SMAT Research Center

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Research activities FEBRUARY 2020

CENTRO RICERCHE

Research activities

FEBRUARY 2020

BS OHSAS 18001:2007
CERTIFICATO N. 9192.MACT

UNI EN ISO 14001:2015
CERTIFICATO N. 9191.SMTO.

UNI EN ISO 9001:2015
SGQ Certificato n. 343

Research Center SMAT: our commitment to research and innovation

One of the most critical challenges that companies are called upon today to face is the creation of new competitive advantage that guarantees the sustainability of the companies themselves. The achievement of these goal cannot be separated from research and innovation: innovate to improve, innovate to progress.

SMAT reserves a substantial part of its structure and resources for Research and Innovation. Participating in prestigious national and international projects, it draws into its Research Centre new talents and qualified collaborations.

It is fundamental to comply with the goal we set for ourselves. **SMAT Research Center** chooses and develops projects that shares its mission: transfer knowledge, gained throughout studies and experimentations, in multiple industries contributing to technological innovation and to the industrial development of water supply services.

Environmental sustainability is both the engine and the conditioning for all the actions to be taken in the near future for the protection of health, water resource and of the environment in general, becoming a fulcrum of the activities of the Research Center.
To foster sustainable development, many of our efforts are aimed at encouraging the application of low environmental impact processes at SMAT production sites, the protection and safeguard of the environment and in particular of resources and water reserves, heritage of its own activity and of all humanity, also in light of the ongoing climate changes.

This is now our sixth annual research report: the first was in 2015, when a new path for our Research Center started, with the entry of young researchers dedicated exclusively to research and innovation. Since its foundation in 2008 and after 5 years of uninterrupted growth, we have achieved important results.

- 140 projects concluded, of which 11 in 2019
- 26 ongoing projects
- 8 projects set to launch in 2020
- 2 project funded by EU Horizon 2020
- 7 full-time researched
- 6 assistants, trainee
- more than 100 employees involved in the projects
- 48 research-parternships
- 2 time winner of the Top Utility Award for research and innovation
- 29 scientific publications
- 2 research centers in Torino and Castiglione T.se

On that bases and that commitment, we are sure that the Research Center will be able to offer new and innovative solutions for the future.

Research Center Director

Lorenza Meucci

President

Paolo Romano

February 2020

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CARBON FOOTPRINT OF THE WASTEWATER TREATMENT PLANT IN CASTIGLIONE TORINESE

Energy/Environment

STATUS
Closed

STARTING DATE
March 2019

DURATION
6 months

FUNDING
No

PARTNERS
Polytechnic University of Turin

The recent growing attention towards environmental impact assessment and mitigation measures towards climate change effects resulted in national policies and in the legislation framework. The Authority for Electric Energy, Gas and Water Systems (ARERA), within the regulation concerning technical quality of integrated water services, identified the Carbon Footprint as a significant indicator to assess environmental impact of wastewater treatment services, in order to reduce the overall impact of wastewater treatment activities.

The project applies the Carbon Footprint methodology to the wastewater treatment plant on Castiglione Torinese, as a pilot to quantify and report greenhouse gases emissions and absorptions related to SMAT's wastewater service. The work is performed in compliance with the prescriptions of the UNI EN ISO 14064-1 norm, following the guidelines of the World Business Council for Sustainable Development/World Resource Institute.

The second phase of the project focuses on greenhouse gases emissions quantification activities, including gathering and elaboration of relevant data.

In order to provide annual reports and assess progressive trends of the Carbon Footprint indicator, the project main output consists of a structured inventory, to be periodically managed and updated.

The final phase in aimed at the identification of emissions reduction measures and the elaboration of future scenarios, towards a zero-emission target.

"The wastewater treatment plant in Castiglione Torinese resulted a virtuous example in terms greenhouse gases emissions and additional reduction initiatives are planned towards a zero-emissions future scenario"

BIOGAS4ENERGY

Energy/Environment

STATUS
Closed

STARTING DATE
October 2017

DURATION
24 months

FUNDING
Yes

PARTNERS
Hysytech, Polytechnic University of Turin

The production of biogas from anaerobic digestion of wastewater treatment sludges is an optimal example, from the circular economy perspective, of the transformation of waste into renewable energy resource.
Recent technological developments in the field of fuel cells allow the use of this energy resource with growing performance and efficiency, both from the energetic point of view (electrical efficiency >50%) and from atmospheric emission point of view.

A potentially critical issue in the application of biogas from sewage sludge to supply fuel cells (particularly Solid Oxide Fuel Cell), is the need of biogas pre-treatment in order to reach the almost complete removal of contaminants (mostly sulphur compounds and siloxanes) that might compromise fuel cells' performances and functionality.
Biogas4energy project, financed by Regione Piemonte as part of European Regional Development Fund, is focused on studying the purification and ultra-purification of biogas to be used in high efficiency fuel cells.

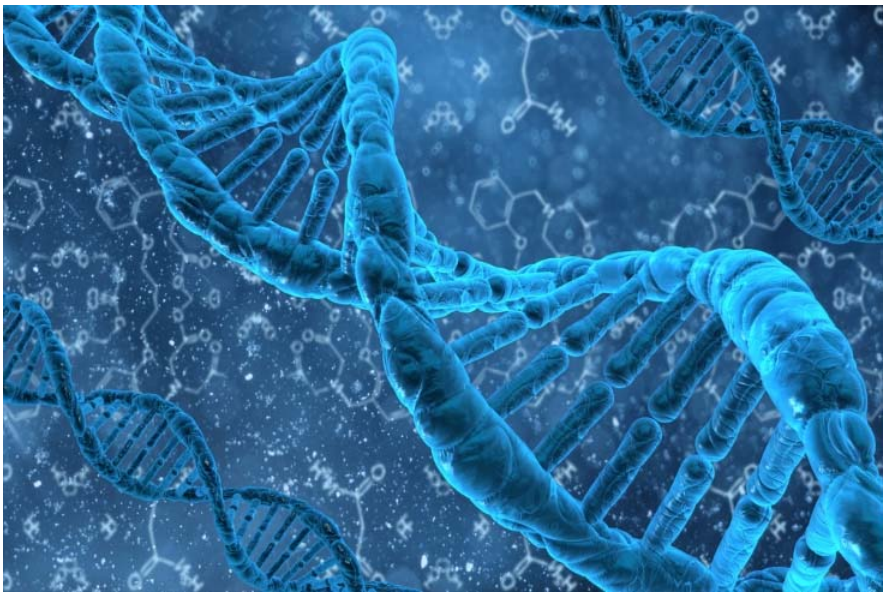
The first part of the project has been focused on lab experimental test and modelling of several commercial adsorbent materials for ultra-purification of biogas. Lately the activities were aimed at field testing the selected adsorbent materials at the wastewater treatment plant in Collegno, where modules of SOFC fed with biogas were installed as part of European project DEMOSOFC. The experimental results showed excellent removal performances of target contaminants.

Finally, a prototype reactor for biogas treatment has been developed were we tested, with fair adsorbing performance, an adsorbent material (biochar) produced by the activation of dried wastewater sludge.

"The project is focused on studying the purification and ultra-purification of biogas for application in high efficiency fuel cells"

EVALUATION OF BACTERIAL DNA PURIFICATION METHODS AND SELECTION OF A PCR TECHNIQUE FOR DNA AMPLIFICATION FROM VIABLE CELLS

Analysis/Quality



STATUS
Closed

STARTING DATE
December 2017

DURATION
24 months

FUNDING
No

PARTNERS
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The list of waterborne microorganisms with a pathogenic potential is long and many diseases can indeed be ascribed to water contamination. Classical culture methods, whenever available, are not always species-specific, are usually long-term (days) and are not always straightforward to interpret. Back in 2008, SMAT introduced PCR as a first attempt to apply fast and reliable biotechnological methods in parallel with traditional microbiology. Following the recent substantial advances in the development of molecular methods, it was necessary to improve and optimize the whole process, from sample preparation to the subsequent analytical steps.

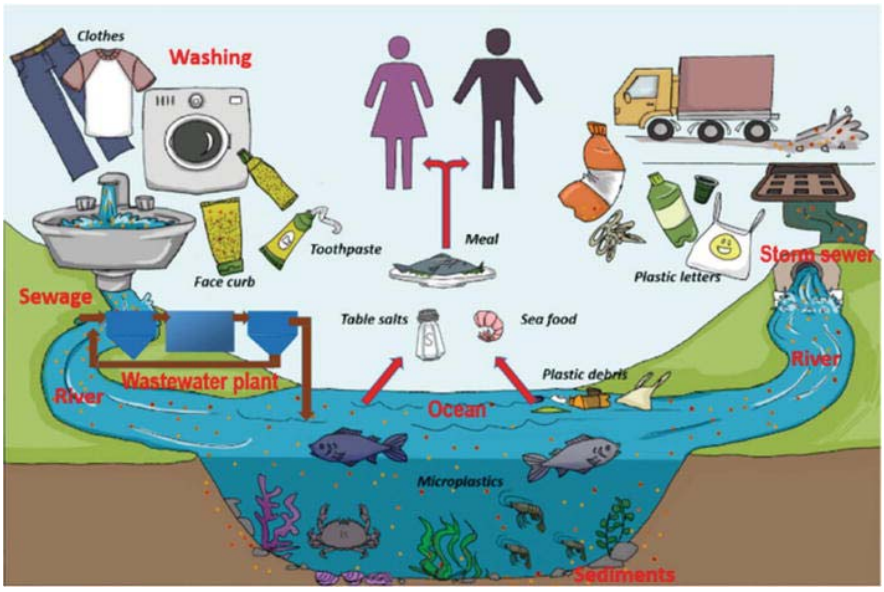
The project was aimed at studying the most promising concentration, extraction and purification techniques for bacterial DNA. Nucleic acids can then undergo PCR to amplify selected genomic regions that allow identification of the microorganism with a higher degree of sensitivity and specificity than traditional methods. The application field includes virtually all microorganisms for which the genomic sequence is publicly available. Research activities were conducted in two areas. The first consisted in a systematic comparison of multiple concentration, extraction and amplification methods to identify the best combination of techniques. The second included the optimization of the analytical phase by real-time and digital PCR, a new generation instrument for the direct quantification of target sequences. Finally, the study led to the design, synthesis and validation of a novel custom assay for the detection and discrimination of pathogenic and non-pathogenic Legionella species, characterized by high efficiency, precision and sensitivity, with reduced costs and hands-on time.

