SMAT Research Center

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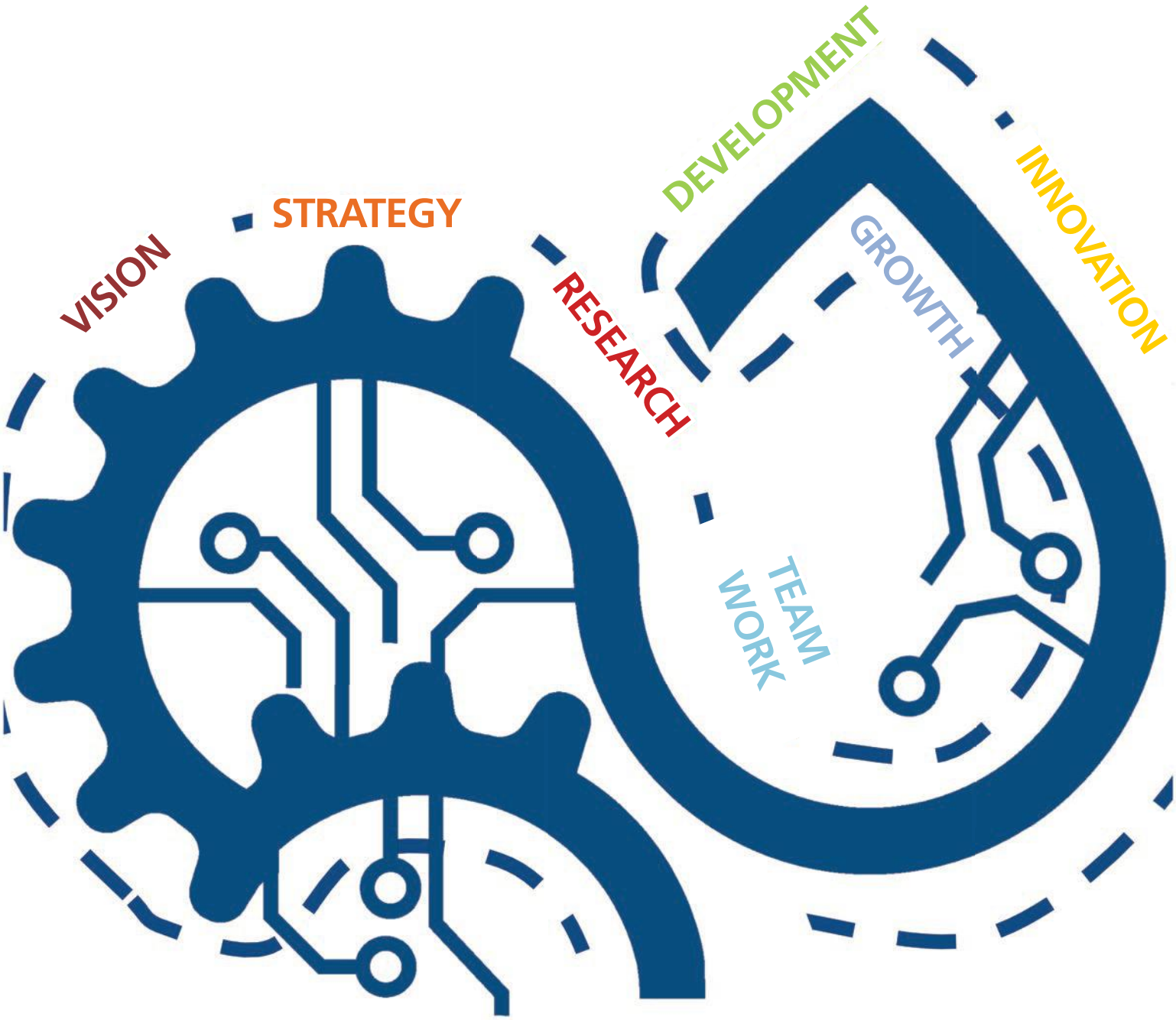

Research activities

YEAR 2020

smat
CENTRO RICERCHE

Research activities

YEAR 2020

CSQ ISO 45001 ISO 45001:2018 N. 9192.MACT
CSQ ISO 14001 ISO 14001:2015 N. 9191.SMTO
ACCREDIA
CSQ ISO 9001 UNI EN ISO 9001:2015 N. 0782.2020.
CERTIFIED SYSTEM IQNet QS ISO 22000 CSYD

SMAT Research Center during 2020: resilience and confidence towards the future

2020 was the year in which Sars-Cov-2 was the absolute protagonist. A virus consisting of a proteins shell that encloses about thirty genes and that is the virus most studied of the history.

During this difficult and challenging year, the scientific communities became the central issues of public consciousness, with the scientists networking capacity and with the inderdisciplinary effort and the recognizing of the fundamental importance to work together to stop the new coronavirus. The science is the means to understand and to make the world a better place: to invest in research and development is an action of resilience and confidence towards the future.

SMAT reserves a substantial part of its structure and resources for Research and Innovation: SMAT Research Center is a point of reference in the Integrated Water Cycle, both at national and international level.

SMAT Research Center selects and develops its projects fostering the sustainable development: the protection of health and the safeguard of water resources, and of the environment in general, is the focus of our activities.

The new strategic and business plan of SMAT, that was approved during 2020 pandemic, maintains in this context the central role of the Research Center for the company development. Our projects will be focused on the use of renewable resources for self-production of energy, the reduction of greenhouse gases emissions, the evaluation of emerging pollutants and of the impacts of climate change on the Integrated Water Cycle.

The ongoing pandemic will leave a greater general awareness of how our survival is strictly connected to the whole biological network of our planet. There is no distance between humans and the whole living world. There is no part of the biosphere or ecosystem that has not been altered by the humans.

This fact, that ecologists and virologists already knows, and that all mankind was beginning to understand through the climate crisis, has now changed our lives.

We must increasingly direct our efforts to increase the application of low-environmental impact processes, the protection and safeguard of the environment, with particular concern for the water resources, that are the assets of our Integrated Water Cycle management and heritage of humanity.

Research Center Director

Lorenza Meucci

President

Paolo Romano

February, 2021

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Projects closed in 2020

Energy Environment

DEMOSOFC - DEMOnstration of large SOFC system fed with biogas from WWTP

STATUS	**Closed**
STARTING DATE	**September 2015**
DURATION	**60 months**
FUNDING	**Yes**
PARTNERS	**Polytechnic University of Turin, Convion, VTT, Imperial College, Risorse Idriche**

DEMOSOFC is the largest SOFC cells installation in Europe that, using the technology based on solide oxide fuel cells, produces high eletrical productivity with low atmospheric emissions of pollutants (NOx, SOx, PM) by expoliting the biogas produced by the anaerobic digestion of sludges from urban wastewater treatment.
DEMOSOFC plant, co-funded by the EU within the Horizon2020 framework program, is located at the SMAT treatment plant in Collegno (TO), a wastewater treatment plant that serves around 180000 inhabitants equivalent.

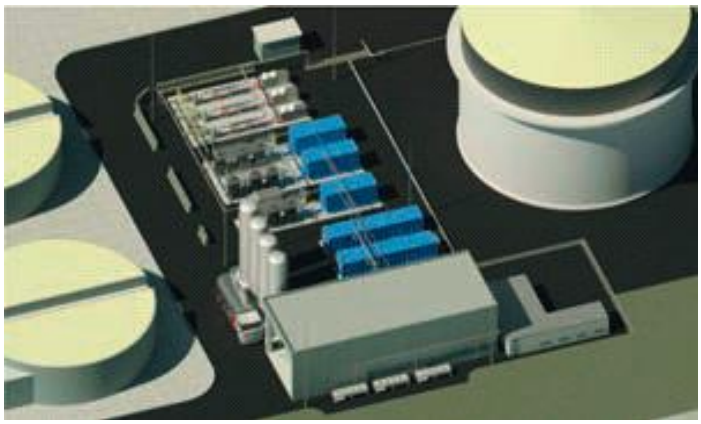
DEMOSOFC is an outstanding plant, that covers the 30% of energy demand of the whole watewater treatment plant, re-using the sludges produced by the treatment plant itself.
DEMOSOFC modules become operational in summer 2018. In order to verify the energetic and environmental benefits of DEMOSOFC modules, the Polytechic University of Turin and the VTT Research Center carried out in 2020 an analysis on the system functionality data.
The electrical efficienty of the SOFC modules show values always higher than 50% (with peaks of 56%), compared with a electrical efficiency of around 30% of the traditional internal combustion engines, usually employed for biogas co-generation.
Also considering the polluting emissions, the SOFC system is extremely advantageous: the measured values were lower than the detection limits of the sensors. Moreover, the atmospheric particulate mesaured after the combustion chamber was lower than the surrounding air. This is due to the fact that the SOFC system filters the surrounding air entering the system and does not produce atmospheric particulate. Finally, considering the environmental impact, the emissions reduction of SOFC system in terms of NOx is higher than 87% respect to the traditional internal combustion engines.
The project finished at the end of 2020 and we are now evaluating the industrial options for biogas re-using, also considering the financial incentives reserved to this renewable fuel.

"DEMOSOFC represents the largest SOFC cells installation in Europe and the largest installation worldwide with SOFC cells powered by biogas"

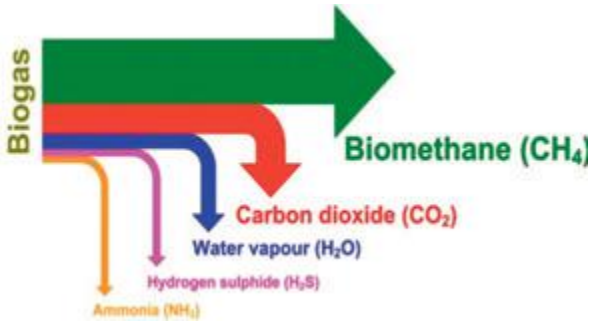
Energy Environment

Biomethane

STATUS	**Closed**
STARTING DATE	**October 2018**
DURATION	**18 months**
FUNDING	**No**
PARTNERS	//



In Castiglione T.se wastewater treatment plant, biogas produced by the anaerobic digestion of sewage sludge was historically reused for cogeneration of renewable electrical and thermal energy. Recent innovations in the Italian legislation opened, and strongly incentivized, a new possibility for biogas recovery: biomethanation is the process by which CO_2 and other contaminant compounds (H_2O, H_2S, siloxanes, halogen compounds, etc.) are removed from biogas in order to obtain a methane concentration almost equal to that of natural gas (usually >95%), suitable for its introduction into the distribution grid.



New Italian regulations provide for biomethane to substitute fossil natural gas in the transport sector that will benefit from a renewable energy source.

Based on the results of the technical and economic feasibility study developed as part of this project, SMAT decided to design and build, at Castiglione T.se waste water treatment plant, a biogas up-grading plant for biomethane production and introduction into SNAM natural gas distribution grid.

The feasibility study was the base for the selection of the best technologies in terms of efficiency, for the optimal integration in the existing plant and for the following design. Despite difficulties linked to the pandemic, building works were completed during 2020, and the plant was started in June.

