LIFE ULISES PROJECT
Layman´s Report

Project co-funded by the European Union under the LIFE Programme Grant Agreement no. LIFE18 ENV/ES/000165

PROJECT INFORMATION

Start date	1st July 2019
End date	30th June 2023
Grant	Subsidy of 55% of budget
Total funding received	1.041.810 €

PROJECT CONSORTIUM

	Aqualia has coordinated the project and has been in charge of the design, installation and operation of the UASB anaerobic pretreatment plant, the Biogas upgrading plant and the AeMBR plant.
	CETIM has operated the enzymatic hydrolysis and the struvite recovery prototypes.
	EnergyLab has been in charge of the evaluation of the environmental impact of the project based on the Life Cycle Analysis.
	CIESOL has operated the tertiary photo-Fenton solar plant and the Fresnel solar collector plant.

PROJECT LOCATION

LIFE ULISES Project takes place in El Bobar WWTP, which treats municipal wastewater from Almería city.

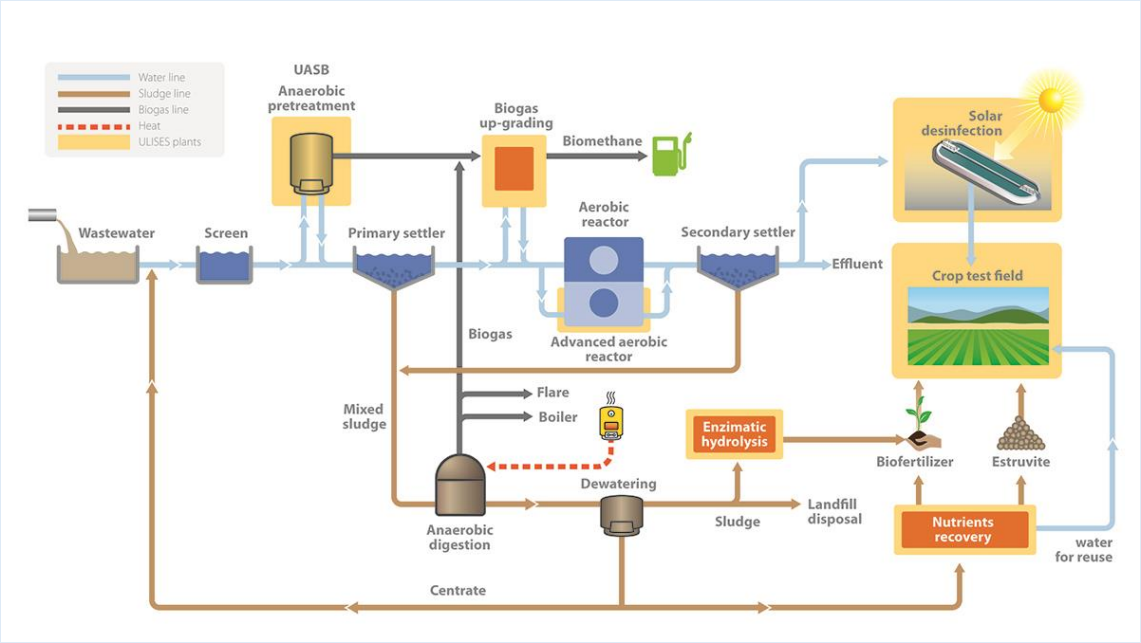
PROJECT OBJECTIVE AND DESCRIPTION

The main goal of **LIFE ULISES Project** is to upgrade conventional wastewater treatment plants (WWTP) by different innovative technologies that produce useful resources from wastewater, such as automotive biofuel, biofertilizers and water for reuse. The project aims to reduce energy consumption and carbon footprint of WWTPs, increasing their efficiency by the integration of different technologies in each of their lines from the WWTP (water, gas, sludge).

During the project, the next low cost technologies was implemented in El Bobar WWTP:

1. Biogas up-grading with ABAD Bioenergy® system to produce a renewable biofuel.
2. Combined PUSH anaerobic pretreatment with advanced aeration control system to half energy demand of wastewater treatment process.
3. Solar tertiary treatment based on photo-phenton to produce disinfected for irrigation.
4. Biofertilizer production from sludge by enzymatic hydrolysis treatment.
5. Struvite recovery system from centrate by direct osmosis technology.