"The study led to the design, synthesis and validation of a novel custom assay for the detection and discrimination of pathogenic and non-pathogenic Legionella species"

COD: LRC_ AC_2017_22

MICROPLASTICS AND POTABLE WATER

Analisi/Qualità



STATUS
Closed

STARTING DATE
July 2018

DURATION
12 months

FUNDING
No

PARTNERS
A2A Ciclo Idrico, Metropolitana Milanese, Ist. Mario Negri, University of Milan

Microplastics in drinking water: researchers from Fredonia University (USA) were the first who launched this alarm with a study published in 2017. The research showed that microplastics were detected in 83% of samples collected from home tabs in different cities around the world. The following year, the same team carried out a similar study on 259 bottled water samples from the most common brands around the world. Microplastics were found in 241 (93%) samples. The news, internationally spread by several media, raised great concern among consumers.

SMAT, together with two industrial partners, Società A2A Ciclo Idrico and Società Metropolitana Milanese (both in charge for the integrated water service in Lombardy Region), decided to start a research project in 2018 in collaboration with Istituto Mario Negri and University of Milan.

Some problems were experienced during sampling procedures: microfibers contamination made the sample collection and treatment quite difficult. Further environmental contaminations could also be experienced during filtration procedures.

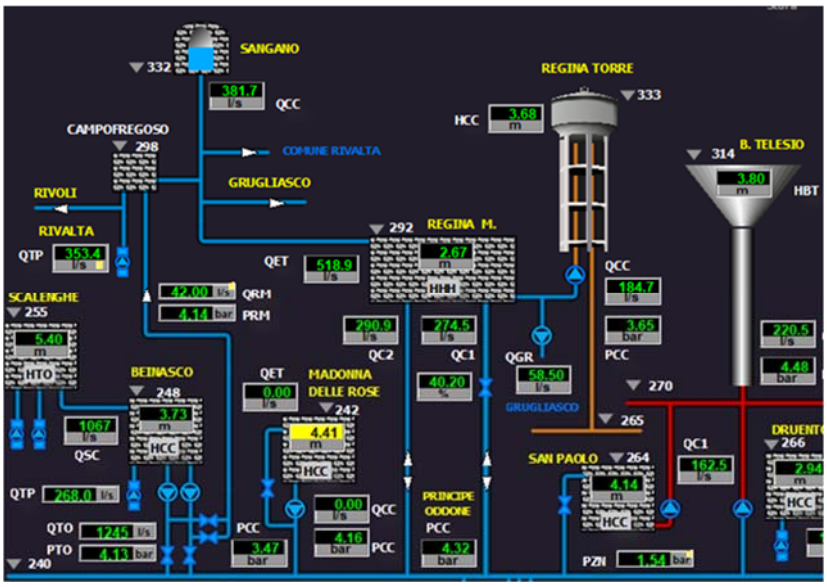
FT-IR spectometry, using microprobes, is the well-know technique used for analysis. FT-IR data validation was developed considering GC/MS techniques.

Considering the available technologies, none of the collected groundwater samples (20 liters each) showed microplastic pollutants (less than 1 microparticle in 5 liters of sample). The fibres observed in the samples have natural origin, mainly due to environmental contamination during sampling procedures.

"In 2017, researchers from Fredonia University (USA) published a study showing the presence of microplastics in 83% of drinking water samples. None of the collected SMAT samples showed microplastic pollutants"

EXTENSION OF TURIN WATERSCHEME'S MATHEMATICAL MODEL TO CONNECTED MUNICIPALITIES IN THE HILLY AREA AND MODEL EXPLOITATION FOR FINALIZED APPLICATIONS

Water networks



The project had a double objective. The first was to extend the mathematical model of Turin water scheme (built and calibrated within a previous project) to neighbor municipalities in the hilly area, which are connected to the same network. The second objective was to exploit the model for operational applications, for example the assessment and possible amendment of network development projects.
Mathematical modelling is acknowledged, both by academics and technology providers, to be an essential tool towards the accurate evaluation of parameters describing the dynamic of pressures and flow rates within a water system.
One of the applications of the existing model was the verification of the distribution network districtualization project. Districtualization means division of the distribution network into sub-networks, where flow rates and pressures are permanently measured. Since this activity led to substantial changes to the topology of the networks, it was necessary to verify in detail and precisely that these changes did not cause negative consequences both as regards the operating pressure and as regards the quality of the water.

Another application concerned the optimization of energy consumptions from pumping stations. In fact, it was possible to obtain a reduction in the energy necessary to support the pressure level necessary for the proper functioning of the network by changing the configuration of the starts and stops of the individual machines as well as the pressure settings.

"Mathematical modelling is acknowledged, both by academics and technology providers, to be an essential tool towards the accurate evaluation of parameters describing the dynamic of pressures and flow rates within a water scheme."

STATUS
Closed

STARTING DATE
June 2018

DURATION
12 months

FUNDING
No

PARTNERS
Polytechnic University of Turin

LP-WAN REMOTE TRANSMISSION OF METERING CONSUMPTION DATA

Water Networks

STATUS
Closed

STARTING DATE
August 2018

DURATION
12 months

FUNDING
No

PARTNERS
Polytechnic University of Turin

Remote transmission of metering consumption data is a significant improvement for the service provided to end-users. It permits to quickly alert the user with regard to anomalous consumptions detection(water losses downstream of the meter), to monitor the volumes of water and to allocate the costs in a sustainable way.

From a management point of view, instantaneous meter reading permits to carry out a punctual water balance, refining consumption data over specific areas of interest and to build an effective leak-detection system through the districtualization of the distribution network.

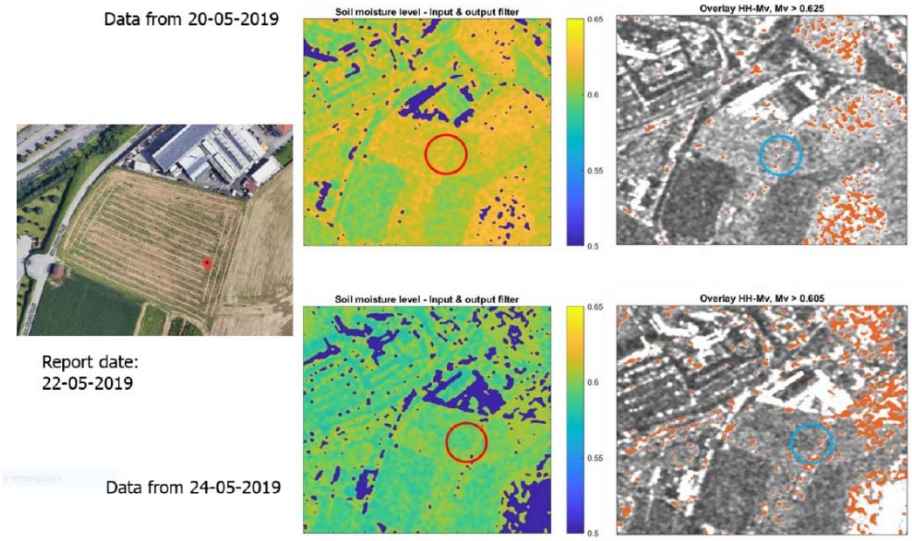
Remote data acquisition can be done using "*LP-WAN*" radio architecture (LoRa network). This solution permits ultra-low-power and high-distance connections using single-hop techniques. These techniques overcome the line-on-sight limitations, thanks to receivers with a sensitivity 30dB higher than traditional techniques. Moreover this solution is characterized by very low band transportation (from a few score b/s to 50 kb/s) and requires a forefront gateway able to interact with existing platforms (BlueTooth, LAN, Wi—Fi, mobile).

SMAT, together with the Polytechnic University of Turin, studied a transmitter able to receive consumption data from meters with different transmission systems and frequencies, redirecting these signals on LoRa networks.

"The goal of this project was the realization of a smart metering system for remote data meter acquisition"

X-BAND SATELLITE SAR DATA ANALYSIS FOR LEAKAGE DETECTION

Water networks



STATUS
Closed

STARTING DATE
December 2018

DURATION
7 months

FUNDING
No

PARTNERS
Polytechnic University of Turin, Acque Veronesi

The research activity aimed to X-band SAR (Synthetic Aperture Radar) satellite data acquisition and analysis, preferably generated by the constellation of Cosmo-SkyMed satellites, owned by the Italian Space Agency, for water leakage detection in the municipality of Turin.
SAR data can be acquired both night and day, independently from cloud coverage, thus allowing a 24/24 monitoring on water networks: this represents a great advantage for water utilities that wants to detect water leakages as quickly as possible. Secondly, and most importantly, SAR images can be analyzed to monitor changes on land surface over time. Water utilities can exploit this information to assess soil changes in the proximity of water distribution networks and determine if soil moisture local are caused by water leakages from the network.

The aim of this project was to produce thematic maps with representation of the degree of soil moisture, an indicator of the possible presence of water leaks from pipelines. The geo-referenced overlap of these maps with the pipeline maps allows the precise location of the leaks.
The project allowed the validation of the algorithms and of the process of analysis and construction of the outputs.

"The result of the research activities will be the production of thematic maps with soil moisture content in the terrain, that can be used as an indicator of leakages from the water network"

OPEN SOURCE PLATFORM FOR THE INTEGRATION, ANALYSIS AND PUBLICATION OF WATER DATA

STATUS
Closed

STARTING DATE
October 2018

DURATION
12 months

FUNDING
No

PARTNERS
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Supervision

The goal of this project was the development of a platform, called Octopus, which represents the highest layer of a 4.0 SCADA system. In fact, in the current concept, the scheme of a normal SCADA includes: in-field infrastructure (sensors, PLC, RTU), communication (radio links, GSM, GPRS, etc.) and control room. Octopus would represent the highest layer of the system, with the purpose to transform the continuously incoming data into valuable information. Today, data are used by the control center for real-time operations and subsequently stored and "forgot" in databases.

One of the 4.0 revolution paradigms foresees the exploitation of all available data and their correlation with data from different sources, in order to generate new information to support objective and evidence-based decision-making.

Octopus has been developed to perform multiple operations: analysis, forecasting and detection of anomalies in time series; analysis of ordinary and extraordinary maintenance data on infrastructure interventions; analysis of distribution networks water balance or energy consumption at plant scale, in order support plants and distribution networks management and to increase processes' safety and efficiency.

At full capacity, Octopus represents a true tailor-made intelligent operator, built to be interfaced with all company databases and to grow according to new emerging needs. Being entirely based on open source software, Octopus does not imply license costs.

