"Developments, Promise, and Research Needed to Enable the Use of Algae to Monetize CO2 from Coal Power Plants."

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The environmental impact of CO2 emissions is currently putting strong negative pressure on the generation of electric power using coal. As is well known, the CO2 can be monetized if it is used to accelerate the growth of algae, which needs to be dewatered, harvested and converted into fuels. However, currently algae are grown in either raceway ponds, or in small sized pipe, bag or tank photobioreactors. It is generally acknowledged that raceway ponds will not economically produce the amount algae biomass that is needed to significantly reduce the CO2 emissions and to monetize the CO2. Slow growth, dilute concentrations, contamination, land use and sudden death events are key reasons. The algae growth in small diameter pipes, and/or the batch production in narrow tanks or bags will not meet the mass flow needs and is unlikely to be economically viable. Thus, an industrial engineering approach vs. a farming approach is needed. This will require a large-scale closed photobioreactor that can process continually, be temperature controlled, be partially artificially illuminated, and can be stacked rather than spread out.

We present such a system, which carefully integrates the use of plant electricity and waste heat. This approach will require higher initial costs than the pond/bag approach, but as we will show can do the job and have a rapid payback. The patent applied for algal production system presented can be explored now. However, the promise of monetizing this biomass by conversion to a fuel, requires the further development of an in-line continuous flow dewatering process, that can provide the algal biomass with desired water content to either a large-scale High Temperature Liquefaction (HTL) system, and/or anaerobic digestors (AD). The HTL system can result in strong monetization of the algal biomass in the form of crude oil, whereas the well-developed AD process can reduce costs by producing biogas.

A key feature of the new invention is that it requires much lower energy input to accomplish the mixing necessary for optimal algal growth. In particular, the invention puts significant energy into large scale cross-flows which natural turbulence does not do. These new energetic large-scale motions bring the algae to the light, rather than requiring the light to get to the algae in the interior of a photobioreactor, which is the key design limitation preventing the scale-up of traditional photobioreactors.

We discuss the parameters needed to develop a matched continuous flow dewatering system. We also discuss preliminary designs for a matching high-throughput HTL. We present a preliminary economic analysis of the hypothetical "profit center" that can result from the implementation of these processes. Surprisingly, we will show that at $40/barrel for the 'bio-crude oil' created, the capital costs of the algal/HTL based profit center can be recovered in approximately 3 years and will make more money for the utility than the electricity the coal power plant was built to generate; thus, extending the life of the plants, by both reducing CO2 emissions, and at the same time reducing the cost of electricity generation.