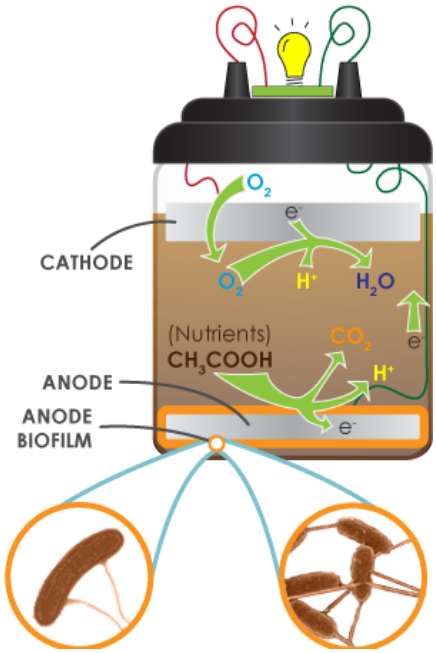
Dirt = Power: An Intro to Microbial Fuel Cells

Microbial fuel cells (MFCs) are bio-electrical devices that harness the natural metabolisms of microbes to produce electrical power. Within the MFC, microbes munch up the sugars and other nutrients in their surrounding environment and release a portion of the energy contained within that food in the form of electricity.

Microbes are thriving throughout virtually all soils, sediments, and streams on the planet. Among these thriving communities of microbes are particular species with unique abilities that enable them to release electrons onto metal compounds, such as rust. In a sense, these so-called "electrogenic" microbes are able to "breathe" metal compounds much like humans and other organisms breathe oxygen. MFCs utilize these unique abilities by providing electrogenic microbes with a certain configuration of two inert, carbon-based electrodes (see Figure 1).

Figure 1. The MudWatt™ Architecture



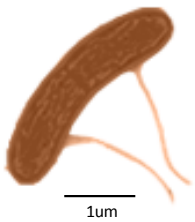
The Anode is buried within the mud, while the Cathode rests on top. In this configuration, a biofilm will spontaneously develop on the anode surface over time resulting in power generation. Soils are naturally teaming with a diverse consortium of microbes, including the electrogenic microbes needed for MFCs, so the MudWatt™ doesn't require any additional microbes. Also, mud is full of complex sugars and other nutrients that have accumulated over millions of years of plant and animal material decay, so there is plenty of food for the microbes to thrive for years. There are two species of electogenic microbes in particular that are often found in soils and sediments

Figure 2. The Key Players

Mr. Clean
(aka *Shewanella*)

Known for their versatility, *Shewanella* species can be found almost **everywhere** on earth, from mountain soils, to ocean sediments. They have an ability to metabolize a wide variety of elements that are toxic to humans, yet they don't cause disease in humans. They even have the ability to metabolize radioactive **Uranium**, precipitating it out of contaminated waters. These abilities make *Shewanella* an ideal bacterium for **bioremediation** processes.

The Iron-Breather
(aka *Geobacter*)



Known as the **"iron-breather"**, *Geobacter* species have the ability to "inhale" iron compounds and use them in a way similar to the way humans use oxygen. In fact, they prefer to live in environments where there is no oxygen, such as deep underground or within ocean sediments. *Geobacter* species have the ability to consume many environmental pollutants, including **petroleum** and **Uranium**, and have been used in many soil and water **bioremediation** efforts.

Once a microbial community forms on the anode, it will start to munch up the sugars and nutrients in the surrounding environment, generating highly reduced biomolecules (i.e. biomolecules with extra electrons attached to them). These biomolecules then donate their spare electrons to the anode in one of three ways, as diagramed on the next page:

1) Direct transfer from the microbe's cell wall to the anode surface

2) Employing a secondary biomolecule to shuttle the electron to the anode

3) Transferring the electron through conductive appendages, termed "nanowires", grown by the microbe. These nanowires can form vast conductive networks, as is shown in Figure 4.

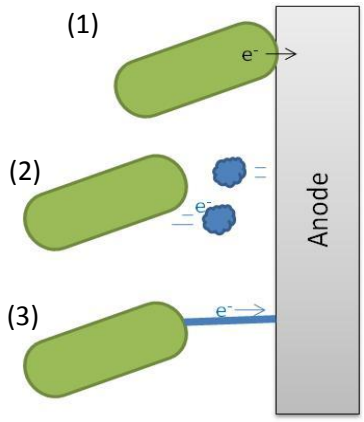


Figure 3 - Microbe-Anode

Figure 4 - A microbial community electrically connected by a vast network of nanowires

Once the electron has been transferred to the anode, it then travels to the cathode, where it reacts with an oxygen molecule and a proton, a byproduct of electrogenic metabolism, to form water (as was seen in Figure 1). Thus electrical current is generated, from which one can extract power by simply placing a load (such as an LED light) between the two electrodes.

Power generation from an MFC is continuous so long as there are nutrients readily available within the anodic media. Using typical topsoil, the MudWatt™ should last for years!

For more information, visit our Community Page at www.keegotech.com/community.

***Disclaimer:** The MudWatt™ electrodes are made of graphite fiber, which is a conductive material and will cause shortages when in contact with electronics. Do not to place the electrodes near electronics or power plugs and use care not to disperse fibers into the air. To minimize risk, Keego Technologies encourages customers to use disposable gloves when handling the electrodes.*