Pond Scum or Planet Savers?

Posted by Dave Cohen on January 16, 2006 - 9:07pm
Topic: Alternative energy
Tags: algae farming, bioreactors, carbon emissions, greenfuel technologies, power plants [list all tags]

No, I am not referring to the IEA or CERA. As a change of pace away from the depressing geopolitical news concerning potential oil shocks, this story focuses on bioreactors and oil from algae farming. The title is taken from the story of the same name broadcast by Living On Earth (LOE) for the week of January 13th.

> Pond scum just might be the answer to solving the CO2 woes of the industrial age. Host Bruce Gellerman visits with Dr. Isaac Berzin, founder of GreenFuel Technologies Corporation. Berzin is working on a prototype that uses algae to convert power plant emissions into biofuels.

Here's the audio for the interview (mp3). The primary issue for algae-based fuels is stated succinctly here [Biofutur, No. 255/May 2005 by Olivier Danielo].

> In the context of climactic changes and of soaring prices for a barrel of petroleum, biofuels are now being presented as a renewable energy alternative. Presently, research is being done on microscopic algae which are particularly rich in oils and whose yield per hectare is considerably higher than that of sunflower or rapeseed. At the industrial level, bioreactors which use microalgae to trap CO2 and NOx [NO2, nitrogen oxide] are in active development in the United States....
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> Some species of algae are so rich in oil that it accounts for over 50% of their mass. NREL [National Renewable Energy Laboratory] has selected approximately 300 species of algae, as varied as the diatoms (genera Amphora, Cymbella, Nitzschia, etc.) and green algae (genera Chlorella in particular)....
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> Diatoms, or Bacillariophytes, are unicellular, microscopic algae.... These organisms are widespread in salt water, where they constitute the largest portion of phytoplankton biomass, but they are also found in freshwater. There exist approximately 100,000 known species around the world. More than 400 new specimens are described each year. Certain species are particularly rich in oils.

It's worth noting that NREL, which has been active in algae farming research, has had its funding cut in the most recent federal budget round. However, Greenfuel Technologies anticipates a profitable privatized business for bioreactors. Let's take a look at the true promise of algae farming in the context of high oil prices and climate change.

Conceptually, algae farming is simple as framed by Isaac Berzin of Greenfuels. Here's the bioreactor at MIT.

Smokestack emissions bubble through algae-filled tubes at MIT's Cogen plant (from LOE)

Bioreactors will be co-located with power plants that emit CO2 (carbon dioxide). The CO2 must be sequestered at the plant and fed as an input to the algae farm. From Berzin:

> Actually, in professional terms it's called a bioreactor. It's nothing but three tubes connected together with some sea water and algae in them. And you can see the bubbles bubbling through the system. And you can kind of look at the bubble and follow it, and in the ten seconds or so that the bubbles are spending in the bioreactor 80 percent of the CO2 is moved and 85 percent of the NOX [NO2]. And at the end of the day you harvest the algae, whatever was growing during the day, you take out of the system. It's like a cow you milk it and you make biofuels from the algae.

Sounds pretty good, doesn't it? In fact, the interviewer Bruce Gellerman thought it sounded too good to be true.

> GELLERMAN: So, I was taught, you know, if it sounds too good to be true it usually is. What am I missing?
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> BERZIN: I'll tell you what the problem is. You have to produce algae in a cost that will be cheap enough to compete with fossil fuels. Then you think, wait a minute, what does this technology need? It needs land, and you need water, and you need CO2. So, CO2 is not an issue. You're located next to a CO2 generating facility. Water, you get to use any quality of water. Treated sewage water, brackish water, ocean water, any water available. The third thing is, the land, usually near these big power plants, no one wants to live. It's non-fertile land, nothing grows there even. So, you don't really compete with agriculture. So, how realistic this is? We believe it is realistic.

So, the process requires CO2, water and some unused land. Not competing with agriculture is one

of the stronger points supporting bioreactors, as Olivier Danielo notes

> The production of traditional biofuels requires expansive land surfaces for cultivation. Terrestrial biofuels come traditionally from two sources: oil, produced from sunflower or rapeseed, and alcohol, produced from the fermentation of sugars from beets, wheat, or corn.
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> The production of these biofuels necessitates the use of large tracts of land. According to Jean Marc Jancovici, an engineer specializing in greenhouse gas emissions, it would require a sunflower field 118% the size of France to replace the 50Mtep of petroleum consumed each year by the French for their transportation needs (104% of the size of France for rapeseed, 120% for beet, 2700% for wheat).

Oil from algae requires less land but as Gellerman notes, "theoretically, if you created *an algae bioreactor twice the size of New Jersey*, you could supply the entire petroleum needs of the U.S". So, there's still a small land problem in replacing our fossil fuels with biofuels from algae farms. And of course, bioreactors are not a panacea that frees us from CO_2 emissions. Yes, most of the CO_2 (and NO_2, another greenhouse gas) is captured at the power plant and consumed by the algae. The resulting biofuels can be "used to run engines, or converted into methane or fermented into alcohol". But there is still a problem of course because CO_2 will be released into the atmosphere via downstream tailpipe emissions.

This subject first came up at TOD months ago in a few comments I can't find. A recommended resource advocating producing biodiesel from algae is the UNH Biodiesel Group (University of New Hampshire). This topic also came up in some comments by ericy and joule in response to a previous post Weyburn, CO_2 Injection and Carbon Sequestration. You can find out more about what NREL is up to here.

On the whole, using pond scum to decrease CO_2 emissions (at least at power plants) seems like a good idea. Harvesting eukaryotic algae doesn't put us in much spiritual jeopardy, right? If the technology was intensely used internationally, we wouldn't have *as much to worry about* when it comes to this guy.

This high-tech farming doesn't solve all our woes but it's certainly better than nothing.