"Octopus at full capacity represents a true tailor-made intelligent operator, built to be interfaced with all company databases…"

ASSESSMENT OF DISINFECTION METHODS IN MIDDLE SIZE TREATMENT PLANTS

STATUS
Closed

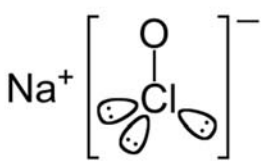
STARTING DATE
September 2017

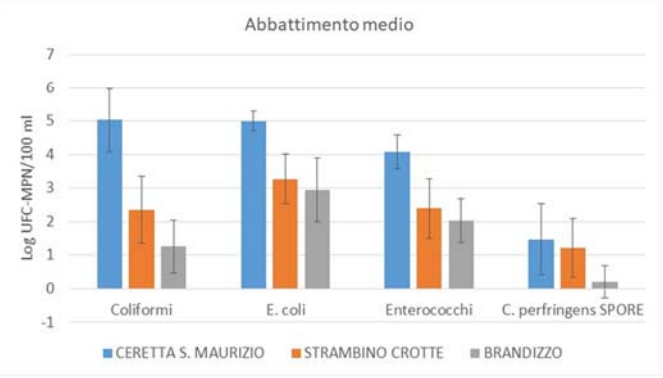
DURATION
24 months

FUNDING
No

PARTNERS
University of Turin

Treatment





The purpose of this study was to compare the effectiveness of three disinfection methods (sodium hypochlorite, peracetic acid and UV) in deactivating pathogens and indicators in three treatment plants managed by SMAT, evaluating the effects both on major indicator micro-organisms (*feacal coliforms*, *E. coli*, *Enterococci*, *Clostridia spores* and *Salmonella spp*) determine with classic culture methods, and on pathogenic microorganisms (*Salmomella spp, Campylobacter spp, jejuni e coli, E. coli O157:H7*) evaluated with molecular methods.

Samples collected before and after the disinfection system were analyzed. Microbilogical parameters were evaluated, together with chemical ones and ecotoxicological tests (*Daphnia magna* and *Pseudokirchneriella subcapitata,* Microtox).

Seven sampling campaigns were done, showing disinfection effectiveness for each of the three different methods, allowing to meet the discharge *E. Coli* legislative limit.

The greatest reduction of indicator parameters was obtained in samples treated with sodium hypochlorite (San Maurizio T.se treatment plant), followed by UV treatment (Strambino Crotte) and peracetic acid disinfection (Brandizzo). Nevertheless, sodium hypochlorite was found to be toxic by all three test methods applied for ecotoxicity evaluation.

Feacal coliforms and *E. coli* are the micro-organisms with higher abatements, indipendently of the disinfection method considere, while *Enterococci* are more resistant. The micro-organisms more difficult to eradicate are *Clostridia spores*. Also in this case the greatest reduction was obtained in samples treated with sodium hypochlorite, while UV and peracetic acid methods seem to have no efficacy.

"Sodium hypochlorite resulted to be the most effective treatment in disinfecting wastewater, but the toxicity found in effluents underlines the necessity to evaluate alternative treatment methods"

Ongoing projects

DEMOSOFC

Energia/Ambiente

STATUS
Ongoing

STARTING DATE
September 2015

DURATION
60 months

FUNDING
Yes

PARTNERS
Polytechnic University of Turin, Convion Oy, VTT, Imperial College, Risorse Idriche

Biogas produced by the anaerobic digestion of sludges from urban wastewater treatment is characterized by high heating power. This property makes it particularly suitable for the production of electricity and thermal energy. Currently, the most common systems for energy recovery from biogas is represented by boilers or internal combustion engines coupled to electricity generators.
An innovative technology based on solid oxide fuel cells (SOFC) would allow higher electrical productivity and lower emissions by exploiting a highly efficient electro-chemical process, which is virtually free from pollution production.
SOFCs are new generation cells, operating at temperatures of 850°C, able to exploit biogas as fuel. Before being used in SOFC generation cells, biogas needs to be pre-treated in order to remove pollutants, especially sulfur compounds and silicon (siloxanes).

DEMOSOFC project, also co-funded by the EU within the Horizon2020 framework program, foresees the installation of 3 modules of 58 kWe each, at the SMAT treatment plant in Collegno (TO).

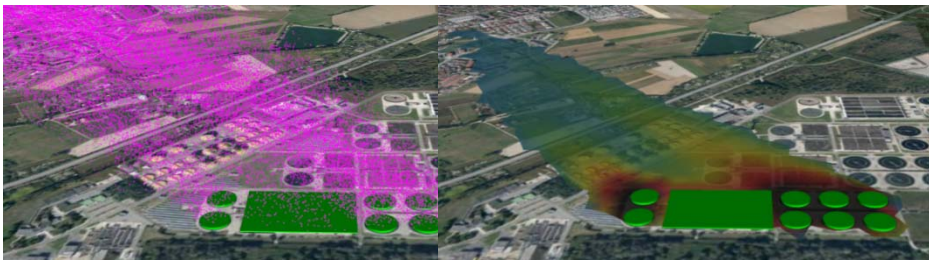
Having obtained the necessary authorisations from the competent organizations, the first plant was put into service in summer 2018. It represents the largest SOFC cells installation in Europe and the largest installation worldwide with SOFC cells powered by biogas.

Once the trials were finished, in October 2018, the second of the three modules was switched on. It shows high electrical efficiency (54%-56%) and extremely low emissions.

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

MODELING THE ATMOSPHERIC DISPERSION OF ODOR-PRODUCING SUBSTANCES

Energy/Environment



STATUS
Ongoing

STARTING DATE
March 2017

DURATION
24 months

FUNDING
No

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

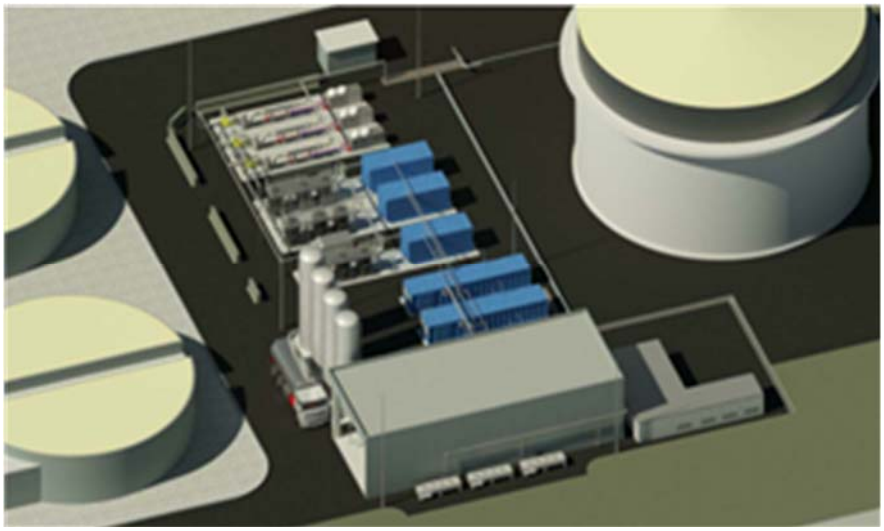
The integrated monitoring system of odor impacts includes:
• installation of a station for continuous monitoring of local weather conditions;
• specific characterization, by means of appropriate measurement campaigns, of the chemical species and the emission sources that are mainly responsible of odor 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.

Currently, the meteorological monitoring station is in operation and the site characterization phase is completed. Thanks to the implementation of the dispersion modelling chain, the critical areas were identified and further interventions will be planned.

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

BIOMETHANE

Energy/Environment



STATUS
Ongoing

STARTING DATE
October 2018

DURATION
18 months

FUNDING
No

PARTNERS
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In Castiglione T.se wastewater treatment plant, biogas produced by the anaerobic digestion of sewage sludge is 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.
During the last year project activities have been focused on technical support for the plant design, for the best technology selection in terms of efficiency and for the optimal integration in the existing plant.
The building works are ongoing and the new plant will be started in the first half of 2020.
Finally, we focused on biomethane sustainability analysis which highlighted the conformity to European and Italian 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"

CLIMATE CHANGE ADAPTATION PLANS

Energy/Environment

STATUS
Ongoing

STARTING DATE
February 2019

DURATION
18 months

FUNDING
No

PARTNERS
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.
Adaptation, and its integration into territorial government tools, represents a complex issue that needs a multidisciplinary approach. 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, SMAT, trade associations, utilities, organizations, common goods stakeholders and leading territory realities that works on climate change mitigation and adaptation. This action further strengthened the effort and collaboration between the City of Turin and SMAT.
The goal of this MOU is the dissemination of information and knowledge gained through the project DERRIS (DisastEr Risk Reduction InSurance, financed under LIFE EU's programme). DERRIS was the first European project that involves the public administration and small and medium enterprises (SMEs) to reduce the risks deriving from extreme weather events.
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.
The pilot phase of this project started in 2019, with the organization of specific training courses for the personnel of SMAT Water Networks Center. This center will be 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.
The team composed by SMAT researches and water network specialists is now working on the identification of the different level of risks for the selected site, for achieving the drafting of the Action Plan by spring 2020.

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

INTEGRATED METHODOLOGIES FOR MANAGING AND SAFEGUARD OF GROUNDWATER RESOURCES

Energy/Environment

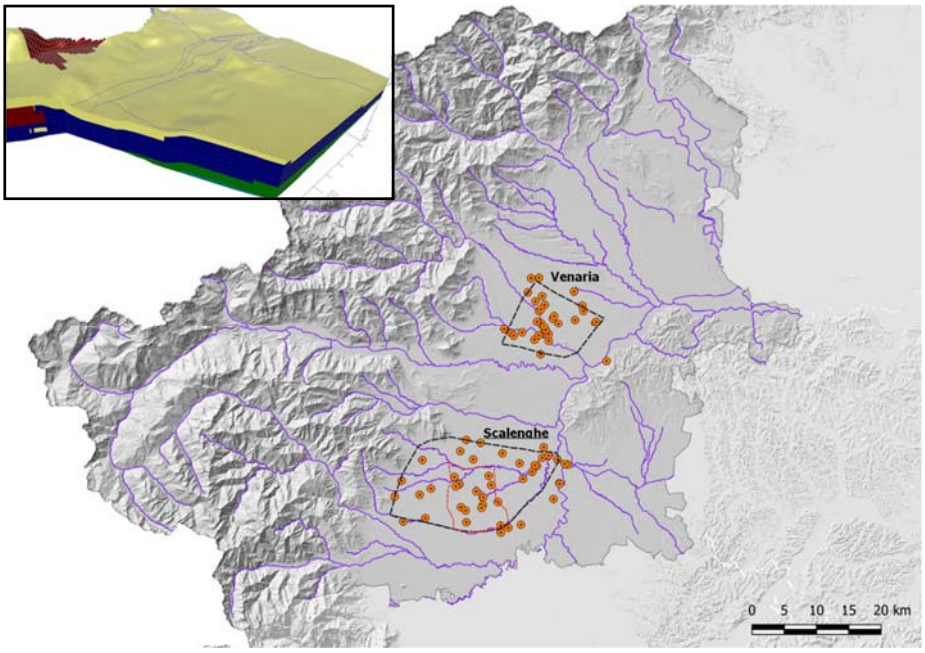
STATUS
Ongoing

STARTING DATE
March 2019

DURATION
24 months

FUNDING
No

PARTNERS
CNR-IGG, Arpa Piemonte



Groundwater resources represent about 97% of global freshwater resources and almost 80% 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;
- Hydrodinamic conditions study (piezometric campaigns data, punctual monitoring of piezometric levels and correlation with hydro-meteorological parameters, …);
- Aquifer supply components identification and source recognition (hydrogeochemical and isotopic analysis data collected through ad-hoc monitoring campaigns);
- 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 and pollutants patterns.