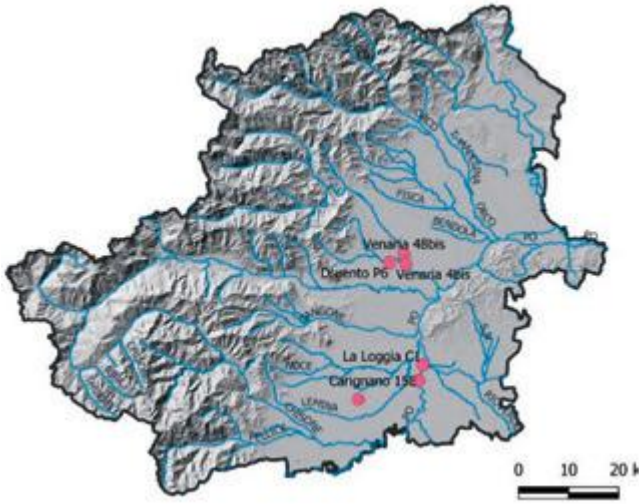
Finally, we focused on biomethane sustainability analysis, which resulted compliant to European and national technical standard and law in terms of green-house gases net emission savings, in comparison with traditional fossil fuel replaced by biomethane.

"The objective of this project is to study the technical and economic feasibility of a biogas up-grading technology for biomethane production in Castiglione T.se wastewater treatment plant"

Energy Environment

«LOCKDOWN_COVID-19» effects on groundwater resources

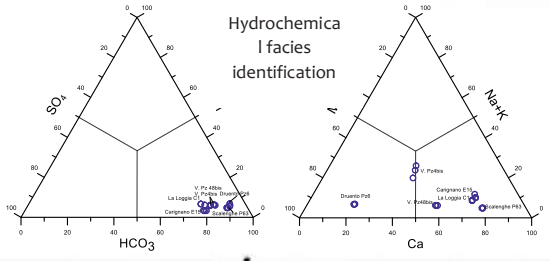
STATUS	**Closed**
STARTING DATE	**April 2020**
DURATION	**9 months**
FUNDING	**No**
PARTNERS	**CNR-IGG, Arpa Piemonte**

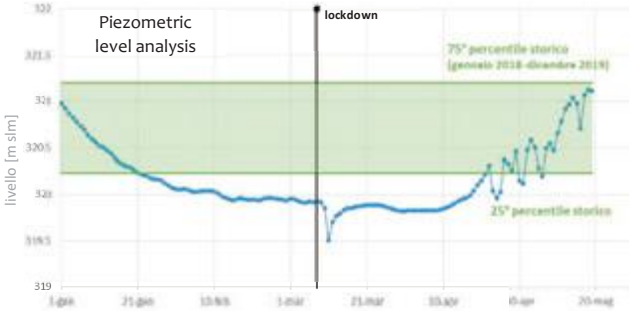


During the italian lockdown caused by the Covid-19 health emergency many water-intensive activities were stopped, as well as the related groundwater extractions.

The hydrodinamic status of the bodies of groundwater induced in short and medium term by Covid-19 lockdown allowed to obtain new informations on physical and chemical characteristics of selected aquifer systems, considering their interaction with anthropic extractions.

In this framework, special attention was paid to the wells fields of Regional Interest located in Scalenghe and Venaria, deeply investigated in the research project "Integrated methodologies for managing and safeguard of groundwater resources".





The following actions were carried out:

1. statistical analysis of the piezometric network data managed by Arpa Piemonte and located in the Greater Turin Metropolitan area: some counter-trends were identified;
2. sampling campaigns in selected wells, considering the nearest to those piezometers where counter-trends were identified;
3. chemical, geochemical and isotopic analysis of the sampled wells.

In the Greater Turin Metropolitan area managed by SMAT, the data collected and analysed didn't highlight a clear impact of the lockdown period on the aquifer hydrodinamic status, unlike what occured in other italian regions (such as Tuscany), where the stop of water-intensive economic sectors (tanneries, paper mills, …) had a significative impact both on the piezometric level rise and on the chemical and isotopic composition of the groundwater resources.

"In the area managed by SMAT, the data collected and analysed didn't highlight a clear impact of the lockdown period on the aquifer hydrodinamic status"

Energy Environment

Climate change adaptation plans

STATUS	**Closed**
STARTING DATE	**February 2019**
DURATION	**18 months**
FUNDING	**No**
PARTNERS	**Municipality of Turin**

Source: awareness campaign, DERRIS project, Municipality of Turin

Climate change is one of the greatest challenges facing the mankind in the near future, and climate crisis is one of the major politic priority. Individual nations, regions and local communities should develop adaptation methodologies that meet their specific needs. The Municipality of Turin started an important process to reduce climate-related risks, also thanks to the direct collaboration with SMAT Research Center.

On december 2018, a Memorandum Of Understanding (MOU) was signed between the Municipality of Turin and SMAT for the dissemination of information and knowledge gained through the project DERRIS (DisastEr Risk Reduction InSurance, financed under LIFE EU's programme).

This dissemination process was developed as support activity to compile Climate Change Adaptation Plans.

The Research Center is leading SMAT in this process, also defining the training pathways on climate change, risk assessment and management.

In 2019 specific training courses for the personnel of SMAT Water Networks Center were organized. This center was the first SMAT site that will develop a Climate Change Adaptation Plan. Thanks to the CRAM TOOL (https://cram.derris.eu/), a simple tool that gives the opportunity to understand the risks to which the site is exposed and what could be the solutions to prevent damages, the probability of occurrence of seven potentially hazardous meteorological events (flood, lightning, rainfall, hail, landslides, wind and extreme temperatures) was evaluated.

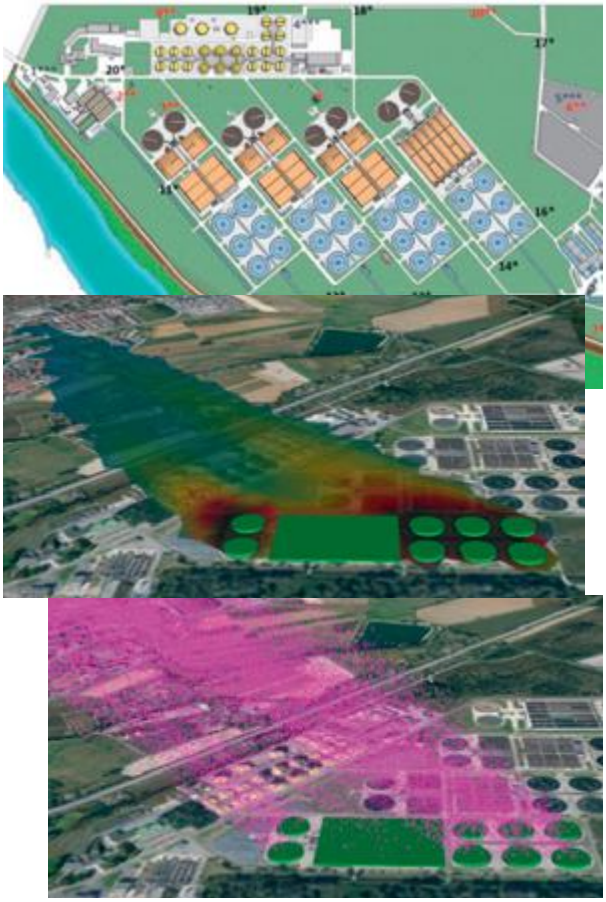
In 2020 a multidsciplinary team composed by SMAT researches and water network specialists worked on the identification of the different level of risks for the selected site, and drawn up the Action Plan.

"SMAT Water Networks Center, leading by the Reasearch Center, was the first site to develop a Climate Change Adaptation Plan"

Energy Environment

Modeling the atmospheric dispersion of odor-producing substances

STATUS	**Closed**
STARTING DATE	**March 2017**
DURATION	**36 months**
FUNDING	**No**
PARTNERS	**Polytechnic University of Turin, Ecole Centrale de Lyon, Società Meteorologica Italiana**



The local acceptability of a large wastewater treatment plant, like the one serving Turin and its outskirts, requires an ever-increasing attention to the containment of odor-producing substances propagation.

The objective of this research project was to assess the impact of odor emissions from the treatment plant in Castiglione Torinese on the surrounding environment; the model elaborated is intended to allow the identification of containment actions that will integrate the three deodorizing sections already installed within the plant.

The integrated monitoring system of odor impacts included:

- installation of a station for continuous monitoring of local weather conditions;
- specific characterization, by means of appropriate measurement campaigns, of the chemical species and the emission sources that are mainly responsible of odor impacts;
- analysis, through joint measurements and subsequent elaborations, of the relationship between concentration of volatile chemical species and odor concentration measured onsite;
- development of a monitoring network for concentrations in air of the substances that are mainly responsible of odor impacts (VOCs, hydrogen sulphide and ammonia);
- development of a modelling chain integrating the measurements of the monitoring network and, based on the local meteorological conditions, simulating odor dispersion, in way to characterize the area eventually affected by odor emissions.

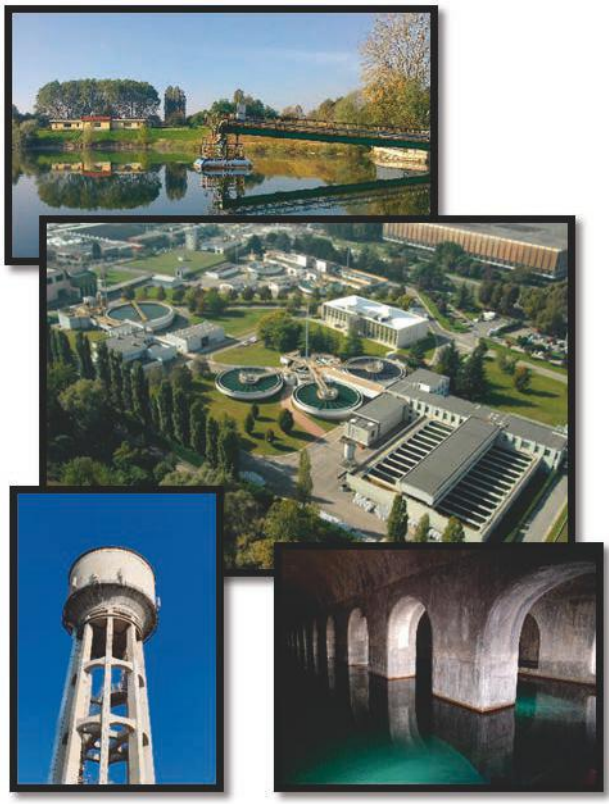
The modelling results are consistent with odor notifications and the comparison between modelled and measured is significant.

"The objective of the project was to create a model for assessing the impact of odor emissions from the wastewater treatment plant in Castiglione Torinese on the surrounding environment"

Analysis Quality

Water Safety Plan for the City of Turin

STATUS	**Closed**
STARTING DATE	**January 2018**
DURATION	**36 months**
FUNDING	**No**
PARTNERS	**National Institute of Health**



Starting from 2018, Smat started a research project to draft the complex City of Turin Water Safety Plan (WSP), subsequently in 2019 an agreement was signed with the National Institute of Health (ISS) with the aim of verifying and completing the City of Turin WSP, through the detailed analysis of a part of the WSP drawn up previously (area 2, area 7 and supply network).

The collaboration was completed at the end of 2020, during which numerous meetings for mutual analysis were held, thanks to which it was possible to complete and refine the WSP and the method used for the drawing up of the WSP.

The multidisciplinary team, composed by Smat internal staff and members of external authorities such as Arpa Piemonte, Regione Piemonte, Autorità d'Ambito Torinese, ASL "City of Turin" and ISS, met in technical meetings (6 in total) and on-site inspections.

The external authorities provided data, which were used and integrated in risk assessment.

On-site inspections of the two analysed areas, were carried out by the multidisciplinary team on each health attention node included in the risk assessment.

The risk matrices, that is the key document of the PSA, have been completed for all the areas that make up the entire water system of the City of Turin, including the supply network.