All these innovative technologies reduce the electric consumption of El Bobar WWTP and then, minimize its environmental impact and carbon footprint.



BIOGAS UPGRADING PLANT

In LIFE ULISES Project biogas was upgraded to biomethane meeting the requirements for vehicular use (UNE-EN 16723-2) and tested in a fleet of passenger cars.

Volkwagen Up

Fiat Dobló

- More than 21,000 km traveled during the project.
- An average of 4.8 kg of biomethane per 100 km driven.
- Analysis of vehicle operation in urban cycles and extra urban cycles (more aggressive speed conditions)

QUALITY OF BIOMETHANE

Raw biogas comes from the anaerobic digesters of the wastewater treatment plant. The upgraded biomethane composition fulfills with the law requirements for use as automotive fuel.

	CH_4	CO_2	O_2	H_2S	Humidity
	%	%	%	%	%
Raw Biogas	60.8	33.5	0.21	3555	-
Biomethane	88.1	8.0	0.02	1.8	21.5

Principal recommendations for the deployment of biomethane as a vehicle fuel

- Establishment of specific targets for biomethane in Spain
- Implementation of a trading system of using Renewable Guarantees of Origin Certificates
- Economic incentives for biomethane production (direct or indirect, such as premiums or tax incentives)
- Help the deployment of vehicle gas refueling infrastructures
- Dissemination of energy technology and application (between Administrations and towards users)
- Full Life Cycle Assessment accounting for vehicular fuels

ANAEROBIC PRETREATMENT PLANT

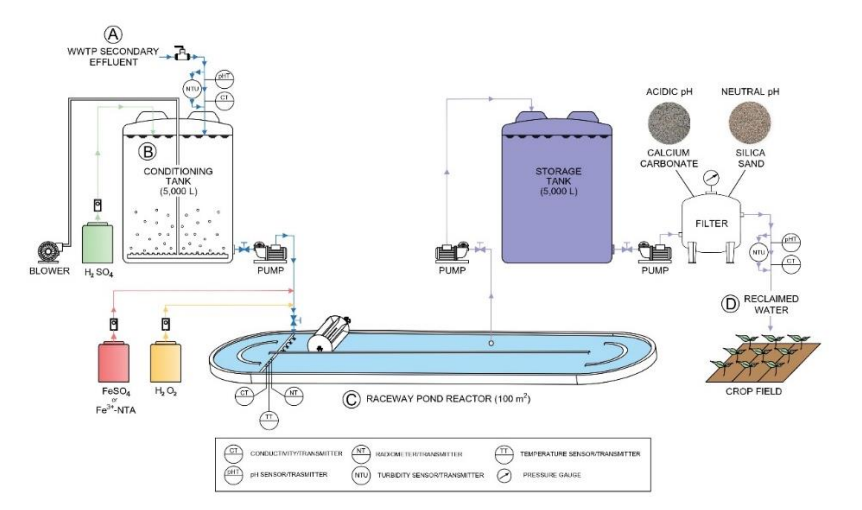
An Upflow Anaerobic Sludge Blanket (UASB) reactor is operated at ambient temperature to remove organic matter from wastewater and produce biogas, thanks to a novel pulsed feeding system PUSH® (European Patent EP 3009408).

The UASB reactor presents a removal capacity of 77% of the chemical oxygen demand (COD), 31% of the soluble COD and 79% of SO_4^{2-}. In terms of total suspended solids (TSS), the UASB reactor is capable to reduce 92% of TSS present in wastewater. The biogas production in the UASB reactor ascends to 450 NL d^{-1} with the next composition: 76% CH_4, 8% CO_2 and 3946 ppm H_2S.

