How to generate resources from urban wastewater

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Image of one of the hybrid photobioreactors that will be installed in the Agròpolis. Credit: Universitat Politècnica de Catalunya

The Environmental Engineering and Microbiology Group (GEMMA) of the Universitat Politècnica de Catalunya (UPC) is investigating how to

produce new energy resources and high-value products from wastewater of urban, industrial and agricultural origin through the European project INCOVER. The solutions proposed include energy recovery in the form of methane and the generation of other products such as bioplastics, organic acids, organic fertilisers and water for irrigation. These solutions will be tested in a pilot plant that is being built in the Agròpolis, in Viladecans.

Urbanisation, climate change and pollution, among other phenomena stemming from human activity, pose a threat to water resources. Until now, urban wastewater, of which there is the greatest amount, is in the best of cases treated and then discharged into the environment. It is also sometimes used for irrigation, but in small proportions. For example, in Catalonia, one of the places in Spain where reuse is most prevalent, only 10% of urban wastewater is used to water gardens or crops.

Today, water scarcity and water pollution are major environmental problems that must be addressed. Managing water resources is particularly important in countries in the Mediterranean Basin, and this involves a variety of treatment and reuse strategies and using water resources responsibly.

To address the problems, the EU has launched initiatives to fund innovative ideas. The INCOVER project launched in June responds to the need for new water treatment and reuse solutions. The main aim is to develop innovative and sustainable technologies for treating wastewater that will, in turn, generate value-added products and zero waste.

Wastewater treatment must change its focus from waste treatment technology to resource production technology, as this will contribute to establishing a circular flow economy. The solutions proposed by INCOVER based on alternative treatments for wastewater of urban, industrial and agricultural origin include the recovery of energy in the

form of methane and the generation of other products such as bioplastics , organic fertilisers, water for irrigation and organic acids. These acids, which tend to be produced in the petrochemical industry, are used in food, medicines and chemicals.

Pilot plant in the Agròpolis

In the framework of the INCOVER project, the Environmental Engineering and Microbiology Group (GEMMA), led by Professor Juan García of the Barcelona School of Civil Engineering (ETSECCPB), is building one of three treatment plants in the Agròpolis, an experimental plot of land in Viladecans that belongs to the UPC and whose facilities are part of the Baix Llobregat Campus. The aim of this plant is to treat wastewater using microalgae. This green treatment does not use chemicals and has proven to be very efficient at removing nutrients and other pollutants. The UPC will implement three photobioreactors—transparent, closed production systems—for the development and optimal culture of algae.

Horizontal pipes that make up the return circuit. Credit: Universitat Politècnica de Catalunya

The photobioreactors, which each have a capacity of 10 m3, will be fed with domestic sewage and agricultural wastewater, which will provide the nutrients necessary for the growth of algae and biomass. The biomass will then be separated from the treated water and digested by anaerobic co-digestion for methane biogas production. The richness of the biogas obtained will be much higher than that which results from conventional digestion processes, as it will pass through an absorption column that will retain volatile gases and other pollutants that diminish the richness of the product.

In addition, the solid waste from the digestion will be stabilised in artificial wetlands located in the Agròpolis and will be used to produce organic fertilisers. The wastewater treated in these photobioreactors is subjected to solar ultrafiltration and disinfection and can be used for irrigation.

Algae that produce bioplastics

Another important development in this line of treatment is the ability of certain types of algae—cyanobacteria or blue-green algae—to produce bioplastics. The conditions of the photobioreactors can be adapted to promote the population growth of these organisms, which can synthesise and accumulate bioplastics in the form of granules in the cytoplasm of the cell as a nutrient reserve. The properties of these bioplastics are very similar to those of traditional plastics produced by the petrochemical industry and have the advantage that they are completely biodegradable. Research is being carried out on their use in biomedicine (for prostheses) and particularly the packaging industry.

The line of treatment of this UPC pilot plant is being designed to treat a volume of between 3,000 and 5,000 litres of wastewater, the equivalent of a small residential building. Scientists predict that it will be possible to produce 3.5 kg of bioplastics a day.

Almería and Germany, INCOVER partners

The INCOVER project includes two other pilot plants for research, one in Almería, Spain and the other in Germany. The objectives of the research team in Almería, led by the company AQUALIA, are similar to those of the UPC's line of treatment, that is, to obtain bioplastics, methane, organic fertilisers and water disinfected by solar systems for use as irrigation water. The main difference is that high-rate ponds (open

systems) will be used for algae growth rather than photobioreactors (closed systems). In addition, the solar disinfection systems are different and the treatment for obtaining fertilisers will not take place in wetlands but in tree plantations.

As regards the third line of research carried out in Germany, it does not use algae but yeasts. In this case, bioreactors will be fed with industrial wastewater and will not generate bioplastics but organic acids. Waste from the yeasts will be processed to obtain organic carbon rather than methane and activated carbons rather than organic fertilisers.

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