The output of this project will consist in a novel and practical management tool to optimally know and manage:

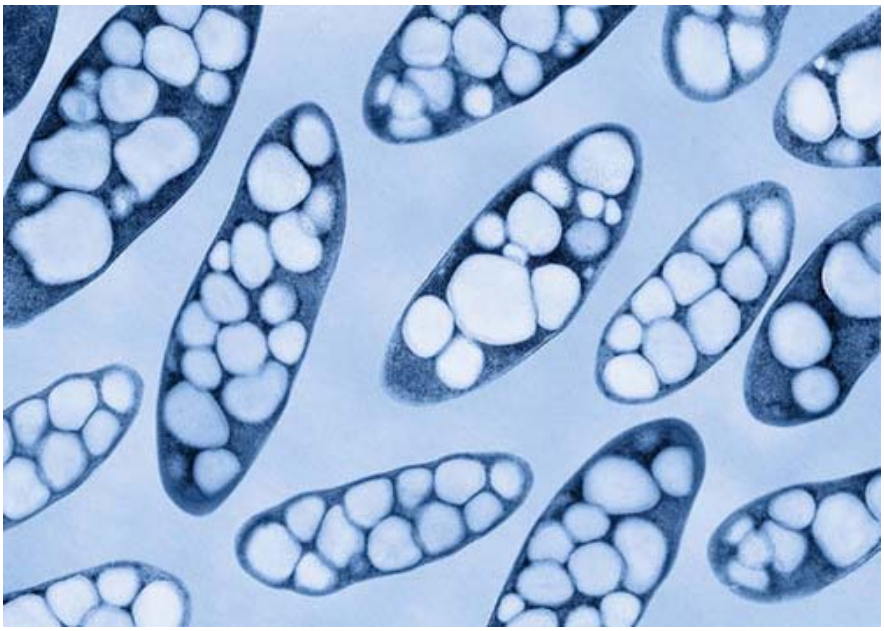
- The wells fileds supply areas, ensuring qualitative stability over time;
- The pollutants thansfer paths;
- The forecast of piezometric levels.

"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"

COD: LRC_2019_02

BIOPOLYMERS

Energy/Environment



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 re-used 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 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. In particular the technologies that have reached a higher development stage will be evaluated and compared based on production yields, operating and capital costs and compatibility with existing processes and plants. Finally we will prepare a preliminary design of the hypothesized system.

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

ANTIBIOTIC RESISTANCE IN THE INTEGRATED WATER CYCLE

Analysis/Quality

STATUS
Ongoing

STARTING DATE
February 2018

DURATION
30 months

FUNDING
No

PARTNERS
University of Turin

According to the World Health Organization, antibiotic resistance represents one of the main global public health issues of this century. Antibiotic Resistant Bacteria (ARB) have been detected in several water environments, while antibiotic resistance genes (ARG) can be transferred between different bacteria, from the human being to animals up to the natural environment and water resources. ARGs have been detected in a number of matrices, including sediments, lakes, rivers and drinking water. These data demonstrate the key role played by the urban water cycle in the diffusion of ARBs and ARGs.

The project is aimed at identifying and monitoring critical points in the integrated water cycle for the transferring and spreading of genes related to antibiotic resistance, also in relation to specific water treatment processes. The first phase of the project mainly focused on an extensive literature review activity along with the optimization of the sampling methodologies and of the DNA extraction protocols from the matrices under investigation. During the second year, the extent of antibiotic resistance was measured in water samples derived from different treatment processes. Samples were concentrated and DNA was extracted to monitor and quantify by real-time PCR the presence of resistance-coding sequences against some of the most common antibiotics (such as genes for tetracycline and sulfonamide resistance). The antibiotic resistance rate will also be evaluated in the total microbial flora.

"The project is aimed at identifying and monitoring critical points in the integrated water cycle for the transferring and spreading of genes related to antibiotic resistance"

COMPARATIVE STUDY ON SAMPLING AND CONCENTRATION TECHNIQUES FOR ENTEROVIRUSES DETECTION IN DRINKING WATER

STATUS
Ongoing

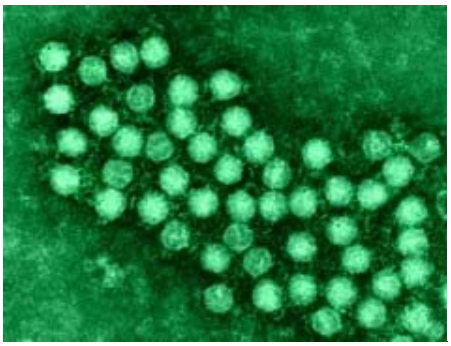
STARTING DATE
September 2017

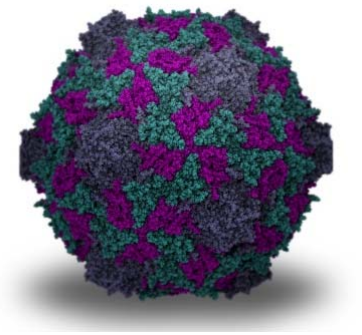
DURATION
24 months

FUNDING
No

PARTNERS
University of Turin

Analysis/Quality





Enteroviruses are ubiquitous and cause a great variety of diseases, sometimes particularly severe, like poliomyelitis, hepatitis, myocarditis, meningitis. However, most of the infections provoked by enteroviruses are asymptomatic, mainly in children, and this favours their spread in the environment. Important concentrations of enteroviruses can be detected in in treated water for human consumption, as well as in surface freshwater and in seawater. These viruses show high adaptability to environmental conditions and resistance to water treatment processes.
Law decree 31/2001 prescribes the complete absence of enteroviruses in drinking water. Virological analysis of drinking water is subject to a number of problems related to volumes to be analysed, methods to be applied in order to isolate and/or quantify viruses in the sample. Specific objective of this project is to compare different methods for samples collection and concentration.

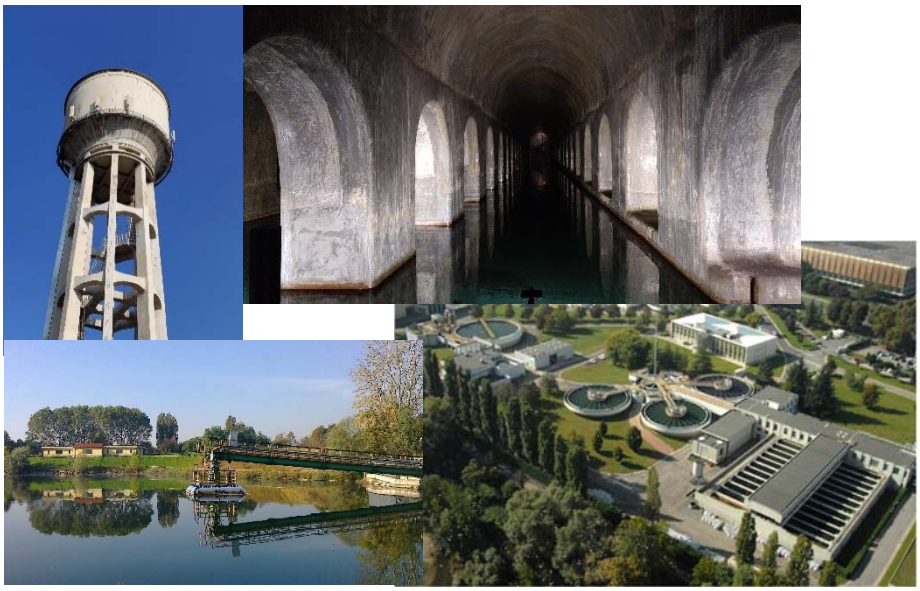
After an initial literature review concerning sampling and analysis techniques, the following concentration methodologies were selected for the comparison: 1) electropositive membranes followed by secondary concentration; 2) tangent ultrafiltration. Moreover, an alternative innovative methodology will be considered.

The operational phase of the project started with the acquisition of the necessary skills to handle adenoviruses (selected as surrogates of enteroviruses for safety reasons). Subsequently, suppliers for concentration equipment were selected. In November 2018, the equipment for tangent ultrafiltration was installed at DSSPP laboratories and personnel properly trained. Currently, tests on drinking water samples are being carried out in order to optimize flow and pressure technical parameters for adenoviruses detection.

"The project's objective is to select the most sensitive and efficient technique to concentrate enteroviruses in different matrices of the integrated water cycle: surface freshwater, treated drinking water, wastewater treatment effluents"

WATER SAFETY PLAN FOR THE CITY OF TURIN

Analysis/Quality



STATUS
Ongoing

STARTING DATE
January 2018

DURATION
30 months

FUNDING
No

PARTNERS
Italian National Institute of Health

Following the introduction of Water Safety Plan in the European Directive 2015/1787, SMAT started a project called "Model for Water Safety Plan" with the aim of identifying a common method to implement Water Safety Plan (WSP) at the whole company level.
In 2016-2017, the model was first applied to 3 pilot municipalities, then to 6 other municipalities belonging to different operators, and finally, in 2018, to the city of Turin.

In 2019 an agreement was signed with the National Institute of Health (ISS) with the purpose of verifying the method implemented by SMAT and completing the City of Turin WSP.
Since the revision of the entire WSP would be too complex, two of the nine water supply chains of the entire water system of the City of Turin were examined: area 2, which developed from the Sangano drainage tunnels and the wells located in Rivalta up to the Regina Margherita plant, and area 7, which includes the Po river drinking water treatment plant and the lagoon.
In this context, the multidisciplinary team was expanded with other authorities, fundamental bearers of knowledge, such as ARPA Piemonte, Regione Piemonte, Autorità d'Ambito Torinese, ASL "City of Turin" and ISS as supervisor.
Moreover, a cloud, that is an essential tool for the approval, was set up in order to share documents among all team members.
In 2020 the City of Turin WSP will be completed, pending the issue of WSP approval guidelines and the following submission.

