIL 2018						
S	M	T	W	T	F	S
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					

Legend:

- SGO-IN
- SGE-IN
- SGO-OUT
- SGE-OUT
- SGO-IN+OUT

- WRT (Water Retention Time) in the two WWTPs: 24 hour samples
- Sampling distributed over two weeks

Volumes sampled:
-IN: 1L
- OUT: 2L

Total number of samples:
18 samples for screening campaign

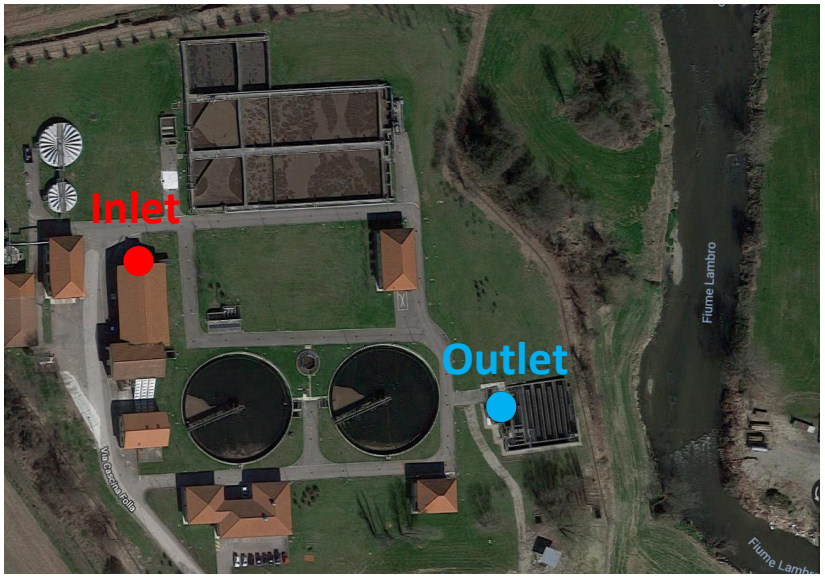
Target analytes

Brominated Flame Retardants (BFRs)	Personal Care Products (PCPs)
PBDEs	Limonene
HBCD-Hexabromocyclododecane (particulate)	HHCB (Galaxolide)
DBDPE-Decabromodiphenyl Ethane (particulate)	ATHN (Tonalide)
	ADBI (Celestolide)
	AHDI (Phantolide)

PerFORM WATER 2030: METALS

- Wastewater samples were collected at the inlet and outlet of two WWTPs (San Giuliano East and San Giuliano West) for 7 days.

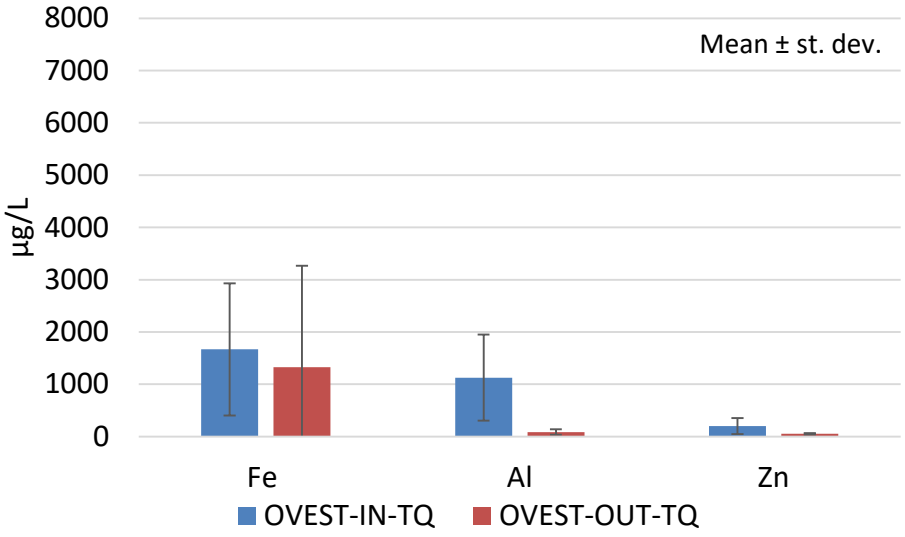
- Each sample consisted in a 24-hour composite sample, collected using an automatic sampler (1 grab sample per hour).

