Using bacteria batteries to make electricity

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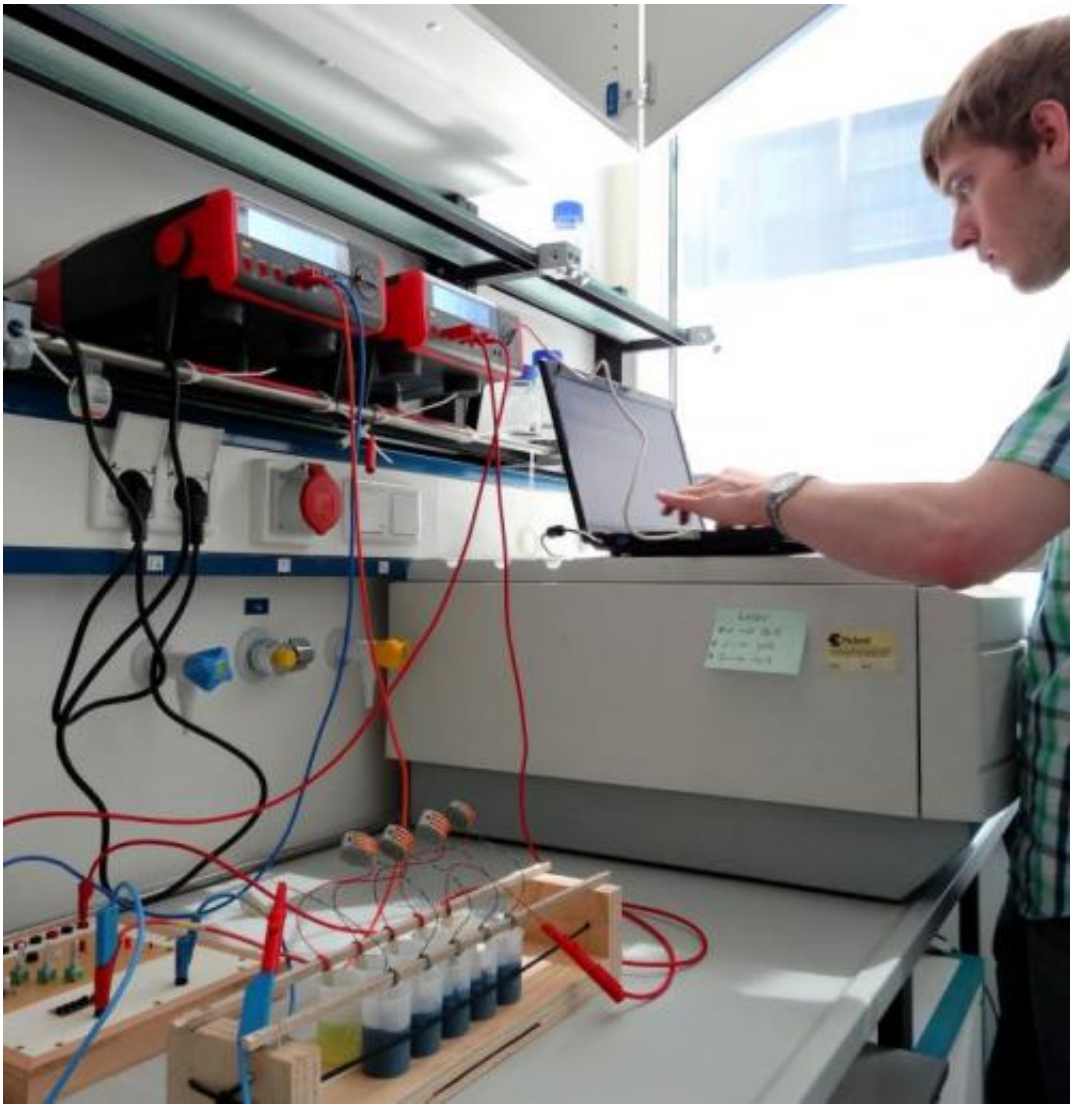

The Bielefeld students produce electricity by using a self-made bio-battery. Besides their normal studies the team members, including Matthias Ruwe, extensive data to develop the project. Credit: iGEM team 2013

(Phys.org) —Their idea is state of the art: Ten Bielefeld students have set their sights on constructing a bio-battery. They want to make use of the bacteria Escherichia coli to convert glucose into energy. With this project, they are taking part in this year's 'international Genetically Engineered Machine competition' (iGEM) at the Massachusetts Institute of Technology (MIT) in Boston, USA. Since May, they have been spending a lot of their free time in the laboratory in order to realise their idea. Now that the first test results are available, the project enters an important phase.