"In 2019 an agreement was signed with the National Institute of Health (ISS) with the purpose of verifying the method implemented by SMAT and completing the City of Turin WSP"

UPGRADE OF DISINFECTION SYSTEMS: SUPPORT MODELS TO PRIORITIZE OPERATIONS AND GUIDE THE DECISION-MAKING PROCESS

Analysis/Quality

STATUS
Ongoing

STRATING DATE
January 2019

DURATION
24 months

FUNDING
No

PARTNERS
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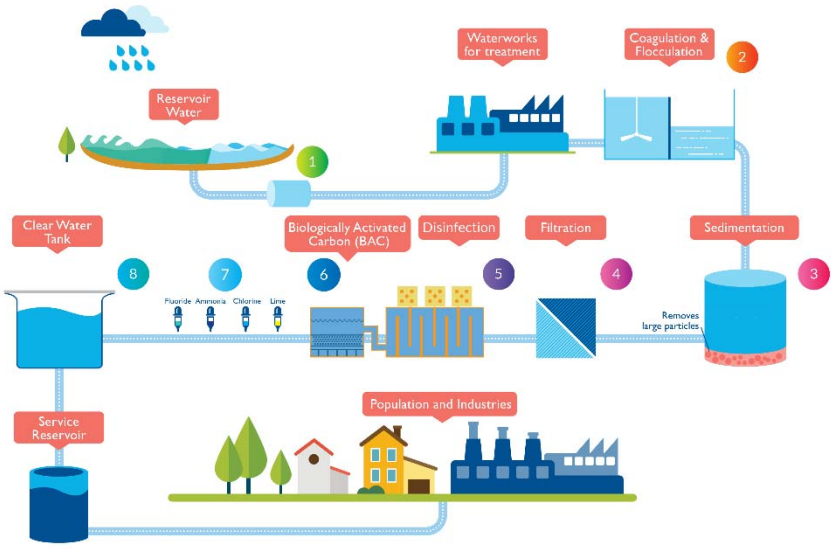


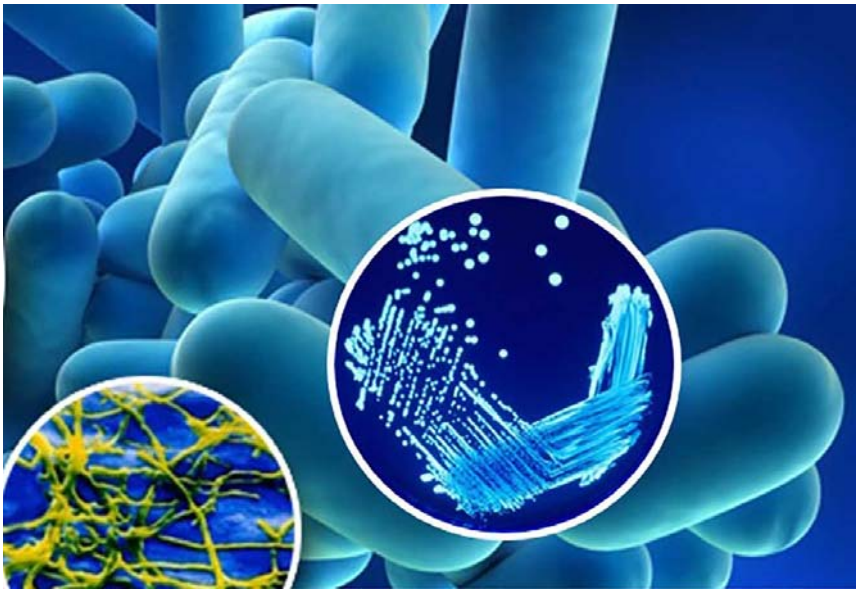
The project is aimed at generating a validated operational tool to guide the decision-making process in order to improve the drinking water disinfection systems in the municipalities characterized by high microbial vulnerability. Building on a systematic screening of the water quality-related problems emerged from the laboratory analysis carried out in the past four years, and with a particular focus on microbiological issues (~ 60% of total anomalies), 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. These municipalities have been further analysed in detail to delineate: (a) the precise location of the problematic sampling points based on the hydraulic, treatment and network schemes, (b) the relative distribution of anomalies throughout the calendar year, (c) the disinfection strategies already in place. Each situation was thoroughly examined to highlight the potential causes, the technical and practical difficulties emerging from disinfection management, and to hypothesize 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, which is now ongoing. During the first year of activities, in parallel with the execution of 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, showing an overall trend towards improvement.

"Each situation was thoroughly examined to highlight the potential causes, the technical and practical difficulties emerging from disinfection management, and to hypothesize the best solutions for each specific context"

LEGIONELLA

Analysis/Quality



STATUS
Ongoing

STARTING DATE
May 2019

DURATION
24 months

FUNDING
No

PARTNERS
A2A, Hera, IREN

In recent years, the number of legionella cases among the most vulnerable fraction of the national population has significantly increased. During the last months, episodes of contamination occurred in Northern Italy, although not ascribable to the drinking water distribution system. Meanwhile, the proposed revision of the Drinking Water Directive 98/83, under debate at the European Parliament, is going to introduce Legionella among the parameters that should be monitored by the integrated water system companies. Analysing in advance the potential problems linked to the drinking water distribution systems and their implications as an infection vehicle has therefore become a critical priority.

Thus, the project is aimed at evaluating the possible risks connected to the presence of Legionella in the water distribution systems by identifying critical nodes, comparing different analytical methods to select the better performing ones and elaborating communication strategies to correctly inform citizens. During the first months of activities, each company has focused on a specific drinking water chain (from surface water, springs or wells), organizing dedicated samplings from the water storage all the way down to the end user meter in order to assess risk and vulnerability. The analytical campaigns planned for the spring/summer season will contribute to better define the situation under temperature conditions particularly favourable for Legionella growth.

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

EARLY WARNING SENSORS

Analysis/Quality

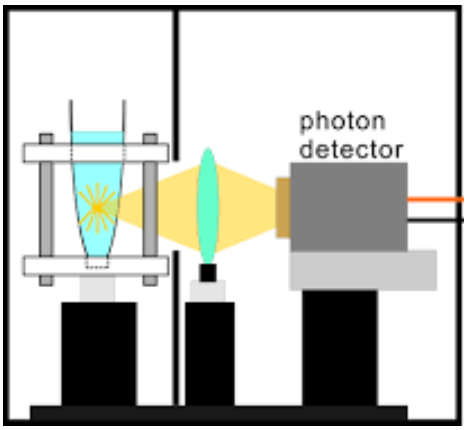
STATUS
Ongoing

STARTING DATE
December 2019

DURATION
12 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 for Energy, Networks and Environment (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 microbiological sensors. Each company elaborated a pilot monitoring project and selected a different analyzer for a performance evaluation in order to share the results with the rest of the consortium. To this aim, SMAT has recently 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, in the installation phase, will monitor water entering and exiting the Po river drinking water treatment plant, providing timely quality data 24/7. The results will be periodically compared with those deriving from parallel laboratory analyses conducted using traditional methods. Furthermore, suitable alarm thresholds will be set to allow a prompt response in case of microbiological anomalies.

"SMAT has recently acquired a latest generation sensor, first in the field, for the automated analysis of the microbiological load through the ATP technology"

ENTERIC VIRUSES IN THE DRINKING WATER CHAIN: EMERGING PATHOGENS AND NEW VIRAL INDICATORS OF CONTAMINATION

Analysis/Quality

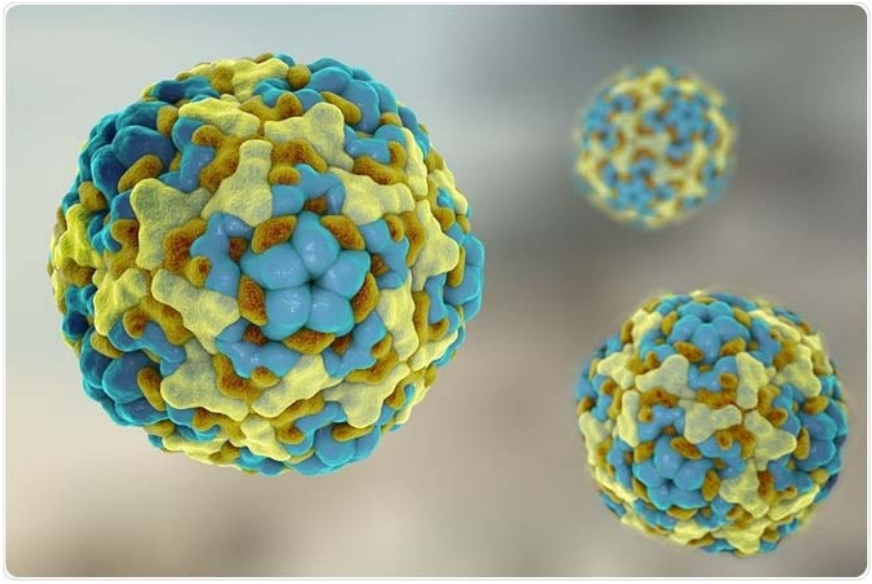
STATUS
Ongoing

STARTING DATE
October 2019

DURATION
14 months

FUNDING
No

PARTNERS
Italian National Institute of Health



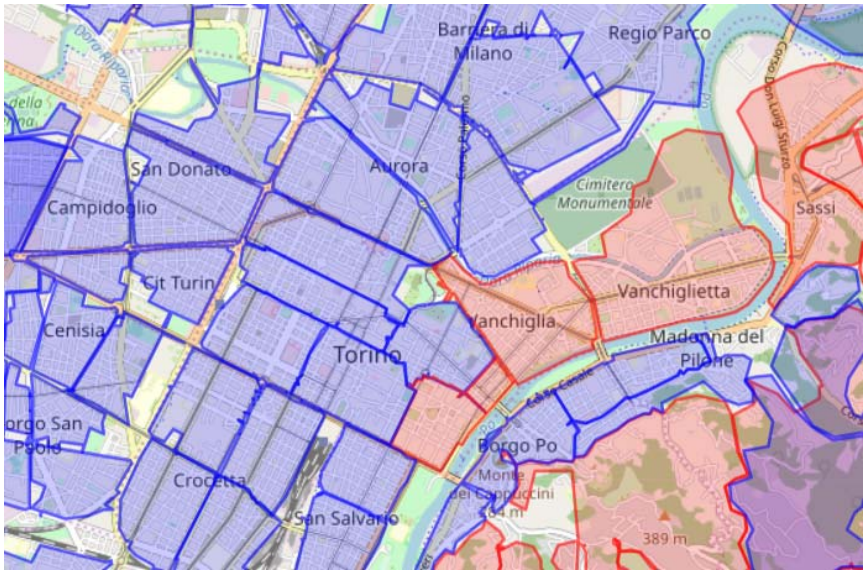
Based on current regulations, waterborne enteric viruses are not routinely measured. However, several studies have highlighted that both surface and groundwater supplies may contain viral pathogens even in the absence of traditional faecal indicators, thus representing a major public health concern. Viruses are indeed responsible of a vast array of pathologies, including gastroenteritis, high and low respiratory tract syndromes, conjunctivitis, hepatitis, central nervous system infections, cardio-vascular system infections and chronic diseases. The main features that make enteric viruses important biological hazard agents are the low infectious dose, the excretion of large numbers of viruses from infected subjects, the high degree of environmental resistance and the moderate tolerance to chlorination.