	Inflow	Outflow	Removal
COD (mg/L)	1804	394	77%
sCOD (mg/L)	366	249	31%
SO_4^{2-} (mg/L)	119	25	79%
SST (mg/L)	1.203	0.089	92%

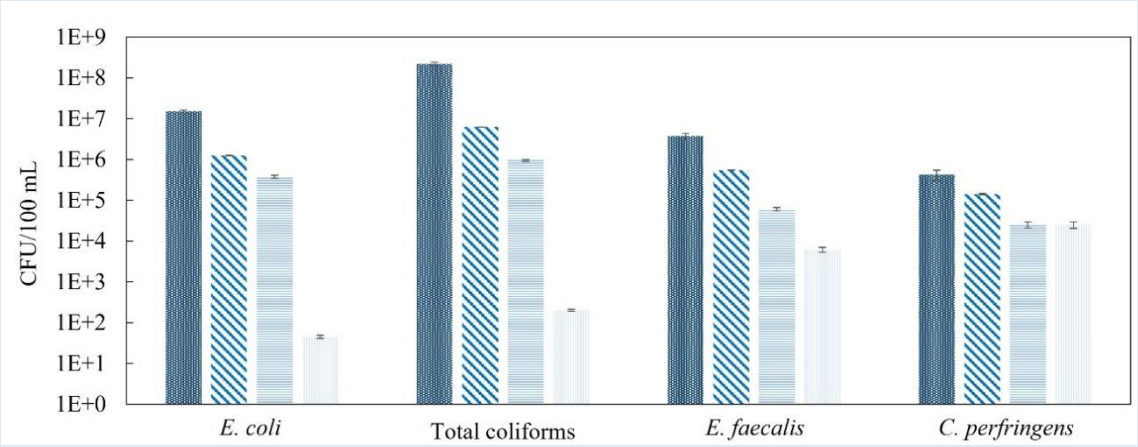
SOLAR PHOTO-FENTON PLANT

The photo-Fenton process is the last treatment that wastewater receives before being reused. This treatment seeks to eliminate pathogenic microorganisms and micropollutants that are still present in the treated water, avoiding the risk associated with their accumulation in the environment. The potential of the process is based on the generation of hydroxyl radicals through the use of small concentrations of reagents which are environmentally friendly.



MOST OUTSTANDING RESULTS OF THE SOLAR PHOTO-FENTON PROCESS

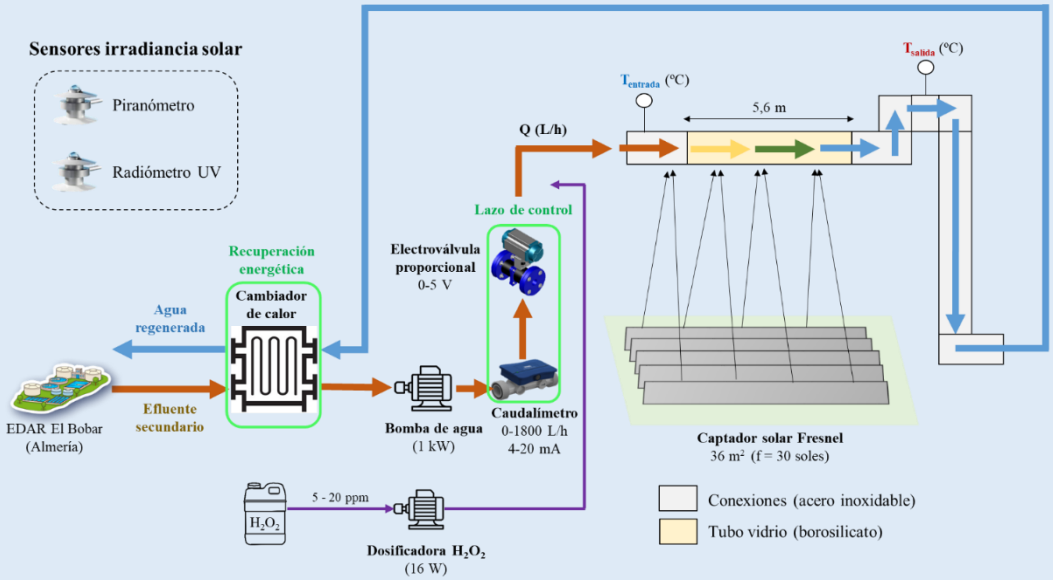
- Obtaining water suitable for reuse in agriculture in accordance with Royal Decree 1620/2007 and European Regulation 2020/741.
- Elimination of micropollutants and pathogens from wastewater, highlighting the elimination of drugs such as venlafaxine, ketoprofen or diclofenac that are not sufficiently eliminated in conventional treatment.
- Treatment capacities up to 2000 L m^{-2} d^{-1}.