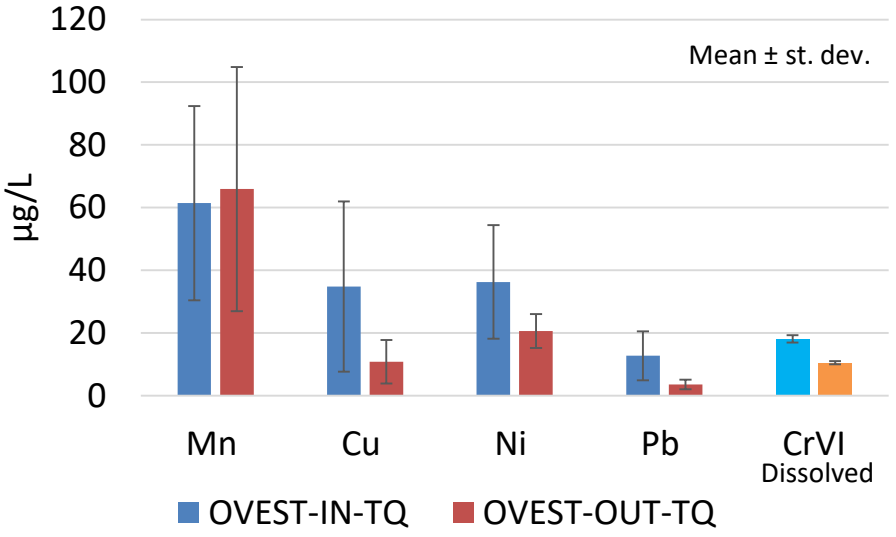


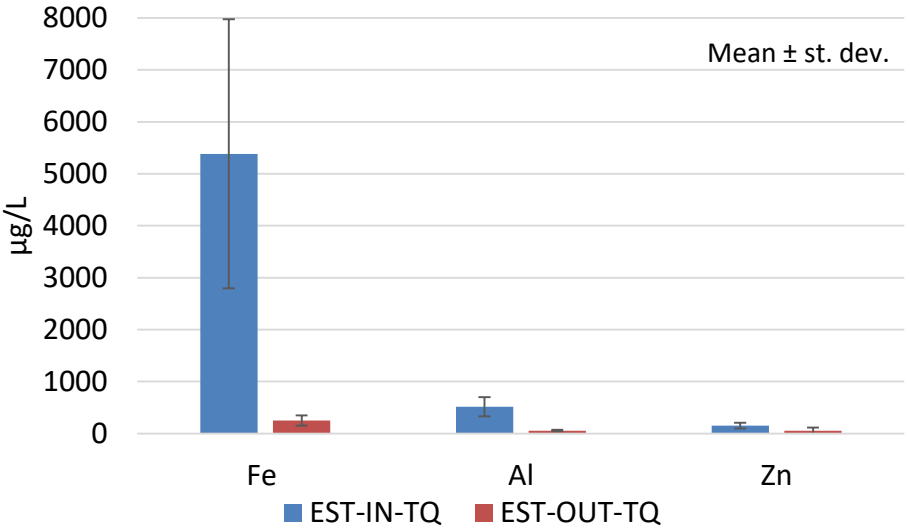
- Part of the sample was immediately analyzed for total **Hg** and (about 1 L) was stored with HNO_3 (pH < 2) at 4°C for analysis of **total metals**.

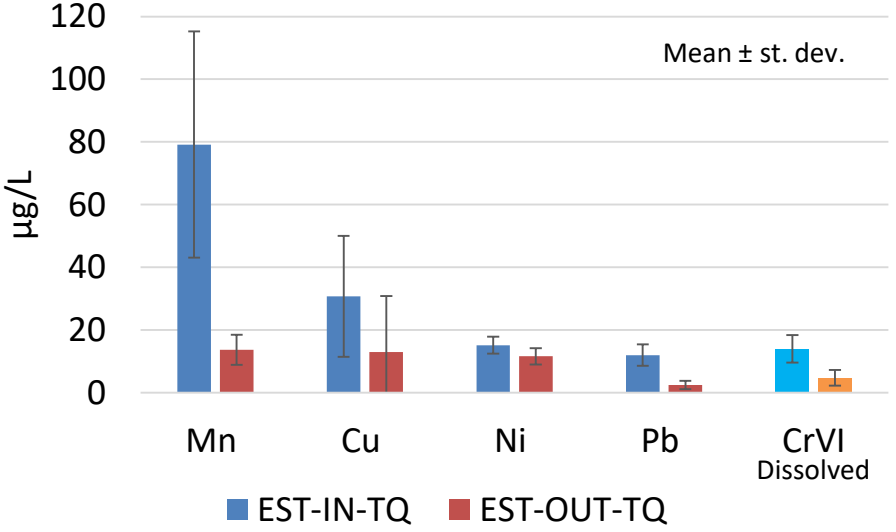
- Part of the sample (about 500 mL) was immediately filtered for determination of **total suspended solids** (GC/c, CA 1.2 µm) and then for analysis of **truly dissolved metals** (polycarbonate, 0.45 µm). These samples were analyzed immediately for **Cr VI** or stored with HNO_3 (pH < 2) at 4°C for analysis of other metals.