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 Turin area; analysis will also include raw and treated waste water from Castiglione Torinese plant, for a total of approximately 100 samples. Each sample will be tested for 10 groups of enteric viruses (norovirus, adenovirus, enterovirus, hepatitis A virus, hepatitis E virus, bocavirus, aichivirus, sapovirus, salivirus and suffoldvirus), as well as for indicator viruses such as somatic coliphages. Positive samples identified by DNA sequencing will subsequently be quantified by real-time PCR. The results will provide useful information for the virologic risk assessment along the drinking water chain and about the suitability of the proposed viral indicators.

"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 Turin area"

DESIGN AND IMPLEMENTATION OF DISTRICT METERED AREAS IN TURIN WATER DISTRIBUTION NETWORK

Water networks



STATUS
Ongoing

STARTING DATE
January 2018

DURATION
36 months

FUNDING
No

PARTNERS
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The project's objective is to implement the guidelines developed by the International Water Association (IWA) and recently 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 measured districts, in order to identify areas characterized by high leakages levels, increase interventions promptness in case of failures and prioritize breaks localization activities.

Each district will be treated as an independent and autonomous element, according to a series of work phases that include: (i) pre-analysis of the available information, for example the number of repairs or reported of failures, (ii) project for losses reduction and, in general, for a rationalization in the distribution network management, based on mathematical modeling, (iii) on-site activities for the project implementation, (iv) setting up of measurement points so as to keep track of the transited volumes and activate alarms in case of anomalies in pressure and flow rate values.

"… practices aimed at implementing measured districts, in order to identify areas characterized by high leakages levels, increase interventions promptness in case of failures and prioritize breaks localization activities"

DEVELOPMENT OF AN EARLY WARNING SYSTEM FOR THE CITIES OF TURIN AND RIVOLI BASED ON REAL-TIME SENSORS SUPPORTED BY MATHEMATICAL MODELING

STATUS
Ongoing

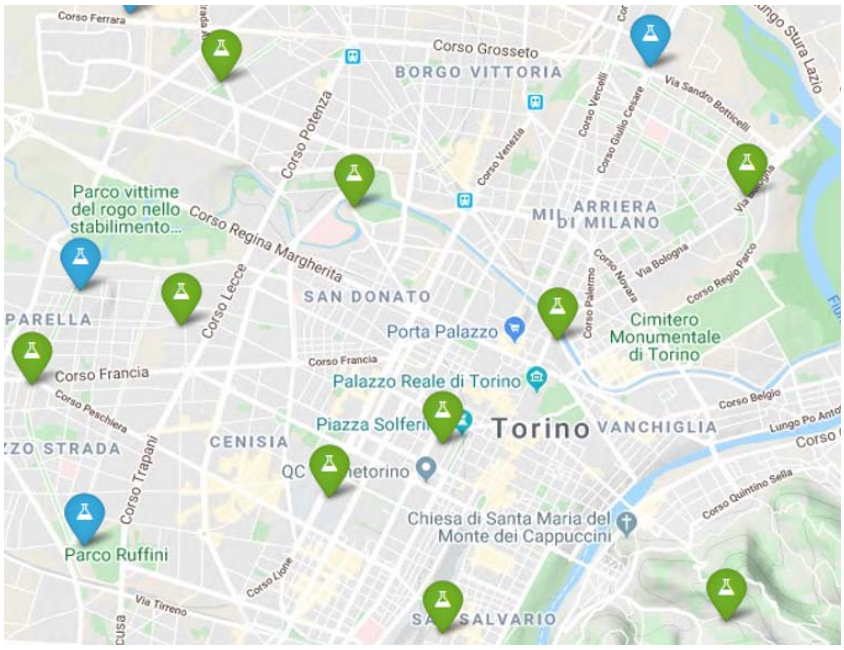
STARTING DATE
June 2018

DURATION
24 months

FUNDING
No

PARTNERS
Politecnico di Torino

Supervision



The project is composed of three parts that cooperate and interact in the construction of an "early warning" system able to automatically detect anomalies in the quality of the water supplied.

A first part concerns measures on the water network. Water quality meters have been installed in all the entry points of the Turin water distribution system and in all the water kiosks on the network. These meters detect temperature, pH, chlorine concentration, oxygen, redox potential, conductivity and turbidity. The measurements are transmitted real-time to the SCADA system (continuous measurement). The measurements are automatically compared with historical data from lab analyzes, so as to evaluate any significant deviation.

The second part cover two different activities: measurements analysis and water quality mathematical modeling. The first of these involves the spatial and temporal analysis of measured time series, with the purpose extract as much information as possible from the measurements, using both classical techniques and innovative methods. The second activity concerns mathematical modeling of the measured quantities on the entire network. The comparison between measurements on the network and data provided by the model will make the system more sensitive, robust and reliable.

Finally, the alert system, nearing completion, is connected with the SCADA system, in order to manage alarms generated in compliance with management rules currently in use.

"The project is composed of three parts that will cooperate and interact in the construction of an "early warning" system able to automatically detect anomalies in the quality of the water supplied"

AQUALITY: INTERDISCIPLINAR CROSS-SECTORAL APPROACH TO EFFECTIVELY ADDRESS THE REMOVAL OF CONTAMINANTS OF EMERGING CONCERN FROM WATER

STATUS
Ongoing

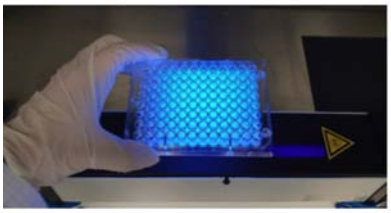
STARTING DATE
October 2017

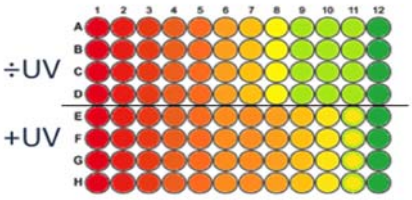
DURATION
48 months

FUNDING
Yes

PARTNERS
Univ. Torino, Aalborg Univ., CNRS (Francia), Plataforma Solar del Almeria, Panespistinio Ianninon, et al.

Treatment





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.). In 2019 different innovative AOPs (Advanced Oxidation Processes) processes were tested, as photocatalysis and high voltage electrical discharge (HVED), with promising results for HVED technique (obtaining 40% of concentration reduction).

PFAS and degradation by-product toxicity was evaluated considering different microbiological markers and microorganisms (*Aliivibrio fischeri* and *Thamnocephalus platyurus*). When different PFAS molecules are simultaneusly present, a toxicity increase was found. Degradation processes shown a toxicity decrease. Pesticides toxicity, before and after UV treatment, was evaluated considering some different microorganisms (*Bacillus subtilis*, *Raphidocelis subcapitata*, *Aliivirbio fischeri* and *Daphnia magna*). Glyphosate and other commercial pesticides containing Glyphosate and treated with UVA, UVB and UVC radiation, and a toxicity reduction between 40 and 80% was found (results obtained from the collaboration with the University of Aalborg, Denmark).

Through multivariate spatial statistical analysis techniques, and by correlating potentially polluting sites in the area with PFAS monitoring results, we developed an innovative methodology for the definition of monitoring plans based on risks assessment (in agreement with the Water Safety Plans principles).
This methodology was applied for selecting the monitoring network of drinking water collection points to evaluate the presence of 16 different pharmaceuticals (some of them are foreseen in the revision of the European directive). To reach this goal it was previously assessed a Liquid Chromatography – Mass Spectrometry Coupled (LC-MS/MS) technique.

"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"

HEXAVALENT CHROMIUM TREATMENT PLANTS

Treatment

STATUS
Ongoing

STARTING DATE
March 2017

DURATION
30 months

FUNDING
No

PARTNERS
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In Italy, the entry into force of a new specific limit on hexavalent chromium, makes it necessary for water utilities to find best technologies to reduce hexavalent chromium concentration in drinking water below 10 µg/l.
The project has the purpose of supporting operational departments in finding best solutions in sites where proper measures should be adopted.

The first trial started in a municipality with less than 500 inhabitants, a mean average flow of 0,5 l/s and hexavalent chromium concentration just above 10 µg/l; operating issue are, in this case, fundamental for choosing best solution since the plant doesn't have permanent workforce.
The choice has therefore fallen to Weak Base Anion Exchange (WBA) resins that are used in single-pass mode (they should not be regenerated). Costs are higher but their use is simpler. The experimentation started with an existing equipment that has been adapted to the new application and lasted about one year and a half. The obtained results have shown a good resin performance that could be improved with a pre-treatment for lower pH.

Thanks to the performed study, a new plant, realized in 2018 in order to treat a flow of 5 l/s, has been equipped with the same type of resin; monitoring results have confirmed the same performance obtained during the previous research.

"In Italy, the future entry into force of a new specific limit on hexavalent chromium makes it necessary for water utilities to find best technologies to reduce hexavalent chromium concentration in drinking water below 10 µg/l"

INNOVATION IN WASTEWATER TREATMENT PROCESSES

Treatment

STATUS
Ongoing

STARTING DATE
September 2018

DURATION
24 months

FUNDING
No

PARTNERS
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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 performances enhancement in terms of contaminants removal, energy use reduction, sludge production reduction and chemicals consumption optimization.

Possible interventions to be implemented are intended to imply minimum modifications to the plant and, where possible, restricted to process adjustments.

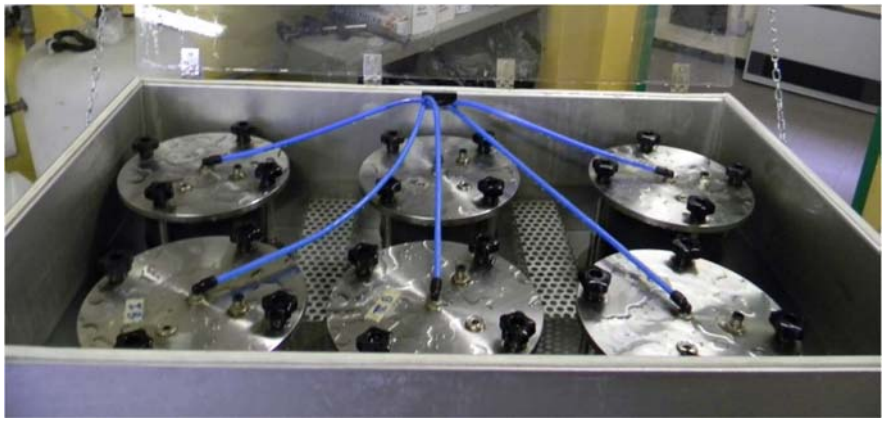
During the last year of the project we carried on the development of a new system to monitor process parameters/indicators that could act as a dynamic interface between plant data, analytical data and process technical data. The system will be a tool for a more systematic and rational “ordinary” process management and plant efficiency monitoring.