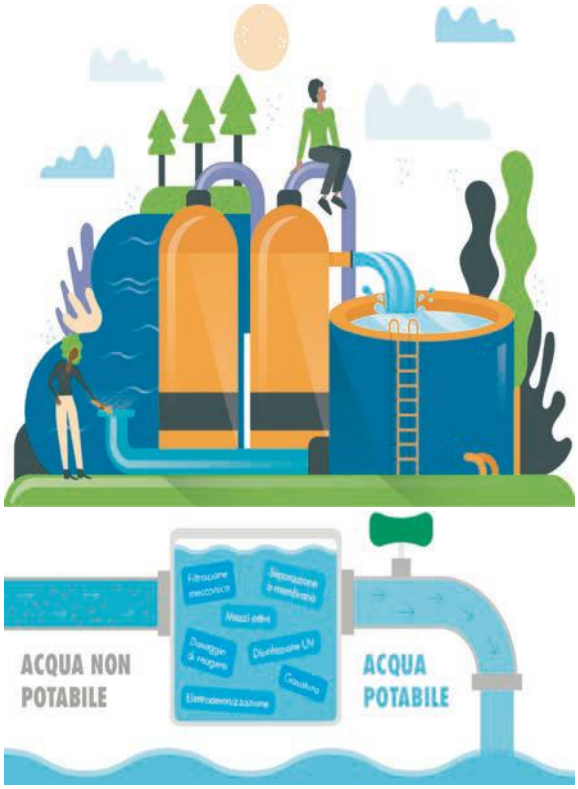
Furthermore, the Cloud, that is an essential tool for sharing documents and for the WSP's approval, has been updated and transferred to a more user-friendly system, directly accessible from the Reserved Areas of the official company website.

"In 2021, the City of Turin WSP will be sent to the Ministry of Health and to ISS to be listed for the approval, pending the issue of WSP approval guidelines"

Analysis Quality

Upgrade of disinfection systems: support models to prioritize operations and guide the decision-making process

STATUS	**Closed**
STARTING DATE	**January 2019**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	//



The project is aimed at generating a validated operational tool to guide the decision-making process in order to improve the drinking water disinfection systems in the municipalities characterized by high microbial vulnerability. Building on a systematic screening of the microbiological issues (~ 60% of total anomalies) emerged from the laboratory analyses carried out in the past, the project pursues the definition of models and guidelines to upgrade the existing disinfection systems.

The most critical municipalities have been determined and prioritized based on a number of indexes mainly depending on the type and frequency of the bacterial contaminations identified. Each situation was thoroughly examined to highlight the potential causes, the technical and practical difficulties related to disinfection management, and to hypotesize the best solutions for each specific context.

This approach contributed to define the most frequent categories of problems and the different options of intervention, to finally come to agreed operational choices and to their implementation.

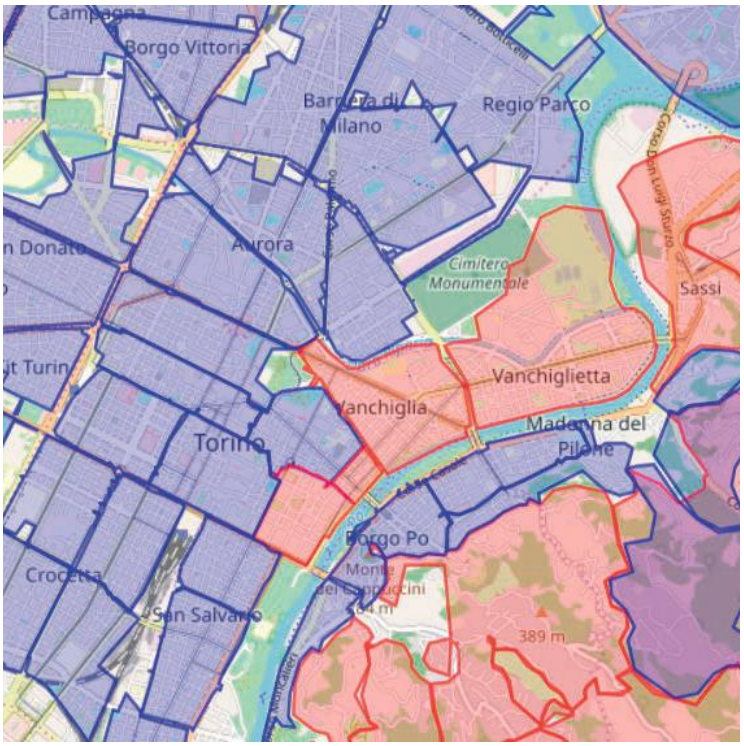
During and after the planned interventions (such as UV plant and online sensor installation, treatment variations, etc.), the microbiological data from the municipalities under investigation have been constantly monitored, indicating an overall trend towards improvement. In the two years of follow-up, thanks to the activities undertaken, microbiological anomalies have shown a 45% decrease, with only 4 out of the 45 municipalities analyzed still requiring some improvement and 21 with no more quality problems at all.

"In the two years of follow-up, thanks to the activities undertaken, microbiological anomalies have shown a 45% decrease"

Water networks

Design and implementation of district metered areas in Turin water distribution network

STATUS	**Closed**
STARTING DATE	**January 2018**
DURATION	**36 months**
FUNDING	**No**
PARTNERS	//



The project's objective was to implement the guidelines developed by the International Water Association (IWA) and adopted by the European Commission through the document titled "EU Reference document Good Practices on Leakage Management WFD CIS WG PoM" in the management of Turin water distribution network.

The guidelines describe in detail practices aimed at implementing metered district areas (DMAs), in order to identify areas characterized by high leakages levels, increase interventions promptness in case of failures and prioritize breaks localization activities.

DMAs are managed as independent and autonomous entities, whose hydraulic parameters are monitored so as to know the state of efficiency in real time. Using DMAs it was also possible to regulate the value of the operating pressure, which in suffered high fluctuations between day and night due to the consumption variation. In addition to a reduction in the level of leakage, pressure management has allowed to reduce repairs to the distribution network by 50%.

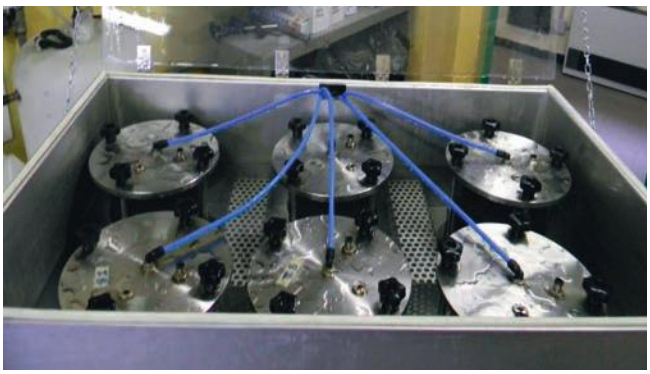
The project, in addition to having demonstrated the effectiveness of the method on the water distribution system of the City of Turin, has made it possible to address all the critical issues relating to the design, construction, management and maintenance phases of DMAs. This experience will be used by the company for the realization of the districtization of the entire Turin distribution network.

"… pressure management has allowed to reduce repairs to the distribution network by 50%"

Treatment

Sludges III

STATUS	**Closed**
STARTING DATE	**June 2018**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**Polytechnic University of Turin**



Sludge disposal represents one of the highest costs for waste water treatment plants. Optimization of sludge treatment processes, especially anaerobic digestion, would be highly desirable to increase biogas production (and consequent co-generation of electrical and thermal energy) and to reduce the amount of solid digestion products and the associated drying and disposal costs. This project is devoted to the continuation of a previous experimental work, carried out in collaboration with the Polytechnic University of Turin, to study and test more efficient plant and process solutions to be applied in the sludge treatment line of Castiglione Torinese wastewater treatment plant.

The first experimental test focused on waste active sludge thermophilic (55°C) anaerobic digestion in 50 and 300 litre pilot digesters, which showed a methane productivity increase of more than 50% compared to mesophilic digestion of the same sludge.

During the second experimental test we studied, in 10 litre pilot digesters, the so-called Temperature Phased Anaerobic Digestion (TPAD), that is the 2-stage anaerobic digestion of primary sludge, with a low residence time (2-3 days) thermophilic first stage digestion, followed by a mesophilic second stage digestion. The test showed an overall methane productivity increase of around 18% compared to one-stage mesophilic digestion of primary sludge.

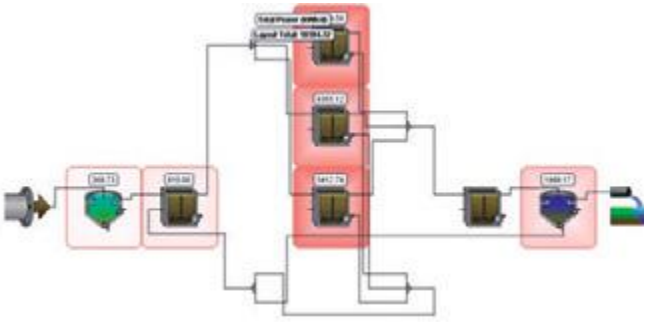
Moreover, besides the biogas productivity increase, the low residence time first stage digestion offers the possibility of volatile fatty acid production which can be used, in future, for phosphorus biological removal or for biopolymer production from sludges.

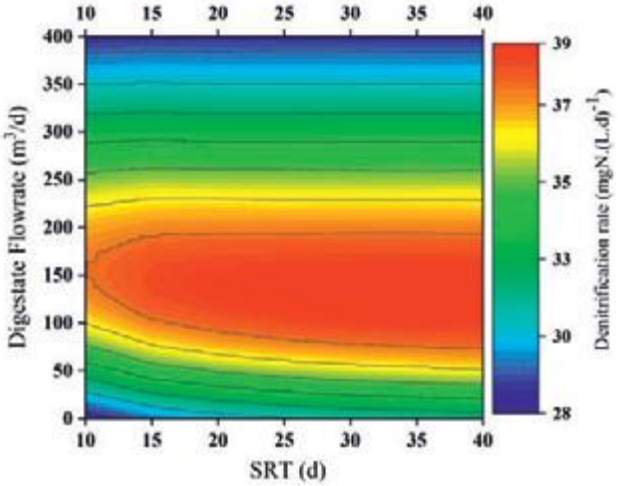
"Optimization of sludge treatment processes, especially anaerobic digestion, would be highly desirable for an Integrated Water Service Company"

Treatment

Modeling of urban waste water treatment processes

STATUS	**Closed**
STARTING DATE	**June 2018**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**Polytechnic University of Turin**





Mathematical models of physical, chemical and biological processes of wastewater treatment are instruments of great importance for plant management, since they give the opportunity to simulate the operation and foresee the plant's behavior in response to changes in operational parameters. The models (for sure the most renowned is ASM – Active Sludge Model) allow to optimize operational management, in terms of treatment performance, sludge production, energy consumption and chemicals consumption.

During last years, in collaboration with Polytechnic University of Turin, we built a simulation model for the waste water treatment line of SMAT Castiglione Torinese plant.
The aim of this project was the improvement of the model parameters evaluation and the analysis of several operative scenarios aimed at plant performance optimization.

