Environmental-damaging waste from coffee production could be turned into electricity, thanks to BBSRC- and EPSRC-funded research at the University of Surrey.

Dr Claudio Avignone Rossa\(^1\) and his colleagues discovered that if they fed coffee waste to a community of microbes originally found in a wastewater treatment plant, the tiny creatures would eat it, producing energy. This energy could then be captured in the form of electricity.

“We showed for the first time that it is possible to treat coffee waste using a microbial fuel cell,” says Avignone Rossa. “We feed the fuel cells with coffee waste, and most of the compounds that cannot be degraded naturally are degraded by the microbes inside.”

A cooperative of Colombian coffee farmers are interested in installing these on their farms.

Waste water from coffee processing is extremely damaging to the environment, as it contains substances that take a very long time to degrade. This is a particular problem in Colombia, the world’s third largest coffee producer\(^2\), where nearly all coffee is grown on small, family-owned farms. The farmers are unable to afford the large-scale water treatment systems needed to process the coffee waste, so it ends up in local water courses, which become contaminated.

The Surrey researchers have created a waste treatment solution that is simple, inexpensive and made from readily-available household materials including ceramic tiles, terracotta slabs, kitchen foil and cardboard. As an additional benefit, it can generate small amounts of electricity.

“You can build one of these microbial fuel cells for only a few pounds, or even pennies, using materials that are just lying around,” says Avignone Rossa, “and because they are very low cost and easy to construct, you can put several on every farm.”

Coffee production requires vast quantities of water. Around 140 litres of water are needed to produce just one cup of coffee\(^3\), and a large proportion of this is released as wastewater. In Colombia, many coffee farms are far from the main water sources, making it difficult to obtain the quantities of water required. By using microbial fuel cells to clean up their waste water, and reusing it, Colombian coffee farmers could relieve a huge strain on their water supply.

The researchers hope that if their fuel cells are used successfully in Colombia, they may be able to interest large coffee companies in Europe in adopting the same approach to treating their waste.

### IMPACT SUMMARY

Researchers at the University of Surrey used funding from BBSRC and EPSRC to create a microbial fuel cell that converts polluting waste from coffee production into electricity. Microbes inside the fuel cell degrade the organic matter in the waste, breaking it down while also generating electrical power.

A cooperative of coffee farmers in Colombia, the world’s third largest coffee producer, are interested in installing the fuel cells on their farms. Because the devices are simple, inexpensive and made from readily-available household materials, they could easily be built and installed on the small, family-owned farms. This would prevent environmentally-damaging coffee waste from entering and contaminating local water courses.

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9.5bn kg of coffee are produced annually worldwide
Europe consumes around 30% of the world’s coffee, roughly 2.5bn kg of coffee per year, and every kilogram of instant coffee produced generates two kilograms of liquid waste. Because of the large quantities involved, removing environmentally-damaging compounds from this waste and converting them to electricity would have significant benefits.

Early support for Avignone Rossa’s work on microbial fuel cells was provided through the £3.4M Supergen Biological Fuel Cells Consortium 2010-2014, funded by EPSRC.

He subsequently received a £970k award, jointly with Cardiff University, from the Integrated Biorefining Research and Technology Club funded by BBSRC, EPSRC and industrial partners, to establish whether it was possible to use microbial fuel cells to generate electricity from ‘dried distillers grains with solubles’, a byproduct of the bioethanol and whisky industries. The project was a success, and it was this work that led Avignone Rossa to consider using microbial fuel cells to treat coffee waste.

An £18k Newton Fund Researcher Links grant from the British Council allowed Dr Lina Maria Agudelo Escobar from the University of Antioquia in Colombia to spend six months working with Avignone Rossa and his team and provided the necessary funding for them to demonstrate that coffee waste could be converted into electricity using a microbial fuel cell. An £18k portion of Surrey University’s Global Challenges Research Fund Institutional Sponsorship Award from EPSRC then allowed the researchers to construct a small, inexpensive device suitable for use on Colombian farms.

“I depend on funding from UK Research and Innovation for my work,” says Avignone Rossa. “All of my research has been funded by BBSRC or EPSRC, and I’m really grateful for that.”

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