Moreover, we evaluated the introduction of an intermittent aeration regulation logic at Castiglione T.se waste water treatment plant. The analysis pointed out very promising opportunities in terms of energy savings for aeration and mixed liquor recirculation, in terms of biological sludge production reduction and for 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 for the first 3 modules of waste water treatment in Castiglione T.se plant, together with the ongoing replacement of turbocompressors.

“we will study and test, in laboratory and in the field, innovative solutions for improving performances and management of wastewater treatment processes”

SLUDGES

Treatment



STATUS
Ongoing

STARTING DATE
June 2018

DURATION
24 months

FUNDING
No

PARTNERS
Polytechnic University of Turin

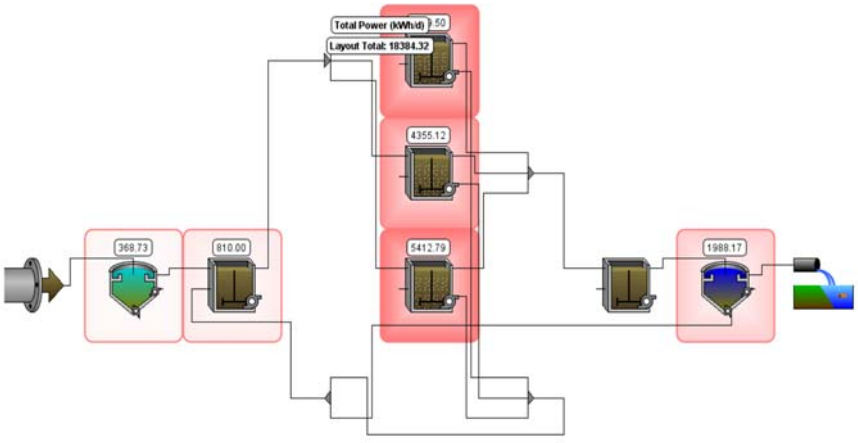
Sludge disposal represents one of the highest expenses for waste water treatment plants. Optimization of sludge treatment processes, especially anaerobic digestion, would be highly desirable to increase biogas production (and consequent co-generation of electrical and thermal energy) and to reduce the 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 the wastewater treatment plant in Castiglione Torinese.
During last year project activities have been focused on three experimental tests conducted in 10 liters and 300 liters pilot digesters.

The first one focused on waste active sludge thermofilic (55°C) anaerobic digestion, which showed a methane productivity increase of 47%. Moreover, we have developed a mathematical model, calibrated on experimental results, that can be used to predict the biogas productivity according to different operative conditions (for example according to hydraulic retention time in the digestor).
The second test was devoted to mesophilic digestion of primary sludge; also for this kind of digestion a mathematical model has been set up and calibrated based on experimental result.
Finally, the third experimental test has been focused on 2-stage anaerobic digestion of primary sludge (with low-HRT first stage – acid digestion) with the aim of evaluating, besides the biogas productivity increase, 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"

MODELING OF URBAN WASTE WATER TREATMENT PROCESSES

Treatment



STATUS
Ongoing

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 a previous project on the same theme, implemented in collaboration with Polytechnic University of Turin, a model was built for one of the four parallel modules that compose the water treatment line of Castiglione T.se plant. The objective of this project is to extend the model implementation to the other three treatment modules using a commercial software.

During the last year the project activities focused on the calibration, both in stationary and dynamic conditions, of the model of water treatment lines using plant data, on-field measurements and dedicated sampling and laboratory analysis campaigns. In particular, we focused on lab activity, mainly based on respirometry techniques, for the evaluation and calibration of kinetic process parameters and for an extensive characterization of the influent waste water in terms of COD fractionation.

In the next months we will take care of simulations aimed at process optimization and at the definition of adequate plant control and regulation strategies (for example aeration, recirculation flows, chemical dosage, etc.).

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

DRYING, THERMAL OXIDATION AND ENERGY RECOVERY FROM SLUDGES

Treatment

STATUS
Ongoing

STARTING DATE
December 2019

DURATION
12 months

FUNDING
No

PARTNERS
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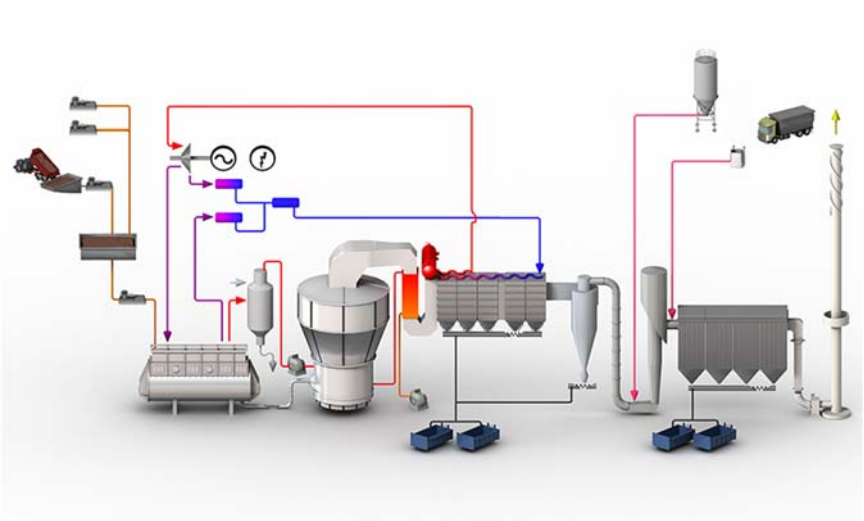


During the last years sewage sludge management and the identification of a reliable final destination for sludge disposal or recovery have become an increasingly serious problem for Integrated Water Cycle companies. Indeed, the sector law and case law framework is evolving continuously and struggle in 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 itself to send sludges to their final destination and, finally, the possibility for waste water treatment plant to execute their own function.

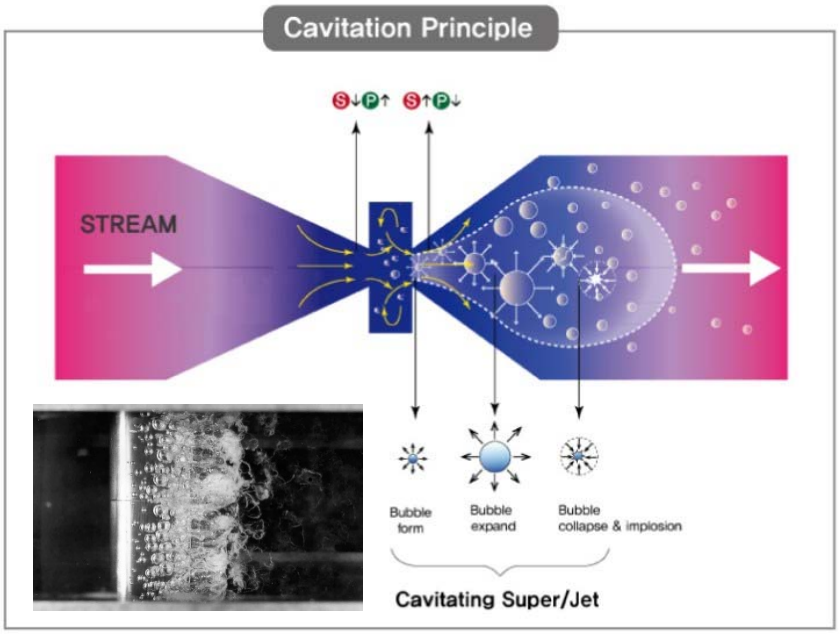
In this incertitude framework is of essential importance, not only from a technical but also strategical point of view, the planning of structural improvements that allow to get free from market fluctuation and make available some sludge disposal/recovery way that prove to be reliable, long-lasting and,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

The aim of this project is the technical and economic feasibility evaluation of the implementation of an integrated plant composed by drying, thermal oxidation and energy recovery of waste water treatment sludges. We will consider several thermal oxidation technologies commercially available with particular attention to the choice of the best technologies for the treatment of atmospheric emissions. Moreover, we will focus on the best energy recovery approach for the production of power (that will guarantee the self-sufficiency of the system) and for the optimal integration with sludge drying process upstream of thermal oxidation. Finally, we will evaluate operative and capital costs, the expected emissions and the environmental advantages linked to the significant reduction of sludge hauling.

"The aim of this project is the technical and economic feasibility evaluation of the implementation of an integrated plant composed by drying, thermal oxidation and energy recovery of waste water treatment sludges"

BIOENPRO4TO

Treatment



STATUS
Ongoing

STARTING DATE
June 2019

DURATION
30 months

FUNDING
Yes

PARTNERS
SEA Marconi, Polytechnic University of Turin, University of Turin, University of Eastern Piedmont and others

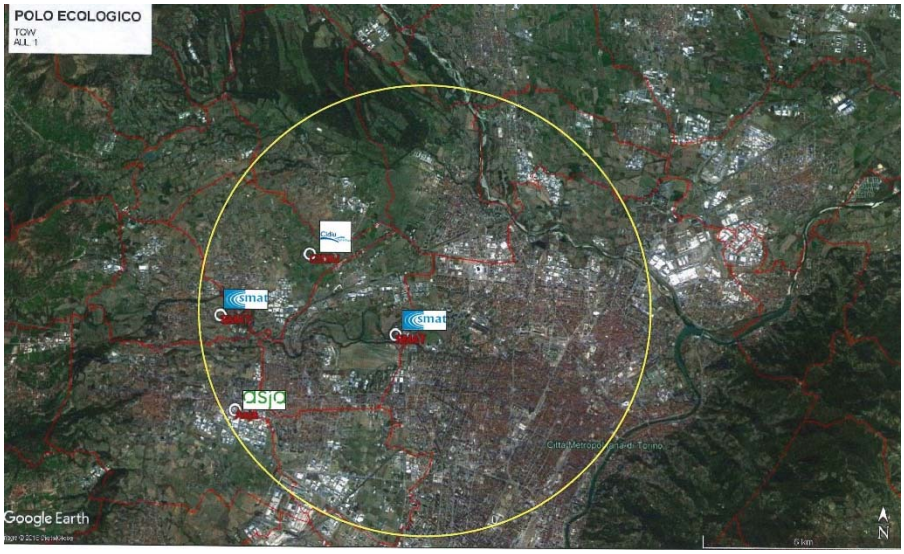
Hydrodinamic cavitation is a physical-chemical phenomenon induced by a pressure variation obtained through a hydraulic system, determining the formation of a vapour (or vacuum) zone within a fluid. The generated microbubbles (or “cavities”) implode upon a subsequent pressure increase, inducing a series of highly energetic phenomena. The reaction may be exploited in a positive way to prime chemical and mechanical processes with a wide range of potential applications. Of particular interest is the study of hydrodinamic cavitation applicability in drinking water disinfection, using its principles to compromise microbial cell integrity and viability with a combination of physical and chemical-oxidative processes.