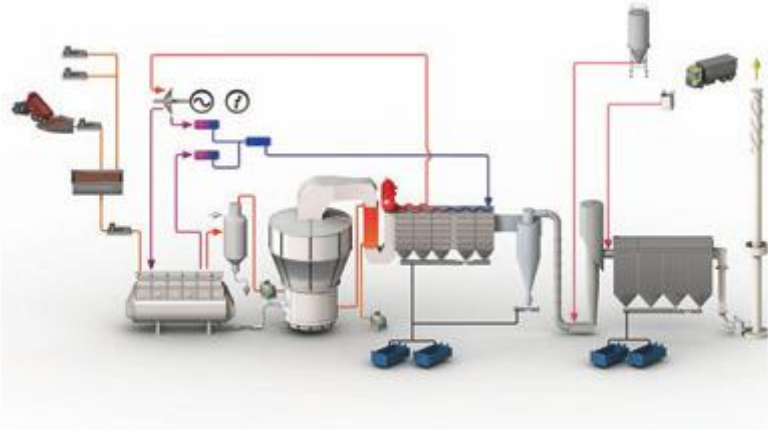
Particularly during the last year, project activities focused on the improvement, by respirometry techniques, of the evaluation of biological process kinetic parameters and on influent characterization (COD fractionation) in different meteorological conditions (dry and wet weather).
In the scope of the project, we focused on the evaluation of the optimal solid retention time (SRT) in order to maximize treatment performances and biogas production.
Finally, we used the model to simulate treatment performance with the hypothetical introduction of 2-stage anaerobic digestion for readily biodegradable COD production and to define the optimal amount of digestate to be recirculated towards water treatment line in order to maximize denitrification.

"The models allow the optimization of the operative management, in terms of treatment performance, sludge production, energy consumption and chemical consumption"

Treatment

Drying, thermal oxidation and energy recovery from sludges

STATUS	**Closed**
STARTING DATE	**December 2019**
DURATION	**12 months**
FUNDING	**No**
PARTNERS	//



During the last years sewage sludge management and the identification of a reliable final destination for sludge disposal or recovery have become an increasingly serious problem for Integrated Water Cycle companies. Indeed, the sector law and case law framework is evolving continuously and struggle in finding a stabilisation; moreover, sludge disposal/recovery market is characterized by an imbalance between supply and demand. All these themes certainly played a role in the recent increase of sludge disposal/recovery costs. Obviously the problem is not only limited to an economic issue, but it involves, with even more relevance, the possibility it self to send sludges to their final destination and, finally, the possibility for waste water treatment plant to execute their own function.

In this incertitude framework is of essential importance, not only from a technical but also strategical point of view, the planning of structural improvements that allow to get free from market fluctuation and make available some sludge disposal/recovery way that prove to be reliable, long-lasting and, eventually, economically sustainable.

During this project we performed a technical and economic feasibility study for the implementation of an integrated plant composed by drying, thermal oxidation and energy recovery of waste water treatment sludges.

We considered several thermal oxidation technologies commercially available with particular attention to the choice of the best technologies for the treatment of atmospheric emissions.

Finally, we focused on the optimal plant configuration and integration aimed at the best energy recovery approach for the production of thermal and electrical power (that will guarantee the self-sufficiency of the system).

"We performed a technical and economic feasibility study for the implementation of an integrated plant composed by drying, thermal oxidation and energy recovery of waste water treatment sludges"

Ongoing projects

Energy Environment

Greenhouse gases emissions reporting and carbon footprint calculation

STATUS	**Ongoing**
STARTING DATE	**Gennaio 2020**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**Polytechnic University of Turin**

The recently growing attention towards impact assessment and climate-change mitigation measures reflected in national policies and regulatory frameworks that became more demanding towards water utilities in terms of environmental sustainability.

In response to the Regulation 917/2017 from the National Authority for Electricity, Gas and Water Supply, SMAT carried out a first pilot study to measure the carbon footprint of the wastewater treatment plant in Castiglione Torinese in 2019.

The ongoing project, following the first pilot phase, aims to extending the greenhouse gases emissions reporting to all the wastewater treatment plants managed by SMAT, as well as the drinking water treatment sector and all the company activities.

The first phase of the project, concluded in 2020, envisaged the classification and characterization of wastewater treatment plants (size, polluting load, process, etc.), data collection and realisation of a tool for the calculation of our carbon footprint.

In order to allow annual reporting and due evaluations of annual trends in the carbon footprint indicator, the inventory created in 2019 was properly updated and integrated, while we are currently working on a new data mining and elaboration tool able to yield the necessary outputs in an automated manner.

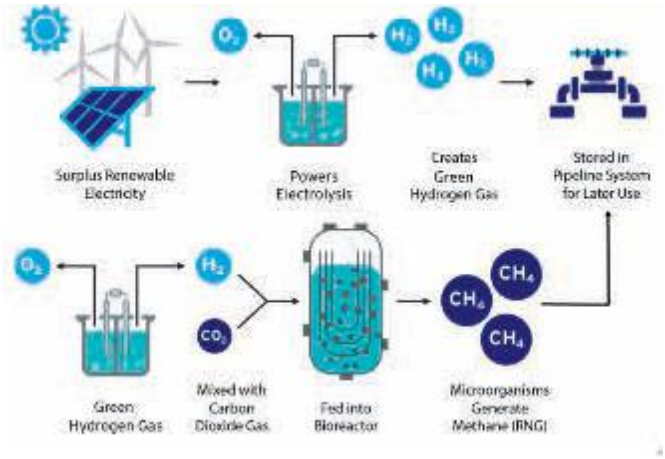
The final stage of the project, to be implemented in close collaboration with the Polytechnic University of Turin, envisages the direct measurement of off-gases from wastewater treatment basins in Castiglione, in order to quantify emissions more accurately and contribute to the definition of a consolidated methodology.

"The 2020 greenhouse gases emissions inventory, shows the effectiveness of reduction and compensations measures, with the realistic target of a zero-emissions balance within 2021"

Energy Environment

Hydrogen production and methanation

STATUS	**Ongoing**
STARTING DATE	**June 2020**
DURATION	**36 months**
FUNDING	**No**
PARTNERS	//



"Power-to-gas" is a promising approach as a solution to the lack of programmability of renewable energy sources, especially photovoltaic and wind power. This is the possibility to convert the renewable source energy over-productions into combustible gas (therefore transforming the electrical energy into chemical energy) that can be stored and transported.

An example is the electrochemical production (electrolysis) of hydrogen which is, however, an energy vector with a still limited diffusion because of the lack of infrastructures.

Until hydrogen economy will be fully developed, combining "green" hydrogen (that is produced from renewable sources) with carbon dioxide, to produce "renewable methane" enables the use of natural gas distribution grid for storing and transporting, in chemical form, the excess of renewable energy in case of overproduction.

With this perspective, waste water treatment plants represent an excellent location for power-to-gas installations, for at least a couple of reasons:

- in plants equipped with anaerobic digestion, carbon dioxide in biogas could be combined with hydrogen in order to produce additional renewable methane (biological methanation) by microorganisms (methanogenic archea) commonly present in anaerobic digesters.
- besides hydrogen, also oxygen is generated from water hydrolysis, which can be favourably used for the aeration of aerobic biological processes of water treatment.

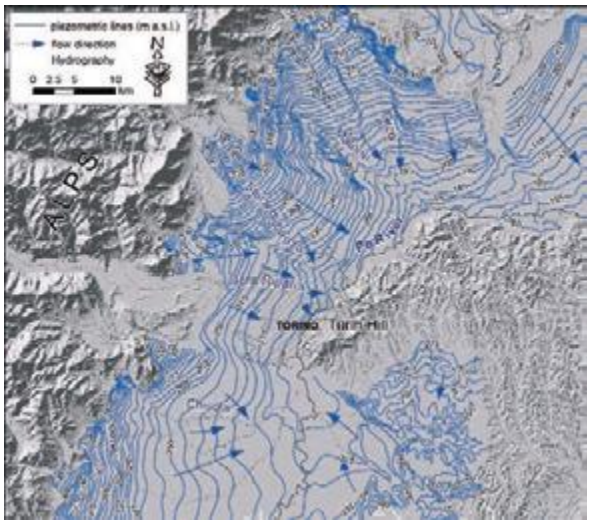
In the framework of the project, we will test biological methanation of hydrogen in pilot anaerobic digesters, aiming at the optimisation of operative process parameters, and at the assessment of the energetic yield and technical-economical feasibility of the solution.

"Waste water treatment plants represent an excellent location for power-to-gas installations"

Energy Environment

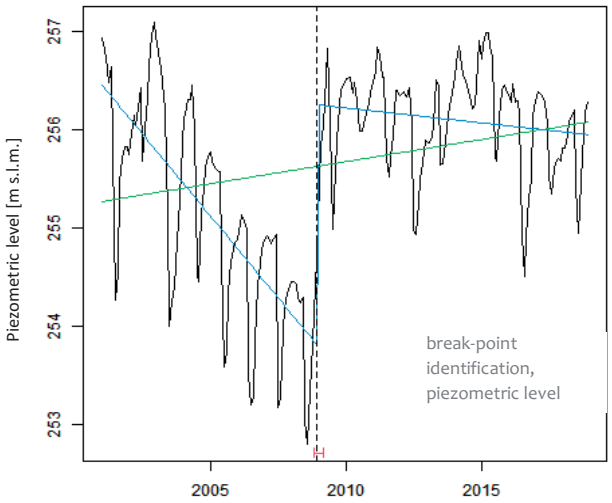
Groundwater level prediction using a statistical forecasting approach

STATUS	**Ongoing**
STARTING DATE	**June 2020**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**CNR-IGG, CNR-IRCRES**



Piezometric lines of the shallow aquifer of the Turin plain

Groundwater leves are the most important hydrological information for the monitoring of the aquifer quantitative state. Piezometric levels of the groundwater real-time monitoring network managed by ARPA Piemonte were already analysed considering ISPRA guidelines developed to evaluate the quantitative state of the bodies of groundwater. In the area managed by SMAT, the analysis performed over the monthly timeseries highlighted a characteristic behavior in the whole area, with a sharp piezometric level rise in 2008-2009, showing a counter-trend break point respect to the previous years. Indeed, the overall temporal trend of the piezometric leves of the study area is characterized by a decreasing trend in 2000-2008 period, a sudden break point with a rise in the levels in 2008, followed by another decreasing trend.



This behavior is common in the whole area managed by SMAT, except for those piezometers located in the Stura di Lanzo river basin. Different hypothesis were developed to explain this characteristic behavior, but there has been no real investigation.

The goals of this project can be summerized as follows:

- to find the cause of this break-point, probably due to a combination of higher precipitation amounts and lower groundwater extractions due to the economic crisis that stopped most of the water-intensive activities;
- once we will identify the fields that influence this piezometric level counter-trend, we will build a statistical model to forecast the groundwater level evolution.

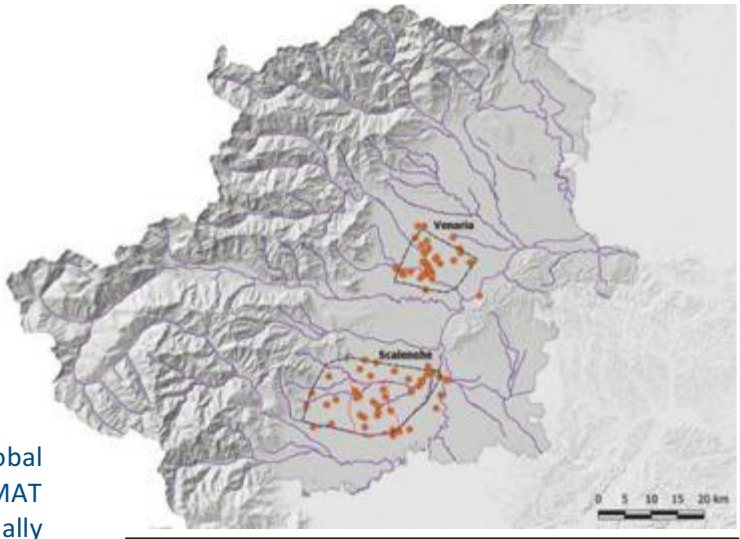
All the analysis are developed considering a monthly time scale, in order to have a forecast useful for monitoring the groundwater level evolution for environmental safeguard purposes.

