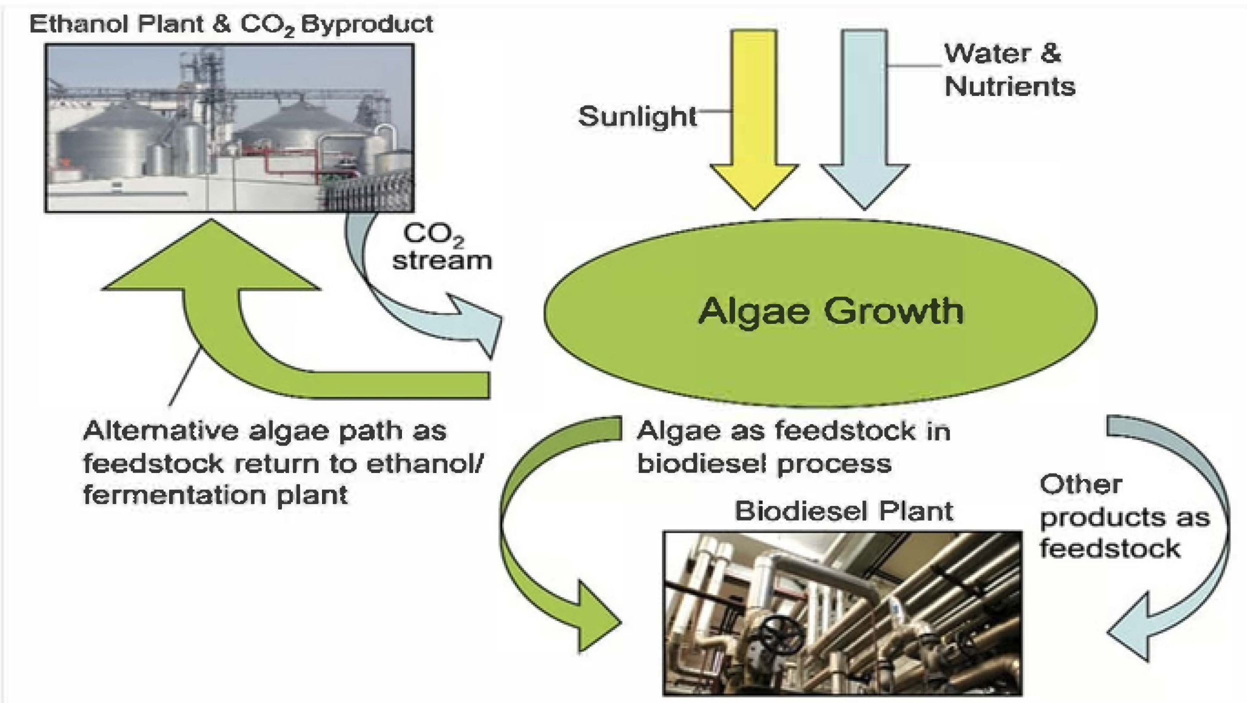

Feedstocks Evolve with the Production of Ethanol

By **Sam A. Rushing** on May 10, 2010

The future of ethanol production in the US is from cellulosic- and algae-based feedstock facilities. By-product CO2 (crude feed) from these plants will be a target of sequestration projects, used as feedstock for liquid merchant CO2 plants, and used in industrial processes such as enhanced oil recovery (EOR) and coal bed methane (CBM) projects.

In the US, the ethanol production is rapidly evolving away from the grain-based, or first generation, feedstock facilities, to second generation biofuels derived from crop byproducts or biomass, and third generation fuels derived from algae *(see "Trash to Treasure," CGI February 2010, p. 30).*

The corn-based production of ethanol, a commodity in increased demand as an oxygenate in gasoline blending, has been in rapid development in the US for many years. However, beginning in 2007, numerous factors — including the collapse of financial capital markets, changing farming practices, uneven commodity prices for corn in the US, and politics — brought corn-based ethanol plant developments practically to a standstill. To a large extent, what changed the appetite for financing grain-based ethanol projects is the so-called "food versus fuel" argument and the US ethanol industry, like much of the world, is moving to non-grain (food) feedstocks for ethanol plants.

