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Getting the Bugs Out, a New Approach to Renewable Fuels

By GAYATHRI VAIDYANATHAN of ClimateWire

The *Geobacter* bacterium could be the biofuel-generating machine of the future, producing energy-rich butanol costing as little as $2 per gallon.

A project seeking to accomplish this, headed by Derek Lovley and colleagues at the University of Massachusetts, Amherst, received $1 million in funding today from the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E). It was not even the largest grant, with 37 projects receiving $106 million to further their research in this second round of funding.

The *Geobacter* project is part of a new wave of biofuel generation experiments that feed electricity into tiny critters and generate valuable "electrofuels" as a product.

They replace an older generation of research in which the power of photosynthesis is processed into biofuels, either directly from plants like sugar beet or indirectly from organisms such as algae.

"This is so novel that it doesn't even have a name, but let's call it a reverse fuel cell," said Jeffrey Way, a scientist at Harvard Medical School's Wyss Institute. A Harvard project using the bacterium *Shewanella oneidensis* got about $4 million of the federal stimulus money. It hopes to generate the energy-rich fuel octanol.

'Magic' done on a rooftop

"With standard photosynthesis, there are many steps along the way, and you need arable land," said Lovley. "This you can run on a rooftop."

And so, on a rooftop at UMass, the researchers grow bacteria on the surface of a graphite electrode. A nearby solar panel captures energy and delivers it to the bacteria-laden electrode.

Geobacter and *Shewanella* are uniquely constructed, in that they generate electricity. The bacteria make long protein tubes that jut out of their blob-shaped bodies. In the middle of these tubes are protein molecules that conduct electricity from inside the bacterium to the outside.

When researchers reverse-engineer these tubes to make them take up electrons from the graphite electrodes, the bacteria become tiny fuel cells. A little genetic modification to assemble a photosynthetic pathway within the organism makes them take in carbon dioxide to produce

the right-sized fuel, such as butanol or octanol.

Such engineering is at the frontier of synthetic biology, a field that aims to create novel biological systems from scratch.

"If that sounds like magic, it kinda is," said Way from the Wyss Institute.

This is true, especially in comparison with photosynthetic energy capture. Even on a sunny day, light-harvesting pigments don't capture light very efficiently. And in the subsequent enzymatic steps of photosynthesis, much of the energy is lost as heat. The efficiency of capture is only about 1 percent.

Zapping bacteria to create 'electrofuels'

A solar panel is 100 times more efficient at capturing the sunlight, according to Lovley. Using this input energy, a bacterial system can be used to convert electricity to "electrofuels."

The funding under ARPA-E is for three years, which places the researchers on a tight timeline to bring their projects to fruition before the money runs out, said Wyss.

It is part of an initiative by DOE to stimulate cutting-edge research into new low-carbon energy sources. The funding was announced at an American Recovery and Reinvestment Act Cabinet meeting today by Vice President Joe Biden.

"By investing in our top researchers, we're not only continuing in the spirit of American innovation, but helping build a competitive American clean energy industry that will create secure jobs here at home for years to come," said Biden in a press release.

Among other projects that were funded are efforts to capture carbon dioxide from coal-fired power plants using special absorbents.

Another is to develop a new generation of ultra-high-density, low-cost batteries in a field that is largely stagnating. About $5 million went to ReVolt Technology for its zinc-air batteries, produced in Portland, Ore.

"ReVolt's Recovery Act award, announced today, allows us to accelerate the expansion of our Portland presence," said James McDougall, the company's CEO.

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