Production of electrical current from plants

Experimental, proposal for one Ph.D. student

Plants use photosynthesis to convert light energy to chemical energy, which is stored in the bonds of sugars they and we use for food. The process takes place in chloroplasts, the cellular light-dependent powerhouses that make sugars. Photons are absorbed by light harvesting antenna of photosystems, and electrical charge separation occurs between chlorophyll molecules of the photosystem II (PSII) reaction center (P680) and primary Quinone an electron acceptor of the PSII in chloroplasts. However, only a portion of the absorbed light energy is used by plants for photosynthetic metabolism. The amount of absorbed light energy that is excessive and cannot be used for CO_2 fixation and sugar synthesis is termed excess excitation energy (EEE). The EEE has to be directly dissipated as light emission by fluorescence or as heat by non-photochemical quenching. Can we use this excessive absorbed energy for electrical current production?

We believe we are able to extract electrons out of the chloroplasts of living plant cells. We are going to use commercially available nanoelectrode made of gold in combination with graphene nanoparticles, for probing inside of growing plant cells and chloroplasts. For this purpose we will use chloroplast coupling factor reduction Arabidopsis mutants, which mesophyll cells possess one or two large chloroplasts instead of 20 or 30 normal (small size) *per* cell. Such large chloroplasts easily resorb nanoelectrodes. From such modified cells, the electrode collected electrons that had been energized by excess light we are expected to generate a tiny electrical current. It may be a first step toward generating high-efficiency bioelectricity that doesn't give off carbon dioxide as a byproduct but it consume carbon dioxide to give electricity. This is potentially one of the cleanest energy sources for energy generation.

Harvesting electrons this way would be more efficient than burning biofuels, as most plants that are burned for fuel ultimately store only about 3 to 6 percent of available solar energy. This process bypasses the need for combustion, which harnesses only a portion of a plant's stored energy.

I am going to apply for one Ph.D. student fellowship to perform proposed experiments.