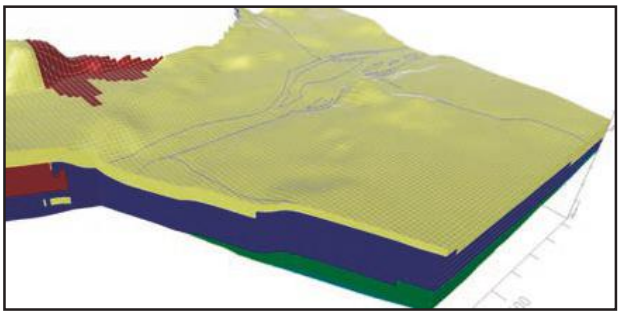
"Groundwater leves are the most important hydrological information for the monitoring of the aquifer quantitative state"

Energy Environment

Integrated methodologies for managing and safeguard of groundwater resources

STATUS	**Ongoing**
STARTING DATE	**March 2019**
DURATION	**30 months**
FUNDING	**No**
PARTNERS	**CNR-IGG, Arpa Piemonte**





3D reconstruction of the bodies of groundwater

Groundwater resources represent about 97% of global freshwater resources and almost 70% of the whole SMAT supply (in terms of volume). Therefore, it is a crucially important task to determine and evaluate water supply stability and availability with regard to short and medium-term.

In this research project, the multi-layer aquifer systems of specific interest areas that host wells fields of Regional interest (Venaria and Scalenghe) are investigating. The goal is to obtain significant knowledge for better safeguarding and protecting these well fields.

The working plan foresees the following actions:

- Reconstruction of hydrogeological and geological characteristics of the selected aquifer systems and hydrodinamic conditions study;
- Aquifer supply components identification and source recognition;
- Definition of geological and hydrogeological framework (considering also processes quantification) in order to define wells fields safeguard areas;
- Development of a medium-scale numerical model that reconstructs the gorundwater flow, pollutants patterns and forecasts the piezometric levels evolution.

In may and october 2019 two different sampling campaings were carried out, considering both wet and dry conditions. Chemical and isotopic data were collected and analysed, allowing the identification of the hydrochemical facies, the mixing processes, the water-rock interaction and the anthropic processes that origins the presence of pollutants in groundwater resources. Hydraulic gradients and flow paths were identified by analysing piezometric data.

A stratigraphic QGis database was built to develop the 3D reconstruction of the bodies of groundwater. To do this, all the stratigraphies were translated into hydrogeological layers.

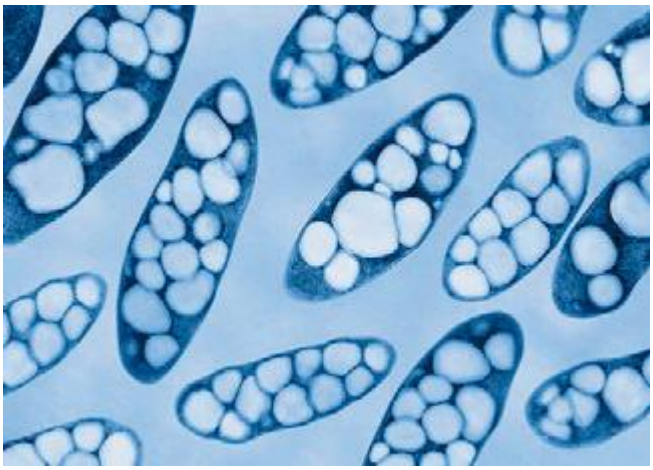
The development of the conceptual model and the meteorological, hydrological and land-use data collection are the last steps we need for the development of the numerical model that will aid the management of the wells fields we are investigating.

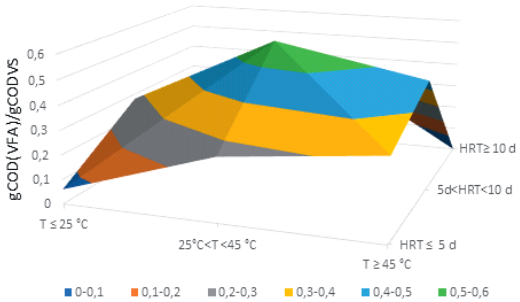
"The reconstruction of hydrogeological and hydrodinamic framework of the wells fields will identify their supply areas, ensuring qualitative stability over time and defining pollutants tansfer paths"

Energy Environment

Biopolymers

STATUS	**Ongoing**
STARTING DATE	**October 2019**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**HERA, IREN, A2A, Polytechnic University of Marche**





Process technology evolution offered, in addition to a continuous improvement of energetic and contaminants removal performances, the possibility to consider wastewater as a resource rather than a waste.

Several technologies are already well-known in the field of waste water reuse or for electrical and thermal energy recovery by biogas production from sewage sludges. A further step along this way is represented by the recovery of raw materials to be reused as common commercial products with economic and environmental advantages.

Beyond well-known technologies for phosphorus and nitrogen recovery by struvite production, several processes have been developed, but still at an experimental stage, dedicated to the recovery of organic substances for biopolymer production with the aim of substituting fossil derived plastics.

The purpose of this research project, in collaboration with HERA, IREN, A2A and with the technical support of Polytechnic University of Marche, is studying the available technologies for biopolymer (more precisely PHA polyhydroxyalkanoates) recovery from urban waste water treatment processes. Moreover, we will study the technical and economic feasibility of the implementation of these technologies in some of the wastewater treatment plants managed by the utilities involved in the project partnership.

Regarding SMAT we selected Castiglione Torinese waste water treatment plant and analysed the overall mass balance. Following the selection of the most suitable process for PHA production, we evaluated the expected production yields and the optimal integration in the existing plant.

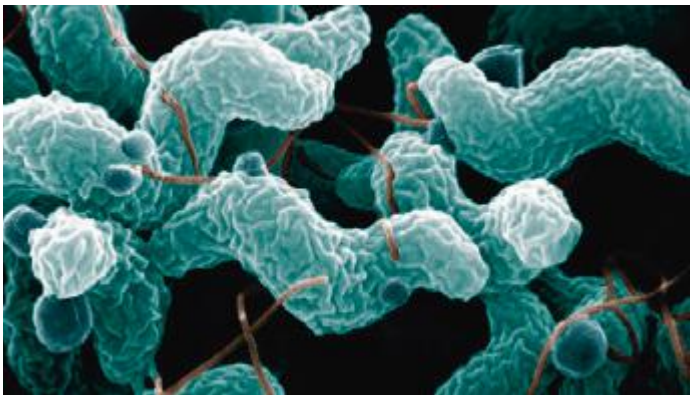
In the final part of the project, we will perform a preliminary sizing of the hypothesized system and an economical sustainability assessment (operative and investment costs).

"The purpose of this research project is studying the available technologies for biopolymer recovery from urban waste water treatment processes"

Analysis Quality

Microbiological indicators in the water resources intended for human consumption

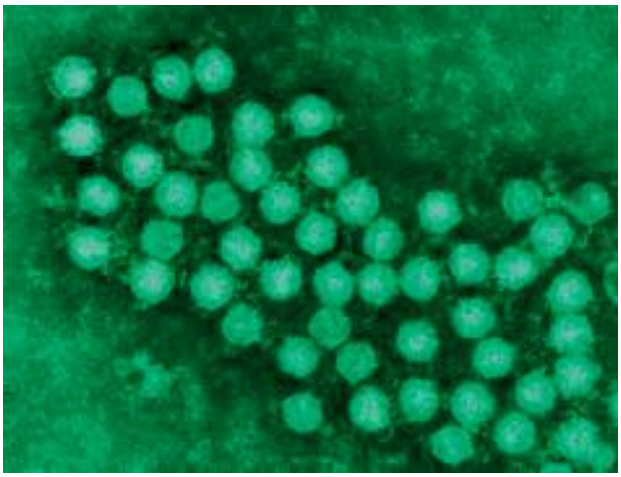
STATUS	**Ongoing**
STARTING DATE	**November 2020**
DURATION	**6 months**
FUNDING	**No**
PARTNERS	**University of Turin**



Specific controls aimed to verify the microbiological quality of the aquatic environments should verify the presence of some pathogens, in order to assess their hazardousness to public health.

Tests and quantification methods are quite complex, and not always available for all the pathogens. Moreover most of the available methods have long response times.

Some indicator microorganisms were identified to overcome these difficulties.



The goal of this project is to evaluate the representativeness of the indicator microorganisms in the detection of the pathogens and/or in the identification of the microbiological water quality, in order to find some concentration ranges (cut-off) that are reasonable for the selected indicators.

A bibliographic research and review was done, in order to find out the correlation between the presence of pathogen microorganisms and those indicators included in the European legislation of the water intended for human consumption.

Some of these pathogen microorganisms will be selected, considering those representative of feacal and environmental contamination.

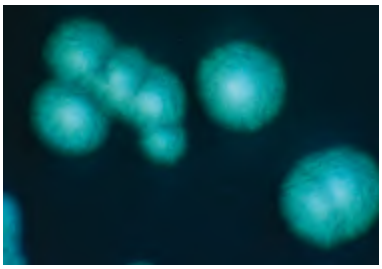
The outputs of this project will be used for SMAT water resources management, considering the available water resources, the contamination risk and the potabilization treatment.

"The goal of this project is to evaluate the representativeness of the indicator microorganisms in the detection of the pathogens and/or in the identification of the microbiological water quality"

Analysis Quality

Legionella

STATUS	**Ongoing**
STARTING DATE	**May 2019**
DURATION	**30 months**
FUNDING	**No**
PARTNERS	**A2A, Hera, IREN**



The new Directive (EU) 2020/2184 on the quality of water intended for human consumption introduces Legionella among the parameters that should be monitored by the integrated water system companies. The WHO notes that, in the Union, Legionella causes the highest health burden of all waterborne pathogens. The parameter shall be evaluated at the domestic distribution system.
Member States shall establish guidelines for the risk assessment.

As water services operators, all the partners of this project were directly involved in ad-hoc monitoring campaigns to evaluate the presence of Legionella in the water distribution systems.
Considering the whole drinking water chain, Legionella was only founded in some domestic distribution systems. In fact, even when the presence of Legionella was detected in some supply sources, the outputs of the water treatment plants were always free of pathogens, which therefore develop in the domestic water networks.
Some analysis were carried out to evaluate critical conditions for the growth of Legionella in the water networks, such as the highest temperatures registered during the summer season. No significative positive correlation was found between temperature and Legionella presence, while a negative correlation was found between the concentration of disinfectant in the water networks and the presence of Legionella.
One of the goals of this project is related to the communication strategies necessary to inform consumers and owners of public and private premises about measures to eliminate or reduce the risk of noncompliance with the quality standards for water intended for human consumption due to the domestic distribution.

"The project is aimed at evaluating the possible risks connected to the presence of Legionella in the water distribution systems by identifying critical nodes"

Analysis Quality

Early warning sensors

STATUS	**Ongoing**
STARTING DATE	**December 2019**
DURATION	**18 months**
FUNDING	**No**
PARTNERS	**A2A, Hera, IREN**

The project, dedicated to the "online" monitoring of the microbiological features of water matrices, is essentially aimed at sharing the experience of the participating companies. It foresees the experimentation of advanced online instruments which could support water managers in handling quality issues in the integrated water system according to national regulations and in view of implementing Water Safety Plans and improving the technical quality indicators required by the Italian Regulatory Authority ARERA.

