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New Small-Footprint Algae Scheme Taps Industrial CO2 for Biodiesel, Maybe FT Fuels

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Contact: Peckham, Jack

Los Angeles-based algae fuel technology developer OriginOil has come up with a scheme that would require vastly smaller amounts of land (compared to pond- or greenhouse-algae schemes) for converting CO2 into methane, biofuels or Fischer-Tropsch fuels.

To develop the scheme, the company announced Feb. 17 that it has signed a cooperative research deal with U.S. Department of Energys Idaho National Laboratory (INL).

The R&D will focus on validation and commercial scaling of the companys technology in the production of algae-based fuels, the company said.

Potentially, OriginOil technology could be employed adjacent to coal- or natural-gas-fired power plants (including integrated gasification combined cycle plants), industrial plants, oil refineries, biodiesel refineries and wastewater treatment plants.

The initial phase, which starts immediately, will focus on the collaborative development of an energy balance model for photobioreactor-based algae systems. OriginOil expects to use this model in the optimization of its algae-to-oil technology as early as the 1st Quarter of 2009, OriginOil said in announcing the DOE deal.

Subsequent phases will center on validation of the OriginOil processes and piloting specific commercial applications.

In an exclusive interview with Hart Energy Publishing, OriginOil CEO Riggs Eckelberry explained that the new joint R&D project aims to come up with estimated costs and estimated energy-balances for producing various end-products including methane (natural gas), oil substitutes, biodiesel and (potentially) syngas for biomass-to-liquids (BTL) Fischer-Tropsch fuels such as diesel and kero-jet.

The simplest and probably lowest-cost pathway for algae-to-fuels would involve tapping the CO2 from an existing natural-gas-fired industrial plant, or employing anaerobic manure digestion. The OriginOil algae process would convert plant CO2 to methane, for re-use at the same gas-fired plant, Eckelberry told us.

A second, parallel initial target would be taking CO2 from biodiesel refineries to feed algae co-located at a biodiesel plant. The resulting algae-oil would supplement or replace vegetable oils (such as soybean, rape, palm-oil) for fatty-acid methyl ester (FAME) biodiesel production.

Because of the replacement of land- and water-intensive crop-oils with algae oil, plus the CO2 recycling factor, such biodiesel plants potentially could earn big, profitable CO2 credits compared to conventional FAME production.

A third target would involve taking wastewater from existing municipal treatment plants to feed a biofuel plant. This scheme possibly trailer-mounted, for space-savings at an existing wastewater plant would take advantage of algaes preference for the nitrates in wastewater.

Key advantages to the OriginOil scheme Very low land-use requirements (compared to pond or greenhouse algae schemes), constant versus seasonal-crop feedstock production, use of artificial lighting (thus enabling round-the-clock production, not relying upon natural sunlight), and unique algae-oil feeding and microwave-assisted cracking schemes. Cracking getting the oil out of the algae is normally a very energy-intensive process, but OriginOil thinks it has overcome key problems.

Because of its unique technologies, OriginOil believes it has advantages over competing algae-oil schemes such as those from Solana or Solarzymes, which would have much bigger land-use requirements, Eckelberry said.

Algae-conversion schemes require huge amounts of CO2 some 2 tons for each ton of algae. They also need lots of light, which explains OriginOils novel Helix Bioreactor lighting scheme.

While artificial light involves an energy penalty versus free sunlight, the OriginOil scheme is more productive, he explained.

The companys cascading production scheme enables continuous production of algae by harvesting 90% of matured algae and allowing the remaining 10% to continue its natural expansive growth to create a new batch.

This eliminates a lengthy incubation period of new algae culture for every batch and can potentially allow for daily harvest of algae oil and mass, OriginOil says.

A commercial-scale plant would have a footprint more like a brewery, rather than thousands of acres of ponds or greenhouses, he said.

Algae go through absorption and respiration cycles, meaning that CO2 feeding must be interrupted occasionally.

Hence the constant CO2 from a baseload coal-fired power plant would first have to go through an emissions cleaning and cooling step and then into storage, before being used in the algae plant, he said. Alternatively, the algae plant could tap CO2 from landfills or manure digestors, from where it would go into relatively low-pressure (<10 atmospheres) storage.

Yet another alternative would be to tap CO2 stored in solid form, such as calcium carbonate, he said.

For biofuels plants, the algae not only would convert plant CO2 into bio-lipids (for FAME production) but also provide methane that could be burned for plant process heat.

Algae will have documentable CO2 benefits, with more CO2 abatement than using vegetable oils, he said. By substitution of food crops with algae-oil, the food-versus-fuel problem would be lessened as well.

While part of the water required for the algae scheme is converted to oil, most of the water is recycled. This results in a net reduction in water use compared to crop-oil production, he said.

Whats more, algae-oil would be 1,000 times more productive per acre than jatropha oil (considered less water-intensive than soy or rapeseed), he said.

While wind and solar power are often touted as renewables of choice, algae-based biofuels plants would be less capital-intensive, could be located in urban areas (because of ultra-low emissions), and could be built relatively quickly, he said.

The algae produce only oxygen (and no foul odors) as a byproduct. If however the oils are converted to fuels or the methane burned for electric power, then the same criteria emissions limits applicable to turbines or refineries would equally apply.

If wastewater is tapped for the process, then the resulting water-cleaning performed by the algae also could generate extra revenue (or avoid costs) for a municipal water-treatment plant, he said.

While OriginOil and DOE have yet to complete their cost studies on making algae-oil, preliminary calculations indicate that we probably can make it at a similar cost range to crude oil, he said.

But in the early days, well need CO2 credits and synergies with plants that could trade their CO2 off-gas in exchange for useful fuels such as methane or biodiesel.

We have an idea of the cost per barrel and its pretty high, he said. However, with dollars earned from CO2 credits and biofuels credits (such as the $1/gallon U.S. credit for biodiesel), the technology seems likely to be competitive, he said.

Compared to the cost of vegetable oils for FAME, Im confident it [algae oil] will be far more cost-effective, he said. One big advantage No transportation cost for hauling soybeans to a processing plant, and then hauling soy-oil to a biodiesel plant, since the algae plant would be co-located at the FAME plant.

OriginOil hopes to find a partner for a field demonstration plant in 2010, then it hopes to move to commercial-scale in 2011 or 2012, he said.

The company doesnt want to build plants but rather provide technology, much as Microsoft sells software but not computers, he said. Jack Peckham