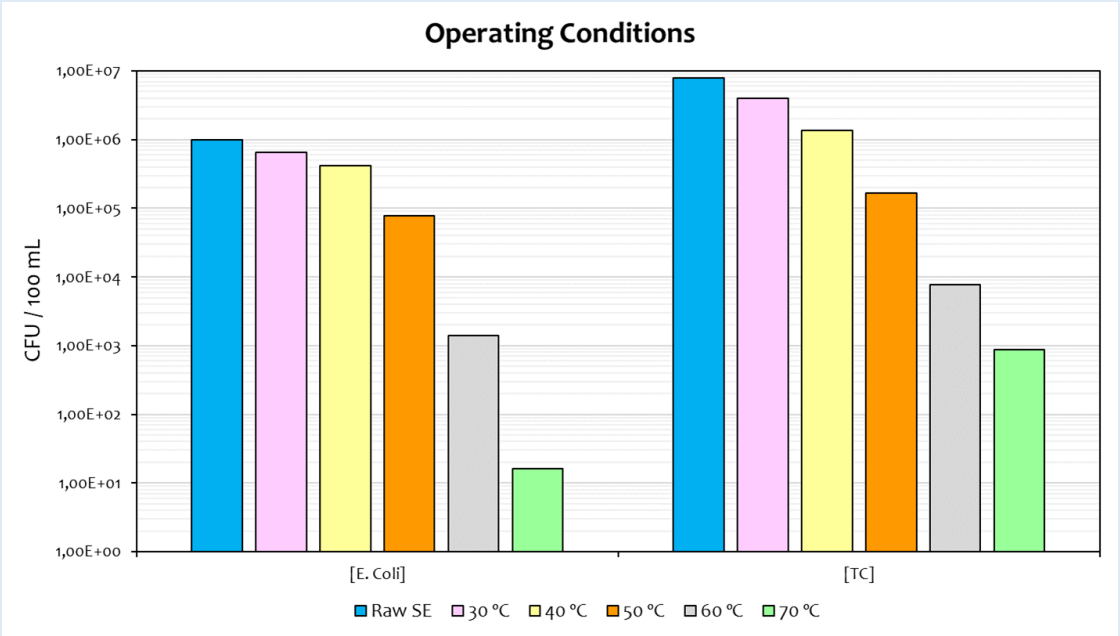
E. coli, total coliforms, Enterococcus faecalis and Clostridium perfringens concentrations in the WWTP influent, WWTP secondary effluent, conditioning tank and RPR

FRESNEL SOLAR COLLECTOR

LIFE ULISES Project also proposes the disinfection of secondary effluents from WWTPs using concentrated solar radiation in photoreactors operated in continuous mode. This initiative aims to provide the necessary knowledge to develop an economical and sustainable alternative for solar disinfection of wastewater, thus reducing the environmental risk caused by current conventional treatments and allowing subsequent reuse of treated water in agriculture.



With the use of the FRESNEL solar collector we obtain water suitable for reuse in agriculture in accordance with Royal Decree 1620/2007 and European Regulation 2020/741 by regulating the operating temperature.

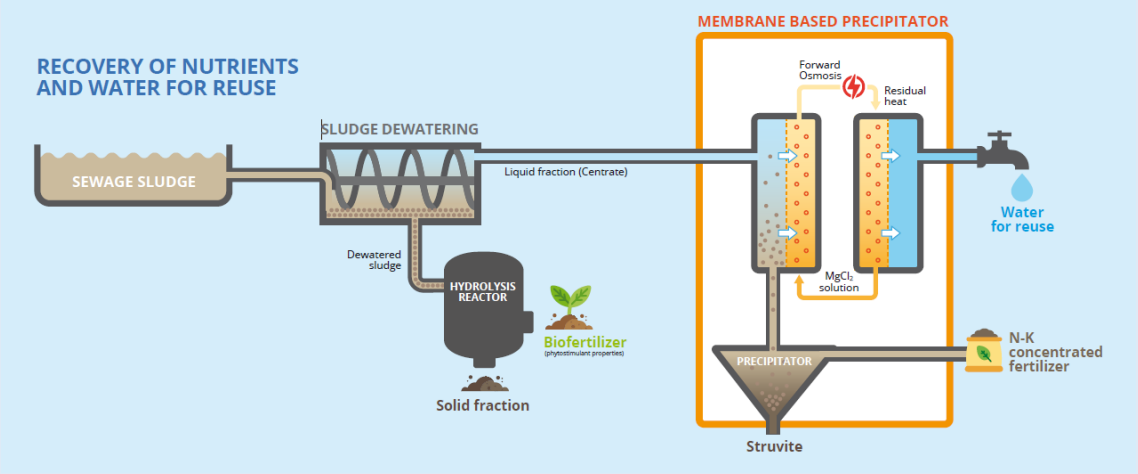


Inactivation of E. coli and TC in continuous flow as a function of Fresnel-type solar concentrator operating temperature