Building on the knowledge acquired in the online monitoring field, the four companies have focused on extensive technology scouting of the commercially available options for innovative sensors. Each company elaborated a pilot monitoring project and selected an analyzer for a performance evaluation in order to share the results with the rest of the consortium. To this aim, SMAT acquired a latest generation sensor, first in the field, for the automated analysis of the microbiological load through the ATP technology, namely the indirect measurement of the microbial concentration by luminescence. The instrument currently monitors the outflows of the Po river drinking water treatment plant and that of La Loggia well water treatment plant, providing timely quality data 24/7. The results, in accordance with those obtained by laboratory analyses conducted using traditional methods, confirm the excellent quality of the distributed water. Appropriate alarm thresholds will be set to allow in the future a prompt response in case of microbiological concerns.

"Appropriate alarm thresholds will be set to allow in the future a prompt response in case of microbiological concerns"

Analysis Quality

CALLISTO

STATUS	**Ongoing**
STARTING DATE	**December 2020**
DURATION	**36 months**
FUNDING	**Yes (H2020)**
PARTNER	**SERCO Italia S.p.A., Certh, Fraunhofer-Gesellschaft, CS Group, Barcelona Supercomputing Center, et al.**

Driven by the vision of the European Commission Destination Earth initiative, CALLISTO - "Copernicus Artificial Intelligence (AI) Services and data fusion with other distributed data sources and processing at the edge to support DIAS and HPC infrastructures", will develop dedicated AI solutions to combine data from heterogeneous sources (including Copernicus satellite data) and help monitor human and environmental activities. The developed solutions will be tested in four pilot cases, driven by the needs of: (1) EU's Common Agricultural Policy (CAP) monitoring, (2) water quality assessment, (3) sensor journalism, and (4) land border change detection.

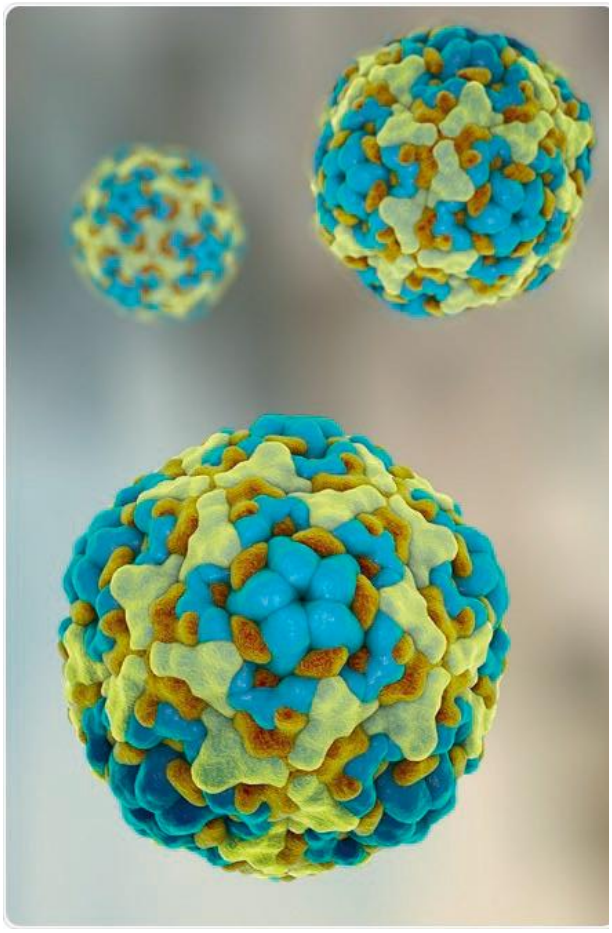
SMAT will be mainly involved in the implementation of the pilot use case related to water quality monitoring. Water scarcity and deterioration of raw water quality are an increasing concern due to intensive industrial or agricultural activities and the increasing occurrence of extreme summers. Intake water quality can deteriorate yielding risks of eutrophication events with algae blooms in the storage basins. This affects the operations of water production centers, with possible clogging of screens, filters and media, higher maintenance costs, as well as taste, odor and other quality problems that might result in restrictions to water intake from storage basins, with negative consequences on resources availability for drinking water production. Regular monitoring is essential to detect changes in chemical, biological and physical parameters and the knowledge of driving factors in changing water quality is of pivotal importance in the multi-barrier approach for source water protection planning.

"CALLISTO aims to exploit satellite data, UAV observations, in-situ hyperspectral data and water quality measurements to offer an improved and continuous water quality monitoring"

Analysis Quality

Enteric viruses in the drinking water chain: emerging pathogens and new viral indicators of contamination

STATUS	**Ongoing**
STARTING DATE	**October 2019**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**Italian National Institute of Health**



Based on current regulations, waterborne enteric viruses are not routinely measured. However, several studies have highlighted that both surface and groundwater supplies may contain viral pathogens even in the absence of traditional faecal indicators, thus representing a major public health concern.

The project is aimed at evaluating the presence of traditional and emerging enteric viruses in springs, wells, surface water and drinking water along the drinking water chain in the Greater Turin Metropolitan area. The analysis were carried out to evaluate both the presence of different well-known enteric viruses (Norovirus, Adenovirus, Enterovirus, HAV) and the presence of emerging viruses (HEV, Saffold virus, Salivirus, Aichivirus, Bocavirus, Sapovirus). Within this research project it was aldo evaluated the presence f non-pathogenic Pepper Mild Mottle Virus, that could be considered as a quality indicator of water supply chains.

During the first phase of the project 31 samples were analyzed, considering the whole drinking water chain (7 groundwater samples, 12 surface water samples and 12 drinking water samples). Moreover 85 samples of urban wastewater were cosidered for the analyses. (43 samples belong from raw wastewater and 42 from treated ones).

Enteric viruses were found in surface waters: Adenovirus were detected in the 75% of the samples; Norovirus GI + GII and Enterovirus in the 58% of the samples, Bocavirus in the 50% of the samples. Aichivirus, Salivirus and HEV were detected in only one sample. All the drinking water samples shown the absence of eneteric viruses. The raw wastewater samples shown high viral contamination and the simultaneous presence of different viruses. Higher contamination percentages were associated to Salivirus and Bocavirus (94% of the samples); Norovirus GI + GII (89% of the samples); Aichivirus and Sapovirus (79% of the samples); Adenovirus (63% of the samples). HAV and HEV were found in few samples (5% and 15% of the samples respectively).

Pepper Mild Mottle Virus was founded in all the raw wastewater samples.

"The project is aimed at evaluating the presence of traditional and emerging enteric viruses in springs, wells, surface water and drinking water in the drinking water chain"

Water networks

Acoustic signals multi-correlation to localize bursts in water distribution networks

STATUS	**Ongoing**
STARTING DATE	**February 2020**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	\\

Bursts localization in water distribution networks represents one of the still unsolved problems for water industry. Even in the hypothesis of being certain of the presence of a break along a pipe, it is necessary to know exactly the position of the break in order to start the excavation necessary for the repair of the pipe affected by the break.

One of the traditional technology for burst localization consists in the characterization of the noise along pipe network using noise loggers; then, in order to precisely pinpoint the break, it is possible to install two accelerometers straddling the potential break, connected to a device that allows to correlate the two signals and precisely identify the break. Alternatively, it is possible to detect the noise along the suspect pipeline by geophone until the point where the noise is characterized by greater intensity is identified.

Due to modern transmission technologies and cloud computing, it is possible now correlating an indefinite number of accelerometers by sending the signals to a remote server which calculate the correlations between all monitoring stations.

This technology allows the distribution network to be kept under control, guaranteeing the operator the possibility of checking the real state of the infrastructure every morning and therefore intervening in a timely manner in the event of an anomaly.

" Bursts localization in water distribution networks represents one of the still unsolved problems for water industry"

Water networks

Turin urban drainage system modeling and analysis of criticalities

STATUS	**Ongoing**
STARTING DATE	**December 2020**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**Polytechnic University of Turin**

The last analysis of Turin's urban drainage system dates back to about 50 years ago. Since then, three events have occurred that have greatly changed the hydraulic situation: (i) increase in waterproofed urban soil in exiting areas, (ii) the construction of new urbanized areas and (iii) climate change.

The urban change that the town has undergone in the last 50 years is evident, with a sharp increase in the waterproofing of the surfaces and the growth of the drainage areas. In several areas of the Turin area, the situation is so compromised that the establishment of new residential and / or industrial areas could be fatal for the urban drainage system.

Another key aspect is the imminent construction of the new Turin median collector. This is a work destined to have a strong impact on the structure of the urban outflow and which, if properly harmonized with the hydraulic context of the existing network, can make a fundamental contribution to making the Turin drainage system safe in future decades.

Finally, there are climate changes, which are evident to everyone in daily experience. In particular, the increase in very intense events, precisely those that most create problems for the drainage network.

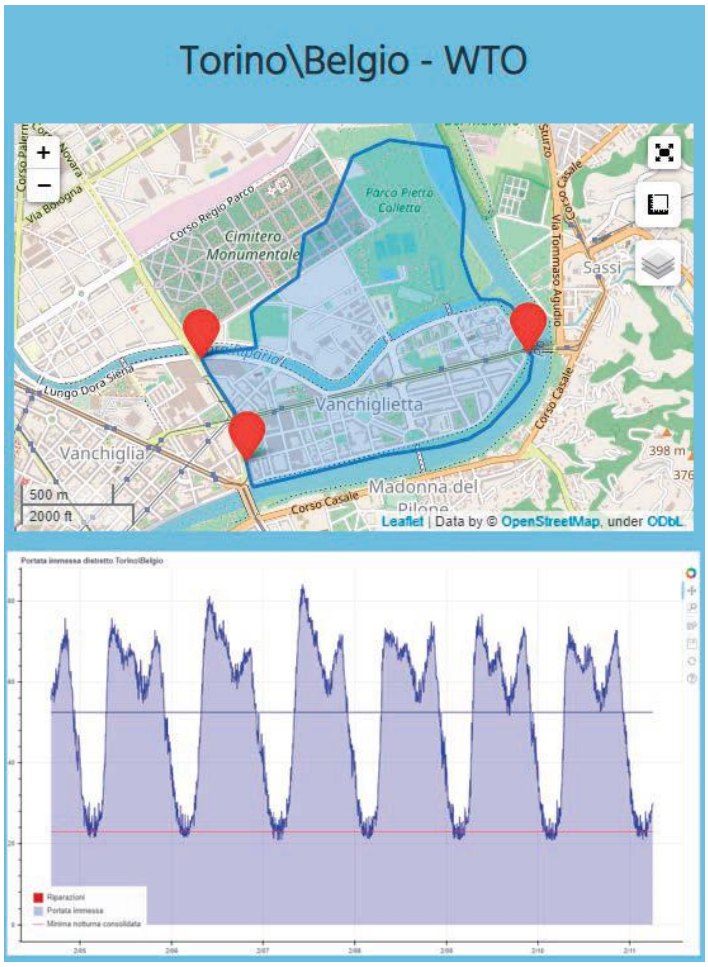
Faced with this picture, an accurate and complete analysis of the current network is therefore urgent, of how it will respond to the growing pressure in the coming years, of what actions can be taken to mitigate the risks of flooding and breakdowns and how it can hydraulically interact with the new median manifold. This study will deal with answering precisely these questions.

"An accurate and complete analysis of the current network is therefore urgent, of how it will respond to the growing pressure in the coming years, of what actions can be taken to mitigate the risks"

Supervision

Innovative platform for remote monitoring of district metered areas

STATUS	**Ongoing**
STARTING DATE	**February 2020**
DURATION	**12 months**
FUNDING	**No**
PARTNERS	\\



The realization of district metered areas (DMAs) in water distribution networks into represents the first step in reducing network losses (European Commission Guidelines). In fact, a DMA, which consists of an area of the distribution network isolated from the rest of the network by closures or connections equipped with a flow meter, allows you to keep under control all the parameters that describe the proper functioning of the whole system.

