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A broad range of industries in Europe is extracting valuable materials from wastewater. © DedMityay, Shutterstock.com

From drain to gain: the hidden treasures in wastewater

EU industries from food and drinks to chemicals and biotechnology are seeking to profit from materials in water after it has been used.

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For decades, most of the wastewater from the Mahou San Miguel brewery in the northeastern Spanish city of Lleida was flushed down the drain.

Now the effluent is being used to generate power and heat for the brewery, which is taking part in a research project that received EU funding to make wastewater a reusable resource.

Bits for biogas

Mahou San Miguel, Spain's top beer producer, is using water to clean the Lleida brewery as well as to wash out fermentation tanks and old bottles before recycling and refilling them.

As a result, the wastewater is full of organic matter – so-called biomass – like old beer and bits of hops and grains that can be turned into biogas.

'You have energy in the wastewater in the form of biomass or heat, which you can recover,' said Dr Anne Kleyböcker, a researcher at the KWB water-research centre in Berlin, Germany.

She said industrial wastewater also contains other materials such as nutrients that could be economically valuable as long as ways can be found to extract them.

Kleyböcker helps lead the EU-backed project, which brings together research organisations, universities and businesses from EU countries that also include, among others, Denmark, France, Greece and Italy. Outside the EU, participants come from Israel, Norway and the UK.

On-the-ground action

Called ULTIMATE, the 53-month project is coordinated by a Dutch water-research institute called KWR and is scheduled to run through October 2024.

It centres on pilot plants in the food-and-drink, petrochemical and biotechnology industries. The goal is to show the feasibility of laboratory-developed technologies at scale for extracting materials from wastewater, according to Dr Gerard van den Berg, a project manager and team leader at KWR.

At a citrus-fruit processing centre in Greece and an olive-oil producer in Israel, pilot plants are extracting plant compounds such as polyphenols and antioxidants that can be used as dyes, food additives and supplements and chemical compounds for manufacturing.

Farther north, a chemical installation in France is exploring whether chemicals and metals such as sulphur and molybdenum can be recovered from water used to wash gases generated by the incineration of waste.

Even farther north is a demonstration plant at the Glenmorangie whisky distillery in the Scottish Highlands.

It extracts ammonia and phosphorus to use as fertilisers on local barley fields and harvests heat for reuse in this process from a reactor producing biogas from wastewater.

The wastewater is also purified so it can be reused to clean the distillery.

The cost-effectiveness of these activities varies and in some cases more work is needed to strengthen the economic benefits. In any case, the underlying importance of the actions is that they point the way towards a new and more sustainable method of industrial operations.

Industrial bonds

Kleyböcker said the project is pursuing 'industrial symbiosis' – the notion of different industries exchanging their waste products.

'Before we start to recover something, we already know who needs it,' she said.

Europe has plenty of potential in this area because European countries have many diverse industries situated relatively close to one other, facilitating logistical questions, according to Kleyböcker.

Ultimately, however, the most efficient expression of this whole "circular economy" idea is when businesses extract and reuse materials from their own waste – as Mahou San Miguel is doing in Lleida, which is located about 150 kilometres west of Barcelona.

The use of biogas produced from the brewery's waste to generate electricity and heat for the site has been so successful that the company is expanding the bioreactor.

This will include a step tested under ULTIMATE to improve biogas production by encouraging the growth of a different type of microorganism – electroactive ones.

At present, around 2% of the energy needs of the brewery can be covered by the biogas system. In future, this share could rise to about 6%.

Making it all work

Beyond the technical challenges to water reuse lie organisational, regulatory, economic and social hurdles being tackled by a separate EU-funded project.

Called WIDER UPTAKE, it runs for four and a half years through October 2024. The project is working on a roadmap for widespread wastewater reuse and resource recovery.

'There are a lot of technical solutions out there, but that doesn't help you if there is no value chain downstream of the treatment plant,' said Dr Herman Helness, a senior scientist and water-management expert at Norwegian research organisation SINTEF.

He co-leads WIDER UPTAKE, which is piloting solutions at five demonstration sites. Four of the sites are in European countries – the Czech Republic, Italy, the Netherlands and Norway – and one is in Ghana.

Water check

In the Czech capital Prague, the project is investigating using treated wastewater that is usually pumped into the Vltava River to irrigate parks and other green spaces in the city.

The idea hit a regulatory snag because the Czech Republic has opted against following non-binding EU minimum standards on water reuse for irrigation, according to Helness.

The result is a Czech legal void that prevents the wastewater from being used for irrigation.

The researchers are seeking to show that it is safe to irrigate green spaces with this grade of wastewater.

The pilot scheme has been testing the treated wastewater on various plants and examining the effects it has on their growth as well as on the accumulation of chemicals in the plants and the surrounding soil.

Three variations of the wastewater are used and the outcomes compared: one straight from the treatment plant, another that has gone through an additional nanofiltration treatment and a third that has been nano-filtered and undergone an ultraviolet disinfectant process.

So far, tests have suggested that all three are safe for irrigating plants and flowerbeds, according to Helness.

The hope of the researchers is that this evidence can be used to develop minimum irrigation standards for the Czech Republic.

Branching out

WIDER UPTAKE is also exploring the use of wastewater for agricultural irrigation in Italy and Ghana.

In Norway, the project is examining the recovery of fertilisers and soil improvers from wastewater.

And in the Dutch capital Amsterdam, the researchers are extracting minerals and plant fibres from wastewater to make a bio-based composite material that can be used for products such as park benches and building cladding.

Helness cited a need to alter some local perceptions about the opportunities presented by such activities, saying occasional evidence of bureaucratic reluctance to change practices has emerged during the project.

‘You need to overcome barriers not only in regulations but also in acceptance,’ he said.

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