The project is aimed at moving from lab scale disinfection through hydrodinamic cavitation, already extensively investigated during previous collaborations with the Polytechnic University of Turin, to a real scale implementation of the technology for drinking water production. Initially, optimization will focus on reducing energy consumption, shortening treatment times, increasing target volumes and minimizing the bulk size of the system. Since cavitation itself can accelerate and amplify chemical and physical reactions, it will also be possible to test its performance in combination with other oxidizing agents (such as chlorine and/or UV), reducing their dosage and consumption. Once ready, the pilot system will be transferred into a representative and suitable SMAT plant in order to proceed with field tests to assess its functionality, limits and applicability.

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

TOW ECOLOGICAL CENTER VALORIZATION

Treatment



STATUS
Ongoing

STARTING DATE
January 2019

DURATION
36 months

FUNDING
No

PARTNERS
CIDIU, Asja Ambiente Italia, Cassagna

TOW ecological center is founded in an area with a high industrial vocation, with public companies like SMAT S.p.A. and CIDIU S.p.A. and private companies like Asja Ambiente Italia S.p.A. and Cassagna S.r.l. All these companies have always shown a strong vocation to develop technologically advanced and environmentally responsible activities, that could be sustainable and with a low environmental impact.
The production phases of the different companies have many touch points:

- Sewage sludges produced by SMAT processes can be used in compost production chain, that needs some structuring material;
- The compost is provided by CIDIU, deriving from the collection of grass cuttings and clippings obtained from urban forestry maintenance;
- Leachates produced in CIDIU landfills can be treated in SMAT urban waste water treatment plants;
- Asja has competence in the field of renewable energy, more specifically in biomass digestion and biogas and biomethane production, and in the construction and maintenance of energy recovery plants;
- Cassagna has specific experience in the construction and management of landfills, also of after-care landfills.

The latest regulatory developments and the funding opportunities induced the companies to sign a specific Programme Agreement and create a Direction Cabinet. The aim is to jointly analyze the development of industrial synergies, to promote research projects for OFMSW treatments, sewage sludges, landfills leachates and solid wastes in general.
The main goals are:

- the optimization of the production processes;
- the achievement of energy savings;
- raw materials recovery;
- to give added value to production by-products.

All these objectives will be achieved following economic and environmental sustainability.

"To develop technologically advanced and environmentally responsible industrial synergies"

Publications 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* (in press).

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Borzooei, S., Miranda GHB., Teegavarapu R., **Scibilia G.**, **Meucci L.**, Zanetti MC., (2019), Assessment of weather-based influent scenarios for a WWTP: Application of a pattern recognition technique. *J Environ Manage*, 242:450–6. DOI: 10.1016/J.JENVMAN.2019.04.083.

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Ruffino B., Cerutti A., Campo G., **Scibilia G.**, **Lorenzi E.**, Zanetti M.C. (2019), Improvement of energy recovery from the digestion of waste activated sludge (WAS) through intermediate treatments: The effect of the hydraulic retention time (HRT) of the first-stage digestion. *Applied Energy*, 240, 191-204. DOI: 10.1016/j.apenergy.2019.02.061

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E. Brussolo, A. Provenzale, G. Masetti, S. Ferraris, M. Previati (2019). Impatto dei cambiamenti climatici sulle risorse idriche sotterranee. *Servizi a Rete*, 4, luglio-agosto 2019, 12-14, http://www.tecneditedizioni.it/servizi-a-rete-n-4-2019/

Borzooei, S., Miranda G.H.B., Teegavarapu R, **Scibilia G**, **Meucci L**, Zanetti M.C. An Integrated modeling approach for Energy optimization of a WWTP under various climatic conditions, Proceedings of 10th IWA Symposium on Modelling and Integrated Assessment (Watermatex 2019)

G. Baiocco, M. Giraudo, L. Bocchini, …, **E. Brussolo**, **D. Giacosa**, **L. Meucci**, **S. Stefenino**, A. Ballario, …, A. Ottolenghi: The PERSEO experience: a water-filled garment prototype for personal radiation protection of astronauts successfully tested on board the International Space Station. XXV International congress of aeronautics and astronautics, 9-12/9/2019, Roma, Italy.

E. Burzio, **F. Bersani**, G.C.A. Caridi, R. Vesipa, L. Ridolfi, C. Manes: Water disinfection by orifice-induced hydrodynamic cavitation. *Ultrasonics Sonochemistry,* Volume 60, 2020, https://doi.org/10.1016/j.ultsonch.2019.104740.

Campo G., Cerutti A., Zanetti M.C., **Scibilia G.**, **Lorenzi E.**, Ruffino B.: Application of semi-continuous pilot-scale AD tests to assess biochemical methane potential and hydrolysis rate constant of raw and pre-treated sludge. 7th International Conference on Sustainable Solid Waste Management, Heraklion, Crete Island, Greece, 26-29 June 2019.

Cerutti A., Campo G., Zanetti M.C., **Scibilia G.**, **Lorenzi E.**, Ruffino B.: Performance comparison between mesophilic and thermophilic anaerobic digestion processes carried out on waste activated sludge. 7th International Conference on Sustainable Solid Waste Management, Heraklion, Crete Island, Greece, 26-29 June 2019.

M. Doveri, M. Menichini, **E. Brussolo**, B. Raco, G. Masetti, A. Irace, A. Provenzale: Groundwater response to meteo-climate variation: example from the foothill aquifer system of the Piedmont Alpine zone (NW Italy). 46th Congress of International Association of Hydrogeologists, 22-27/9/2019, Malaga, Spain.

D. Papagiannaki, **S. Morgillo**, **G. Costantino**, P. Calza, **R. Binetti**: Perfluoroalkyl Substances Assessment in Turin Metropolitan area and correlation with potential sources of pollution according to the Water Safety Plan risk management approach. SETAC Europe 29th Annual Meeting, 26-30 maggio 2019, Helsinki, Finland.

D. Papagiannaki, **S. Morgillo**, **G. Costantino**, P. Calza, **R. Binetti:** Trace level analysis of perfluoroalkyl substances in drinking water and their assessment in Metropolitan Area of Turin, 17th International Conference on Chemistry and the Environment, 16-20 giugno 2019.

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Oral presentations

F. Bersani: "Cibo nello spazio", Torino, 08/11/2019, Festival della tecnologia.

R. Binetti: "Water Treatment: present situation and future challanges, NIS Colloquium - AQUAlity/Project: a combined strategy to address water reuse" May, 16-17th 2019 - University of Turin

R. Binetti: "SMAT Research Centre Activies and Aquality nexus", 3rd AQUAlity meeting 7-8/3/2019 École Polytechnique - Université Paris-Saclay (France).

E. Brussolo: "La gestione delle acque sotterranee e la sfida dei cambiamenti climatici", Roma, 3/10/2019 Forum Nazionale di Legambiente sulle filiere della sostenibilità della risorsa idrica.

E. Brussolo: "Risorsa idrica sotterranea: un approccio integrato per l'analisi della disponibilità", Bressanone, 13-15/5/2019, Festival dell'Acqua 2019.

E. Brussolo, A. Provenzale, S. Ferraris: "Impatto dei cambiamenti climatici sulle risorse idriche sotterranee", Torino c/o Centro Ricerche SMAT, 12/4/2019.

L. Meucci, **C. Burdizzo**: "Il Piano di Sicurezza dell'Acqua per la Città di Torino", Torino c/o Padiglione dell'Acqua SMAT, 30/9/2019, Piano di Sicurezza dell'Acqua per la Città di Torino – Presentazione e Pianificazione delle attività.

D. Papagiannaki: "Trace level analysis of CECs in drinking water using Mass Spectrometry", International Winter School on Mass Spectrometry, 4-5/3/2019, Palaiseau, France.

A. Quazzo, **C. Burdizzo**: "Presentazione PSA SMAT Torino", Udine, 28-29/11/2019, Dalle linee guida dell'Istituto Superiore di Sanità, all'implementazione di nuovi modelli regionali.

M. Scibetta: "Modelli matematici e ottimizzazione degli investimenti", Bressanone, 13-15/5/2019, Festival dell'Acqua 2019.

G. Scibilia: "Progetto DEMOSOFC: pile a combustible e biogas", Venezia, 11/10/2019, Festival dell'Acqua 2019.

S. Steffenino: "Corso di Formazione Nazionale per Team leader per l'implementazione dei Piani di Sicurezza dell'Acqua (PSA) nella filiera idro-potabile", Asti c/o UNI-ASTISS 4-5/11/2019, 11-12/11/2019.

SMAT Researchers

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Risorse Idriche
San Carlo
Santer Reply
SEA Marconi
Società Meteorologica Italiana
Step Solutions
Università di Milano
Università del Piemonte Orientale
Università di Torino
Università Politecnica delle Marche
Universitat Politecnica De Valencia
VBM
VTT

Michela reservoir, Sangano

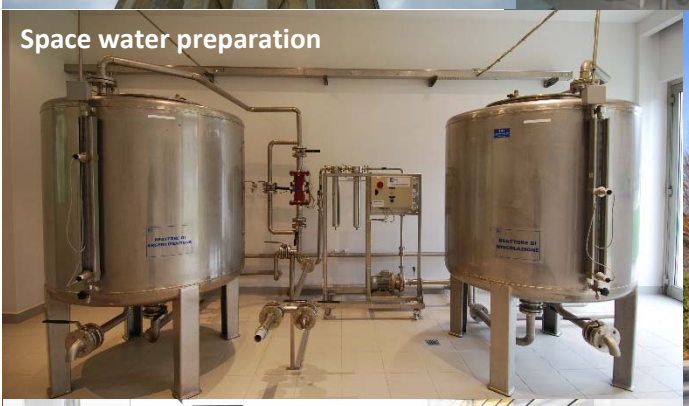
Cyclofloc, river Po potabilization plant

Top Utility Research and Innovation award

Water in space

Online laboratory, Research Center, Turin

Telesio tank



Space water preparation

DEMOSOFC project, Collegno plant

Inauguration of Castiglione T.se Research Center

SMAT Research Center, Turin