This result is achieved by remotely monitoring all the measures relating to the DMA. By crossing the hydraulic measurements with other parameters already present in the other databases, for example the repairs carried out on the network, it is possible to increase knowledge on the efficiency of the district and therefore have an additional tool for optimizing network management.

The platform that will be implemented with this project allows to operate as previously described, as well as to have a tool that can be used by the control room staff for real-time analysis of the network status by accessing cartographic and temporal data via browser.

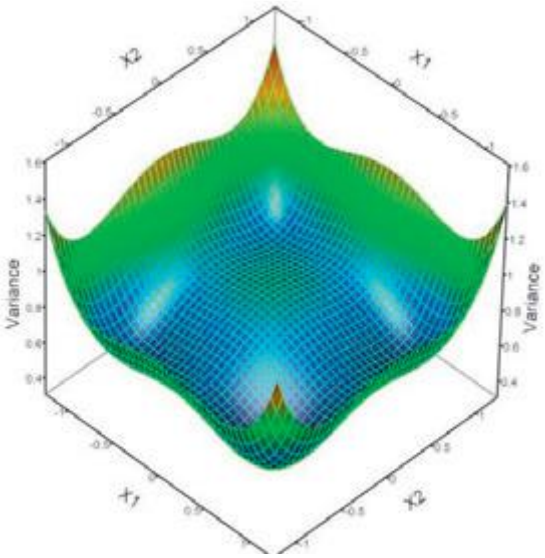
The platform will be powered by the incoming data to the company remote control, to the maintenance intervention management system, as well as by domestic consumption data.

"The realization of district metered areas (DMAs) in water distribution networks into represents the first step in reducing network losses"

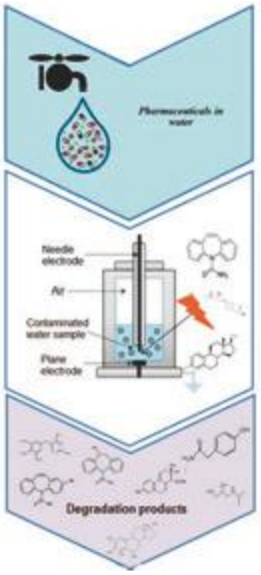
Treatment

AQUALITY: Interdisciplinar cross-sectoral approach to effectively address the removal of contaminants of emerging concern from water

STATUS	**Ongoing**
STARTING DATE	**October 2017**
DURATION	**48 months**
FUNDING	**Yes**
PARTNERS	**Univ. Torino, Aalborg Univ., CNRS (Francia), Plataforma Solar del Almeria, Panespistinio Ianninon, et al.**



AQUALITY is a research project entirely financed by the European Union in the framework of Horizon 2020 Program - Marie Sklodowska Curie Actions - Innovative Training Networks (Project N. 765860). The main research topic is the removal of emerging pollutants from water (PFAS, pesticides, pharmaceuticals, endocrine disruptors, …) through environmentally and financially sustainable hybrid treatment processes as sun-driven oxidation processes coupled to membrane filtration systems (graphene, high flow ceramics, etc.).
During 2020 it was carried out the evaluation of these processes, in particular of high voltage electrical discharge (HVED). The operative parameters of non-thermal plasma generator (an innovative patented prototype process of water treatment) were defined in collaboration with the National Research Council of France (CNRS) – Chemistry Institute of Clermont Ferrand - and IRIS s.r.l. (a SMI specialized in laser and plasma techonlogies), and through the Design of Experiment (DOE) methodology.



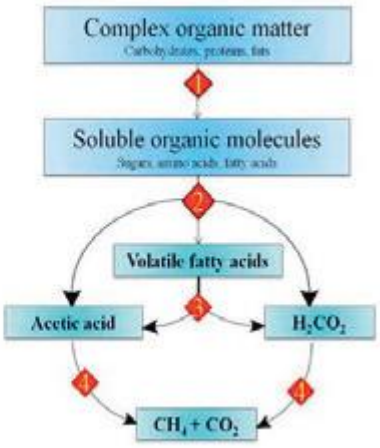
Different experiments were carried out for evaluating the degradation of pharmaceutical compounds (perfluoroalkylated compounds). The results showed a good efficacy of the treatment process (a removal between 50 and 100% was found).
Moreover a screening for evaluating the presence of different pharmaceutical compounds was done, considering the samples of the waters treated by SMAT. This monitoring campaign was carried out in advance with respect to the new UE Drinking Water Directive 2020/2184 that was published on December 2020. As a precautionary measure, it was also evaluated the risk for human health evaluating the Risk Quotient (RQ), considering both single compounds than the combined effect linked to the simultaneous presence of the different pollutants. The results showed a negligible risk on human health when raw water were considered, and almost no-risk for potable water (RQ<0.2).

"The objective of this European "training through research" inter-disciplinary and inter-sectoral project is to investigate innovative and hybrid methods to remove emerging pollutants from water"

Treatment

Sludges IV

STATUS	**Ongoing**
STARTING DATE	**June 2020**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**Polytechnic University of Turin**



The optimisation of sewage sludge treatment processes is a theme of primary importance, not only for the reduction of sludges to be managed, but also for the maximisation of energy and material recovery in a circular economy perspective.

The purpose of this project is a pilot scale experimental test of the performances, in terms of biogas production increase and organic substances recovery, of different 2-stage configurations for primary and waste activated sludge anaerobic digestion.

During the first part of the project, we will investigate further the 2-stage anaerobic digestion of primary sludge. In the first stage the primary sludge will undergo an acid fermentation with a limited retention time (3-4 days), with the aim of fostering hydrolysis and acidogenesis (trough the inhibition of methanogenesis) for the production of volatile fatty acids (VFA). These latter are extremely interesting compounds as they can be used for biopolymer production or, in future, as raw feedstock for chemical industry or, more simply, for biological phosphorus removal in waste water treatment processes.

Later we will perform a pilot scale experimental test devoted to biological pretreatment of waste activated sludge in thermophilic condition followed by mesophilic anaerobic digestion.
The purpose of this activity is the completion of several pretreatment technology tests performed, in collaboration with Polytechnic University of Turin, during the latest research projects.
Notably thermophilic biological pretreatments, as compared to already tested thermo-alkali pretreatments, could achieve comparable methane production increase with thermal energy and chemical savings.

"The purpose of this project is a pilot scale experimental test of the performances of different 2-stage configurations for primary and waste activated sludge anaerobic digestion"

Treatment

Innovation in waste water treatment processes

STATUS	**Ongoing**
STARTING DATE	**September 2018**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	//

The project, implemented in collaboration with the Plant Management Service and the Chemical-Biological Laboratory of Castiglione T.se wastewater treatment plant, will study and test innovative solutions for improving performances and management of wastewater treatment processes, also using process mathematical modelling.
The main objectives are performance enhancement in terms of contaminant removal, energy use reduction, sludge production reduction and chemical consumption optimization.
Possible interventions to be implemented are intended to imply minimum modifications to the plant and, where possible, restricted to process adjustments.

In the project framework we evaluated and proposed the introduction of an intermittent aeration regulation logic at Castiglione Torinese waste water treatment plant, in order to achieve a further improvement of treatment performance and energy savings for aeration and mixed liquor recirculation.
Moreover, we expect a reduction in biological sludge production, and a potential biogas production increase due to less organic substrate (biodegradable COD) needed for denitrification. Finally, this configuration offers the possibility of implementing biological phosphorus removal in the tanks currently used for denitrification.
Based on the analysis results, SMAT decided to implement the proposed regulation logic, that has been installed, in the first 3 modules of waste water treatment in Castiglione Torinese plant, between the spring and the summer 2020.
First results, that will be further deepened during the next months following a longer observation period, highlighted an interesting electrical energy saving and an improvement in nitrogen and phosphorus biological removal.

"We will study and test, in laboratory and in the field, innovative solutions for improving performances and management of wastewater treatment processes"

Treatment

Chlorites and chlorates

STATUS	**Ongoing**
STARTING DATE	**June 2020**
DURATION	**12 months**
FUNDING	**No**
PARTNERS	**HERA, IREN, A2**

The revision of the European Drinking Water Directive envisages new limits for the two disinfection by-products (DBPs) chlorite and chlorate, posing serious questions about the effectiveness of current operating methods of drinking water treatment plants.

The project aims to seek comprehensive solutions for the containment of disinfection by-products, from the definition of operational protocols for better plant management, to the preparation of stricter requirements for the purchase of more stable chemical products, to research of innovative technologies to reduce the formation of DBPs.

The first phase of the project, concluded in 2020, mainly focused on an extensive literature review, aimed at identifying best practices adopted for the containment of disinfection by-products by reducing the dose of disinfectant applied or modifying disinfection practices with chlorine dioxide and sodium hypochlorite. Available systems for removing chlorates from treated water proved to have unsatisfactory performances, demonstrating the need to prevent their formation in the first place. A comparative analysis of the four partner companies allowed comparing their operational protocols and identifying any shared criticalities.

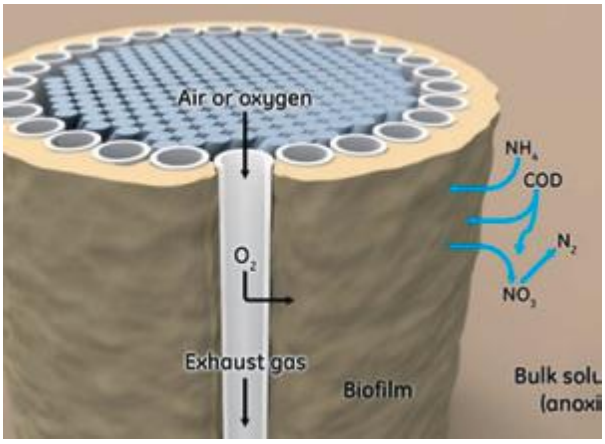
The last phase of the project, scheduled for the first half of 2021, envisages the identification and comparative evaluation of innovative technological solutions to reduce the formation of disinfection by-products in treated water.

"The new limits for disinfection by-products, introduced by the European Drinking Water Directive, require to identify innovative solutions to improve the performances of water potabilization plants"

Treatment

MABR: Membrane Aerated Biofilm Reactor

STATUS	**Ongoing**
STARTING DATE	**June 2020**
DURATION	**36 months**
FUNDING	**No**
PARTNERS	**Polytechnic University of Turin**



Biological waste water treatment processes are notoriously energy intensive, especially the aerobic ones that consume oxygen for the oxidation of organic and nitrogen substances. In fact, oxygen transfer from gas phase to liquid phase (namely the dissolution) is a relatively limiting factor.
Common aeration systems, based on the production of small air bubbles trough diffusers installed at the bottom of the tanks, are characterised by an oxygen transfer efficiency generally in the order of 20%.

A recent and really promising technological innovation, called MABR (Membrane Aerated Biofilm Reactor), provides for the use of hollow fibre membrane for oxygen transfer in liquid phase.
Air is blown inside the hollow fibres immersed in oxidation tanks and oxygen is directly consumed by biomass developed on membrane external surface. By this way there is not more need for producing air bubbles to achieve oxygen transfer, and aeration energy efficiency is greatly increased. Moreover, oxidising conditions develop only inside the biofilm at membrane interface, making possible the denitrification, in anoxic conditions, in the same biological reactor.