Student Thorben Meyer explains how he and his fellow team members came up with the idea for the project: 'There is an ever-increasing demand for sources of alternative energy. The conservation of fossil fuels and the phasing out of nuclear energy in Germany have sped this process up.' Another consideration was the environmental pollution caused by conventional batteries. 'It is not only large-scale electricity production which pollutes the environment, but also household batteries, which contain many harmful substances. Heavy metals and dangerous inorganic and organic electrolytes can be released into the environment by improper handling of batteries.'

Bio-batteries as an alternative source of energy

For these reasons the aim of the Bielefeld iGEM team is to develop an environmentally friendly bio-battery (Microbial fuel cell – MFC), which directly transforms bacteria into energy. Batteries such as these work in the same way as conventional batteries, but with one difference. The MFC consists of two separate units, the anode and the cathode components, just like the batteries now in current household use. A partly permeable membrane separates the two areas. In contrast to conventional batteries, however, there are bacteria in the anode area of the bio-battery instead of electrolytes. These break down substrates, in this case glucose, in a metabolic process. This produces electrons that

after starting from the anode are finally delivered in an external loop to the cathode. The external circuit is then the one with the battery-powered application, for example, for lights or small motors. In this way, bacteria can produce electric energy. The bio-battery offers an array of advantages. Due to their simple construction they can be used in regions where there is shortage of electricity, for example, such as in developing countries. An advantage that the bio-battery has over other regenerative energy sources, such as solar and wind power is that they are not dependent on the weather. In the case of bio-batteries, the more nourishment the bacteria receive the more energy they produce. What is more, in theory bacteria are an inexhaustible source of energy as they multiply quickly when supplied with substrates.

In the laboratory, the Bielefeld students are investigating various bacterial organisms and their genetic components. Through the combination of differing genes it is possible to optimise the organism Escherichia coli with a view to produce electricity more efficiently. The students can already report initial successes: they have isolated various genes that serve to carry the electrons and begun to construct a suitable apparatus for the production of electricity. They would like to have an optimised bio-battery for small-scale use developed by the time the preliminary European round of the iGEM has been decided.

More than just laboratory work

In parallel to experimental work in the laboratory, the students are also supposed to present their project to the public. According to the competitions' criteria, the team is also expected to find sponsors: Participation fees, travel costs as well as accommodation are estimated to be around 20,000 Euros. The team members have been working on the ambitious project alongside their regular studies. What is it that motivates the ten Molecular Biotechnology and Genome-Based Systems Biology students to be so dedicated? 'The work at iGEM offers the

chance to single-mindedly see a project through and to measure up to outstanding young scientists', Nadiya Romanova says. 'Besides, by participating in this world-wide competition it is possible to get an impression of research processes and innovation in the area of synthetic biology whilst still a student. The iGEM team in Bielefeld has support from Professor Dr. Alfred Pühler, Professor Dr. Erwin Flaschel, Dr. Jörn Kalinowski as well as Dr. Christian Rückert from CeBiTec (Center for Biotechnology) from Bielefeld University.

Extensive and fierce competition

The iGEM competition has been hosted annually at MIT since 2004. What started as a course at MIT has steadily attracted more and more participants, from five teams in 2004 to over 210 this year. 'Internationally, iGEM is the most important student competition in synthetic biology. Its form makes it unique in the world,' sums up Dr Kalinowski. 'Synthetic biology is the latest development in the field of modern biology, and participation in the competition opens the students up to new perspectives. They also have the opportunity to prove themselves against young scientists from around the world. 'The European first round takes place in Lyon, France, from 11 to 13 October. There it will be decided which European teams will go to Boston to take part in the final. This is the fourth year in a row that Bielefeld University has taken part in the competition, successfully presenting itself in Boston from 2010 to 2012. In the previously two years Bielefeld scientists were amongst the best 16 teams in the world.

Provided by University of Bielefeld