SLUDGE LINE

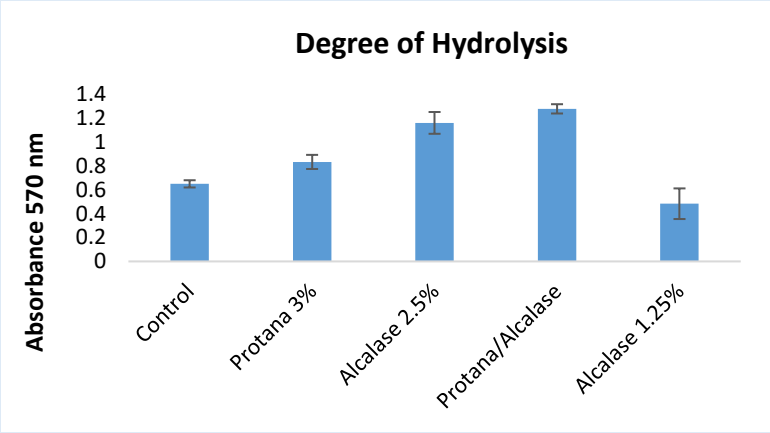
Regarding the sludge line of LIFE ULISES Project, two different processes were implemented to recover nutrients and water of high quality for reuse, and to obtain biofertilizer as a valuable product. These technologies affect both the solid phase and the liquid phase obtained from the centrifugation of the sludge, which includes:

- Enzymatic hydrolysis of dewatered biosolids (solid fraction): One type of biofertilizers are preparations based on peptides and amino acids, obtained by enzymatic hydrolysis, with biostimulant properties for plant growth.
- Struvite precipitation and water recovery of centrate (liquid fraction): A membrane-based system has been developed to concentrate the liquid fraction of sludge, followed by struvite precipitation. Two fractions with potential fertilizer value are obtained: struvite and supernatant.



VALIDATION RESULTS

The results of the operation of enzymatic hydrolysis plant to produce a biofertilizer indicated that Alcalase enzyme (dose 2.5%) has great potential to generate a biofertilizer from dewatered biosolids. This product contains amino acids and peptides that have a potential biostimulator capacity and does not exceed the limit of heavy metals and pathogens indicated in Regulation (EU) 2019/1009.



The struvite recovery plant allowed to achieve a yield of 1.1 g struvite L^{-1} concentrated centrate operating under optimal conditions. High purity struvite was recovery (90-100%), rich in N (50 g N kg^{-1}) and P (128 g P kg^{-1}) as well as other nutrients (3 g K kg^{-1}, 92 g Mg kg^{-1}, 7 g Ca kg^{-1}) and with a low content of heavy metals according to Regulation (UE) 2019/1009 and RD 506/2013. Struvite precipitation allowed a P recovery from concentrated supernatant over 90% at optimal precipitation conditions.

To demonstrate LIFE ULISES Project nutrient recycling strategy, the potential of the fertilizers obtained was tested at different scales: phytotoxicity text, pot trials in growth chambers under controlled conditions and crop testing area at El Bobar WWTP.

Phytotoxicity test demonstrated the toxicity of struvite supernatant to lettuce and cress (inhibit seed germination and root elongation) when applied concentrated (dilution >10% is required). The application of Alcalase 2.5% biofertilizer did not shown phytotoxic effects at concentrations <10% and even demonstrated phytostimulant effects (GI > 1).