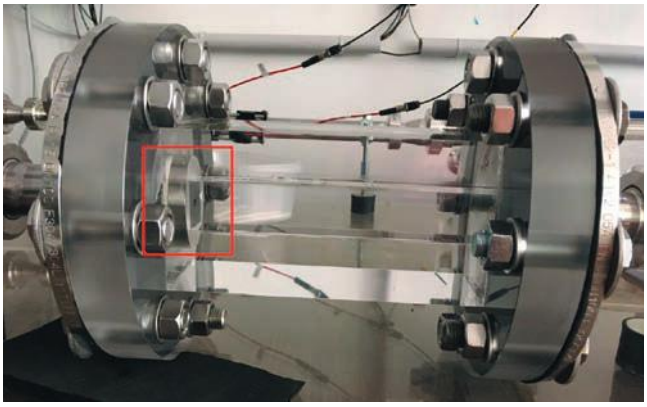
The purpose of the research project is the experimental test of MABR technology performances in terms of treatment efficiency and aeration energy efficiency. To this end a laboratory pilot twill be set up and experimental tests will be performed, firstly with synthetic waste water, later with real waste water, with the aim of assessing MABR strengths and possible weaknesses and their applicability to SMAT plants.

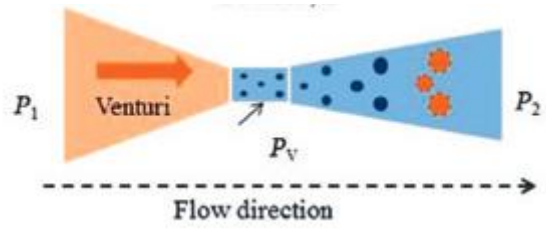
"The purpose of the research project is the experimental test of MABR technology performances in terms of treatment efficiency and aeration energy efficiency"

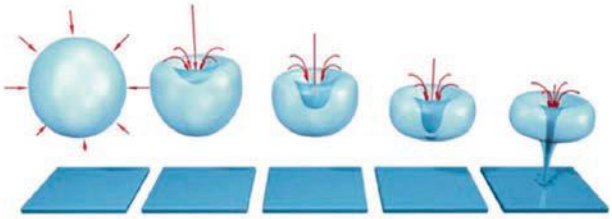
Treatment

BIOENPRO4TO

STATUS	**Ongoing**
STARTING DATE	**June 2019**
DURATION	**36 months**
FUNDING	**Yes**
PARTNERS	**SEA Marconi, Polytechnic University of Turin, and 13 more**







Hydrodynamic cavitation is a physical-chemical phenomenon induced by a pressure variation obtained through a hydraulic system, which determines in the fluid the formation of microbubbles (or "cavities"). When imploding upon a subsequent pressure increase, these in turn induce a series of highly energetic phenomena. Of particular interest is the study of hydrodynamic cavitation applicability in drinking water disinfection, using its principles to compromise microbial cell integrity.

Within the framework of this project, SMAT aims to move from lab scale hydrodynamic cavitation, already investigated during previous collaborations with the Polytechnic University of Turin, to a real scale implementation of the technology for drinking water production. In-depth analysis of the state of the art of disinfection through hydrodynamic cavitation and critical review of published results, led to the generation of a new circuit for lab scale assessments and to the selection of the optimal geometry of the reactor. Several tests have been conducted using E. coli as a model microorganism in order to evaluate different experimental setups, with the combination of two types of orifice plates and three cavitation regimes. Once the anti-microbial efficacy of the system was confirmed, fluid dynamics mathematical modelling was performed to define the requirements for the upcoming tests. Shortly, further experiments will focus on studying the hybridization potential with other disinfection techniques and the optimal layout in terms of microbial depletion/energy consumption, in view of the transition to real scale.

"The project is aimed at moving from lab scale disinfection through hydrodynamic cavitation to a real scale implementation of the technology for drinking water production"

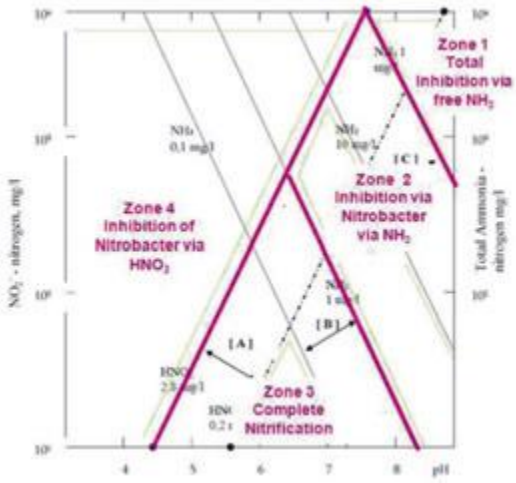
Treatment

Deammonification process modelling

STATUS	**Ongoing**
STARTING DATE	**June 2020**
DURATION	**24 months**
FUNDING	**No**
PARTNERS	**Polytechnic University of Turin**

At Castiglione Torinese waste water treatment plant, SMAT recently installed a biological system for the treatment of sludge dewatering reject waters that have high concentration of ammonium and low concentration of biodegradable organic substances.

Deammonification is a biological process based on the use of Anammox bacteria that are able to remove nitrogen in a very efficient way and with extremely low energy consumption, compared to nitrification-denitrification traditional process, and without the need for organic compounds.



On the basis of the previous studies devoted to the mathematical modelling of "traditional" biological waste water treatment processes, the aim of this research project is the setup of a deammonification process model, by which it will be possible to simulate the operation and optimise the regulation parameters, as a function of boundary condition changes, in terms of treatment performance and energy consumption.

Deammonification process is rather complex and is based on delicate equilibriums, biological kinetics (i.e. nitritation and nitratation) and inhibitions (i.e. to oxygen, ammonia, nitrous acid) that shall be carefully controlled.

During the project we will perform experimental test, also based on respirometry techniques, with the aim of measuring the kinetic parameters of the involved processes and their variation as a function of operative parameters.

"Deammonification process is rather complex and is based on delicate equilibriums, biological kinetics and inhibitions that shall be carefully controlled"

Research articles and proceedings

S. Amalfitano, C. Levantesi, D. Copetti, F. Stefani, I. Locantore, V. Guarnieri, C. Lobascio, **F. Bersani**, **D. Giacosa**, E. Detsis, S. Rossetti. Water and microbial monitoring technologies towards the near future space exploration. *Water Research* 177:115787 (2020).

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E. Brussolo. Integrated Urban Water Management in a Changing Climate. 9/7/2020. 2nd level Master on Climate Change: Adaptation and Mitigation Solutions.

E. Brussolo, Climate change and future scenarios for effective water management: the aquifer recharge. 10/12/2020. IB2019 Knowledge Picnic: Climate Adaptation Strategies

B. Coloru. Carbon Footprint of integrated water service and emissions reduction strategies. 9/7/2020. 2nd level Master on Climate Change: Adaptation and Mitigation Solutions.

G. Scibilia. SMAT e l'economica circolare. 17/09/2020. Circonomia, festival dell'economia circolare, e delle energie dei territori

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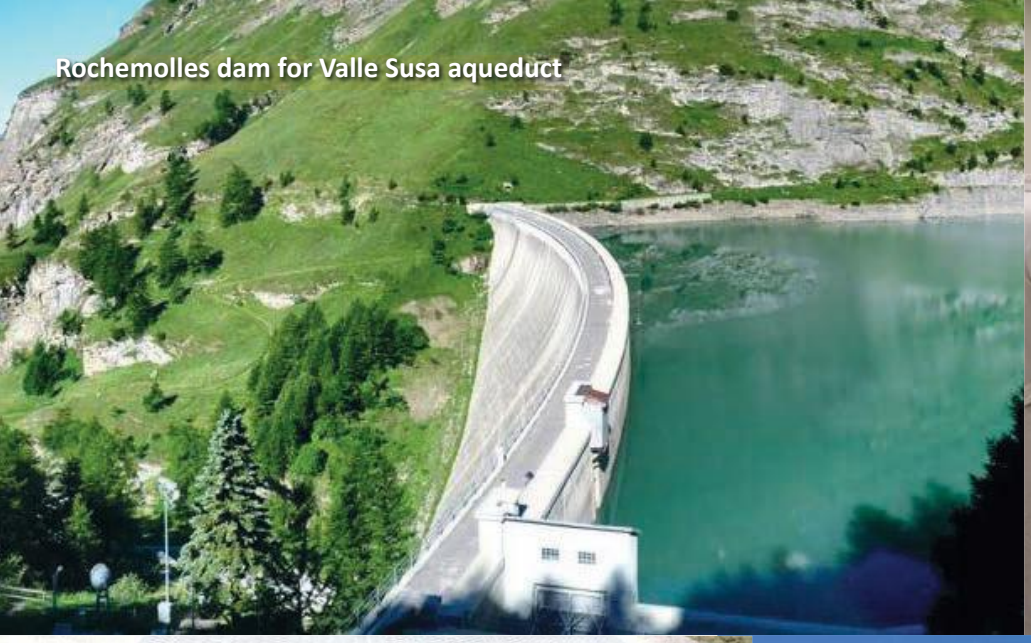
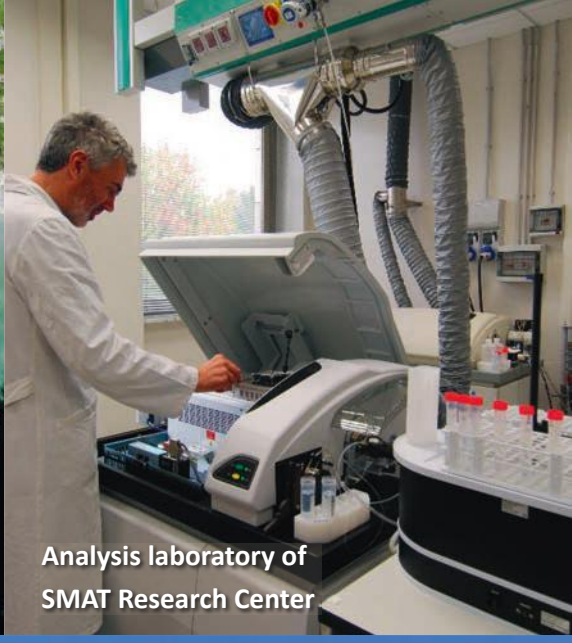
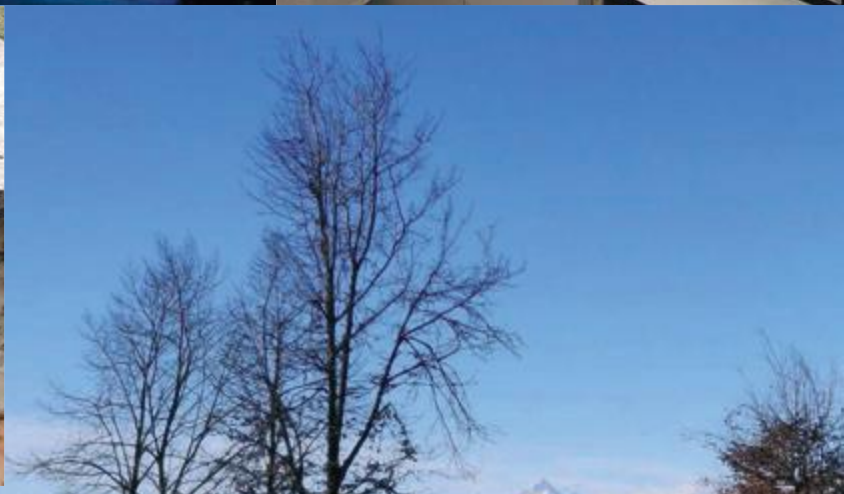


Rochemolles dam for Valle Susa aqueduct



Analysis laboratory of
SMAT Research Center

Pipelines cleaning



Campofregoso - well

Lagooning basin

Piedmont's Regional Councilor for Environment, Energy, Innovation and Research
Matteo Marnati was visiting SMAT Research Center

Water in space