Second generation biofuels, often referred to as cellulosic, include a wide variety of feedstocks ranging from biomass to wood to grasses to MSW (municipal solid waste), and are made from a variety of processes like acid–hydrolysis and enzyme-based production. Sourcing CO2 from an ethanol plant that is MSW-based can raise concerns. While CO2 supply to strictly industrial service, such as EOR, uranium leaching, or CBM projects, would not be a problem, CO2 sourced from a waste-based plant would be unacceptable to food and beverage service, despite the ability to conceivably purify it to meet beverage standards.

Third generation, or algae-based, projects extract oil from algae for biodiesel use. After extracting the oil from algae, the remains of the algae can go back as a feedstock for the cellulosic ethanol production, or the raw algae with no treatment could potentially be used as a cellulosic feedstock *(see Figure 1).* Over the last few years, numerous second and third generation biofuel pilot and demonstration processes have been evaluated, plants opened, and processes and technology proven to be commercially feasible.

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An exception to the second and third generation biofuel movement is the Osage Bioenergy facility in Hopewell, VA, which will recover CO2 for the merchant market. This project will use regionally supplied winter barley, a first generation biofuel, as its feedstock and is scheduled to be completed in 2010. However, I see the Osage project as a transitional facility and believe it is only a matter of time before the cellulosic and nongrain biofuel operations become the most common type of ethanol facility in the US — perhaps even within a year or two.

Plant configurations and capacities may change with the shift to second and third generation biofuels. Current day ethanol plant capacities are around 50–100 million gallons per year annually. There are a few planned facilities with capacities of up to 250 million gallons per year, but these are the exception. Some of the new biofuel facilities may be smaller scale and built as modular plants to allow for gradual expansion. A module would have a capacity of 10–30 million gallons annually. With combined modules, full capacity at a modular plant could reach 100 million gallons annually or more, as technologies develop.

The ties between ethanol and gasoline are becoming stronger, with some of the large oil and refining companies making rather dramatic entrances into the ethanol industry recently. Take Valero, which purchased the sizable Vera Sun Ethanol organization for $477million in 2009 and now plans cellulosic ethanol production. Additionally, Sunoco purchased the bankrupt corn-based ethanol plant in Fulton, NY, which never opened. Now known as Northeast Biofuels, this plant has a planned capacity of 600 tons per day and will be a source of CO2 for Linde. Exxon Mobil also has significant plans for algaebased ethanol production with their technology partner, Synthetic Genomics.

BP, Chevron, Dupont, Linde, Shell, and their respective technology partners, Verinium, Weyerhaeuser, Danisco/Genencor, Algenol, Iogen/Codexis, also have funding, joint ventures, or plans for commercializing new cellulosic or algae biofuels processes (*for more on biofuels and industrial gas companies see “What’s the Alternative,” CGI, April 2010, p. 26-27).* While the credit crisis has made it difficult to fund new biofuel projects, the presence of strong companies like these give second and third generation biofuel entities greater economic strength and make them more likely to move ahead.

I believe concerns that the cost of second and third generation biofuels facilities will exceed those of grain-based facilities are speculative. As technologies are refined and improved for cellulosic ethanol processes, the capital cost for these plants should migrate toward the cost of corn–based ethanol facilities. Costs to purify crude CO2 from second and third generation biofuel plants should not be a problem. As mentioned, the purity of CO2 is of importance to one of the largest users of CO2 — the food and beverage industry. However, the raw gas from new biofuel plants should be refined as the grain-based product is today, with feedgas requirements being fairly comparable to what has been in place with grain-based plants. If additional purification equipment is required, this is a small, incremental expense when considering the full cost of a plant. As cellulosic technologies are developed, the scale of plants enlarged, and second and third generation projects become commonplace, the cost of building and operating these plants will drop.

As more ethanol is used to gain domestic energy independence in the US, to boost octane levels in gasoline, and to meet goals or mandates for higher ethanol blends in fuels, ethanol demands are certain to rise. However, CO2 by-product sourced from new ethanol facilities will have to be cost-competitive on a domestic and global stage with other CO2 sources. And within the industrial gas industry, the location of these plants vis-à-vis CO2 markets will continue to determine the value of the by-product CO2.

About the author

Sam A. Rushing is President of Advanced Cryogenics, Ltd, a chemist, and a global consultant to all sectors of the CO_2 industry, as well as cryogenic gases. If you have a CO_2-related or cryogenic project, and need expertise, please call upon the company. Advanced Cryogenics also supplies a full menu of CO_2 and cryogenic equipment, new and used.

+001 305 825 2597, rushing@terranova.net **www.carbondioxideconsultants.com**