PerFORM WATER 2030: FIRST RESULTSSts FOR METALS IN SGO AND SGE

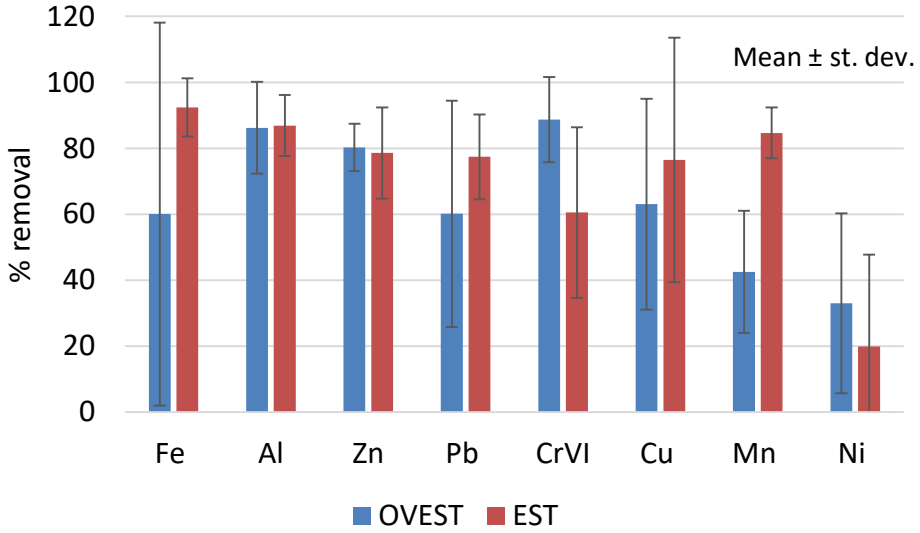








PerFORM WATER 2030: REMOVAL EFFICIENCIES FOR METALS IN SGOAND SGE



Examples from literature

	Fe	Pb	Ni
Üstün 2009 J Haz Mat 172 (Turkey)	-32 (-47 to +15) $FeCl_3$ reagent	<89	16 (-9 to + 20)
Buzier et al. 2006 Chemosphere 65 (France)	Removal efficiency after stabilization ponds: Cr> Al> Fe> Zn> Cu> Ni> Pb Metal contents after activated sludge: Fe> Al> Cr> Zn> Mn> Ni> Pb> Cu> Cd		

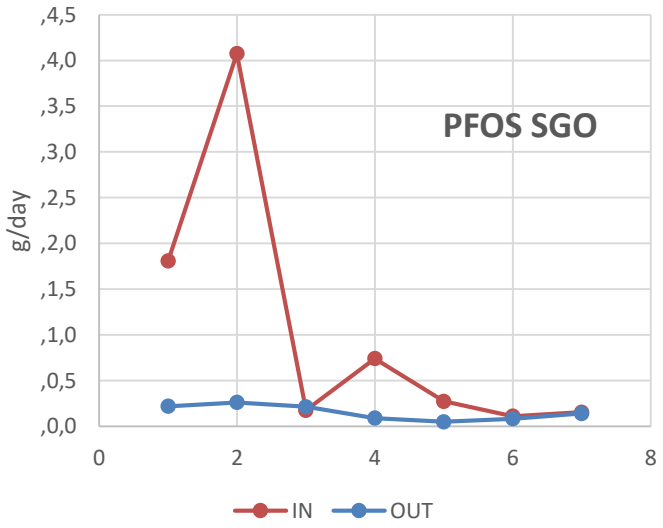
Metal remove efficiency vary according to wastewater treatment systems and processes and according to metal influent concentrations.

