"The electricity is their energy source. We all have to have an energy source –theirs is electricity. We all have to have a carbon source – their carbon source is carbon dioxide."

wastewater treatment system. From a microbiology standpoint, that's wonderful. That means you have a very happy, active population of microorganisms that you feed every day, and they've been feeding them for years. So that means you've got them well adapted to do whatever crazy things they're doing in there."

On a rainy day, May and his research assistants collected a batch of the brewery's tiny inhabitants and brought them back to his lab. Fortunately, for May anyway, they had traveled in separate vehicles to the brewery, and he chose to let the students bring the microbes back with them, "because you don't want to smell your car for a week after that stuff's been in there."

From there, it was a matter of configuring the microbes to become proficient at their task by adjusting the amount of voltage to use, proper temperature and pH, and how much carbon dioxide to give them, among other factors.

Eventually, May and his staff begin to observe the brewery microbes drawing noticeable amounts of electric current. "That told us something was off to the races," he says.

Microbes, it turns out, are capable of producing a variety of organic compounds. "It's how we discovered antibiotics, microbes producing antibiotics and antibiotics are pretty complex molecules," May explains. "The microbial world has a tremendous capability to make lots of different compounds, from anything to plastic precursors to fuels to drugs."

What May's microbes have produced so far primarily are hydrogen, acetic acid and methane. Potentially, several other compounds could be produced, many of them with commercial applications, although May says that stage is a long way off. "If we can produce hydrogen acetate, theoretically you could then make ethanol from that. If you can make hydrogen and butyrate, theoretically you could make butanol. Each of those could be a fuel. You could even convert some products into bioplastics," he says.

Acetic acid, for example, already has a huge market in the production of polymers, paints and plastics. The same goes for hydrogen, which can be used as a fuel or as an ingredient in other products.

Then there is the sustainability factor. May's lab uses nothing more than electric current and carbon dioxide to get results. Nothing else, at least at this stage, is needed, making it extremely cost-effective. In fact, based on a hypothetical rate of five cents per kilowatt-hour, May's lab can produce 60 cents worth of acetic acid with only 35 cents of electricity.

'We've gotten a long way on fossil-based systems, but in the long run, there are these issues with carbon released into the atmosphere," May says about current production methods, "as well as someday, you will run out (of fossil fuels)."

The challenge, of course, is to produce a high enough volume of these compounds to make them commercially viable. May has broached that subject with some engineering firms to explore the possibility. Eventually, the solution may be only a short distance from his Fort Johnson location – the Atlantic Ocean.

"The ocean is gargantuan and captures CO2 more so than fresh water" he explains. "If you could build a reactor and use marine water, you could use the CO2 from the ocean and convert it into a useful chemical. I want to see if we can leverage the ocean for this."

May is also interested in the ocean for other reasons. "The diversity of organisms in the ocean is so vast, we may find another microbe out there that will do this very well or make a different chemical. I want to go look."

"So I proposed (that) you could put an electrode in (with microbes) and that could be the energy source for these things. The reason I proposed that because I knew the reverse was true. We can make electricity in an electrode with microbes, but can we get microbes to consume electricity in an electrode, just turn the process around. That was the basis of my hypothesis,"

May's microbes, with a little electric current, can produce a variety of compounds, including hydrogen, acetic acid and methane.