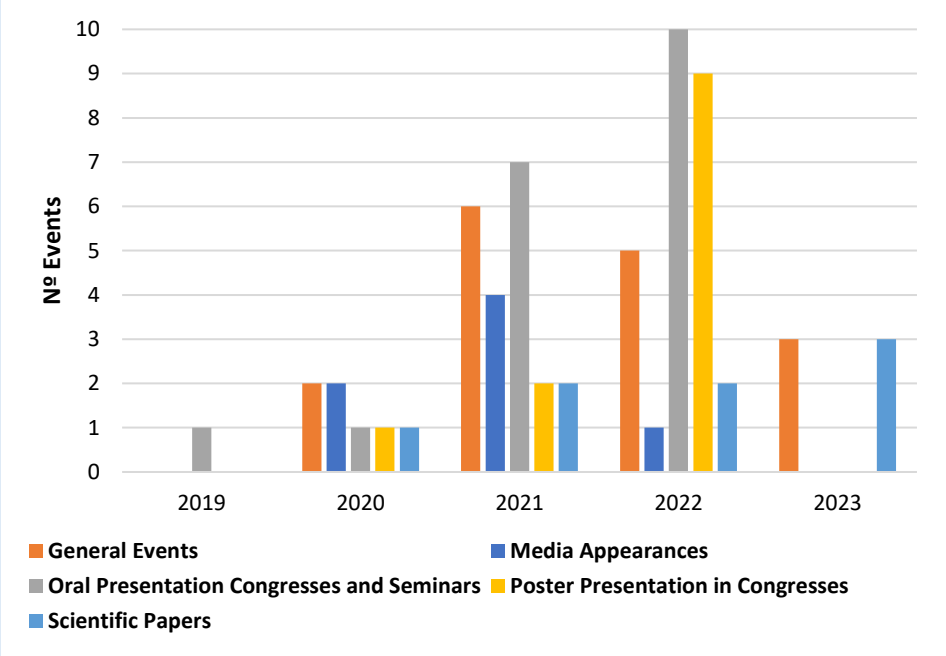
The struvite and biofertilizers were also applied at different combination in 4 plots sown with grass to evaluate their fertilizer potential (control without fertilizer, struvite, biofertilizer, struvite + biofertilizer). The plots were irrigated with water recovered by the solar photo-fenton. Results showed an increase in the biomass production of the three plots where fertilizer was applied, compared with the control.

Result of fertilizing pot essays with Lactuca sativa

Fertilizer's crop test at El Bobar WWTP

COMMUNICATION AND DISSEMINATION

Over the LIFE ULISES Project, the consortium members have attended several activities and events to disseminate the different actions carried out during the project.



Total events per year

GENERAL EVENTS

(Left) European researchers' night in Almería. (Right) XXII Summer course of the University of Almería: Integrated water management in a water stress scenario

INTERNATIONAL AND NATIONAL CONGRESSES

Within this category we have listed the participation with oral and poster presentations in different national and international conferences and seminars, in all of which the project and its results have been presented.

(Left) Oral presentation by Aqualia in the IWA Young Water Professionals Spain. (Right) Keynote presentation by CIESOL in the 5th Iberoamerican Conference on Advanced Oxidation Technologies

MEDIA APPEARANCES


La Voz de Almería

Innovación y sostenibilidad: aliadas en el ciclo del agua

Aqualia desarrolla en Almería varios proyectos enfocados a potenciar la economía circular

Fotografía del proyecto Ulises Almería. LA VOZ

LA VOZ
12:01 - 26 MAY. 2021

En el mundo se recogen y tratan más de 165.000 millones de m3/año de agua, de los cuales solo el 2% se reutiliza, a pesar de que se estima que la necesidad de agua en 2030 aumentará en un 40%. Con este panorama, la necesidad de fórmulas que cambien estas cifras resulta innegable. Aqualia lidera **varios proyectos de innovación encaminados a potenciar la economía circular**, a reducir la contaminación o a mejorar la eficiencia energética.

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Información de rigor directamente en tu bandeja de entrada. Suscríbete a la newsletter y lee cómodamente nuestra selección de noticias.

RECIBIR

REGENERACIÓN DE AGUAS MEDIANTE FOTO-FENTON SOLAR, UNA TECNOLOGÍA EN DESARROLLO

Regeneración de aguas mediante foto-Fenton solar, una tecnología en desarrollo

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(Left) Picture of the press article in "La voz de Almería": "Innovación y sostenibilidad: aliadas en el ciclo del agua". (Right) Picture of the press article in "RETEMA": "Regeneración de aguas mediante foto-Fenton solar, una tecnología en desarrollo"