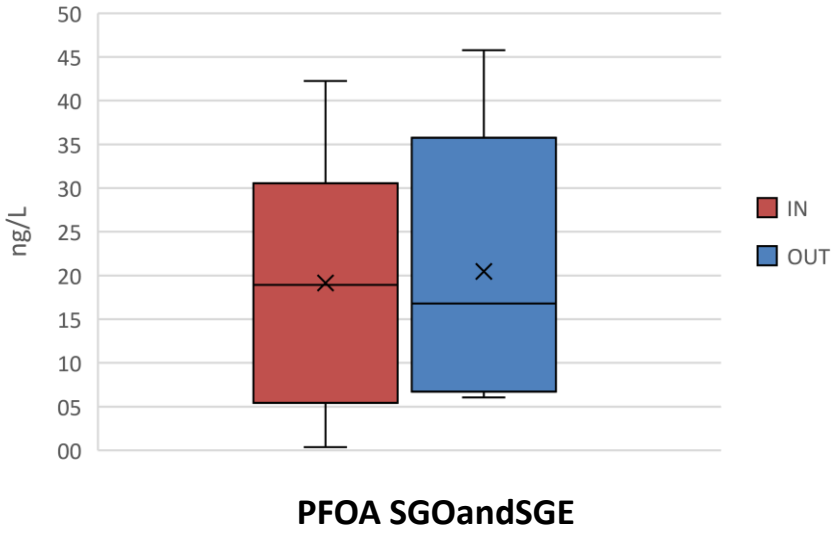
PerFORM WATER 2030: SUSPECT SCREENING ANALYSIS OF P&PCP AND PFAS

- **WWTPs:** SGO and SGE (IN and OUT)
- **7 Samples**: 24-h volume or time-proportional composite raw wastewater samples (1 sample/day)
- **Samples estraction:**
  - Filtration (glass microfiber filters, grade GF/F 0.7 µm)
  - on-line-SPE (PFAS)
  - SPE extraction Oasis HLB (P&PCP)
- **Analysis:**
  - UHPLC-MS/MS (PFAS)
  - UHPLC-HRMS (suspect screening of P&PCP)

PerFORM WATER 2030: FIRST RESULTS FOR PFAS

- Work in progress for PFBA and PFBS: dedicated method
- PFAS <LOD (IN and OUT)
  - PFCA (C_5-C_7 , C_9-C_{14}); PFSA (C_5-C_7, C_9, C_{10}); FTS (C_4-C_8)
- PFOS detected in IN and removed (>80 %)
- PFOA detected in IN and not removed (≈ 5-10%, precursors transformation)





PerFORM WATER 2030: SUSPECT SCREENING ANALYSIS OF P&PCP AND P&PCP

- Selection criteria
  - Polar compounds (HPLC-MS)
  - Emerging compounds
    - Watch List 2015/495/CE
    - Watch List revision
    - Proposal for a revision of DWD, COM(2017) 753 final
    - Gow regulatory values (GW, Germany)
    - Micropollutants in Swiss municipal wastewater, 2010
    - Ordinanza del DATEC, Switzerland 2016
    - Riva *et al.*, 2015 (priority pharmaceuticals in Italian environment)

PerFORM WATER 2030 P&PCP List ≈ 120 COMPOUNDS

- Type
  - Parent compounds
  - Metabolites
  - Transformation products (TP)
- CLASS
  - AOP by product (1)
  - Natural compounds (3)
  - Pharmaceutical (69)
  - Life style products (7)
  - Plant Protection Products (21)
  - Industrial chemicals (17)

PerFORM WATER 2030 P&PCP SUSPECT SCREENING ANALYSIS RESULTS

<10%	<30%	30-80%	80-100%
10,11-Dihydro-dihydroxy Carbamazepine	Benzothiazole	Atenolol	Acetaminophen (0.01-0.30)
Carbamazepine Epoxyde	Candersartan	Azithromycin (0.5-2)	Caffeine
10-Hydroxy-Carbamazepine	Hydrochlorothiazide	Clarithromycin	Olmesartan
Carbamazepine (0.1-0.5)	Methylbenzotriazole	Diazinone (0.01-0.05)	Atorvastatin
Amisulpride (1-5)	Levofloxacin	Furosemide	
Diclofenac (0.5-2.5)	Sotalolo	Ketoprofen (0.3-0.6)	
Lamotrigine	Propyphenazone	Ofloxacin (0.05-0.5)	
Metoprolol	Valsartan	Sulfamethoxazole (0.02-0.1)	
Sucralose	Irbesartan	Terbutryn (0.001-0.01)	
Phenobarbital	Bezafibrate (0.03-0.05)	Trimethoprim	
		Lansoprazole	
		Trimethoprim	

SPECIAL THANKS TO

- Licia Guzzella
- Stefano Polesello
- Sara Valsecchi
- Laura Marziali

IRSA CNR

Consiglio Nazionale delle Ricerche

.....and see you in our plant!!! .....

CAME TO VISIT US AND OUR PARTERNS