Biofuels for Energy Independence

A universal concept for the production of biofuels on a mass scale?

Only a few very well known countries currently enjoy energy independence. Every single country throughout the world, however, has the inherent ability to achieve complete and lasting energy independence on a renewable and therefore sustainable basis. This may be accomplished by adopting the simple agricultural approach of growing vegetable oil crops for the purpose of refining biodiesel fuels. Chuck Steiner, WaterSmart Environmental, USA outlines a concept that could lead to production of biofuels on a mass scale in many regions of the world.

The climate, size, and geographic location of a country are nonfactors if vegetable oil farming occurs within multistory greenhouses that utilize artificial lighting. Biodiesel fuels may be refined to produce heating oil, jet fuel, and vehicle transportation fuels as well as lubricating oils and greases (see **www.biodiesel.org**). Traditional fossil fuels may well become obsolete when greenhouse farming coupled with biodiesel refining produce biofuels at a lesser marketplace price than petroleum distillates.

Biodiesel

Vegetable oil was used as a diesel fuel as early as 1900 when Rudolf Diesel (1858-1913) demonstrated that a diesel engine could run on peanut oil. The name "biodiesel" was introduced in the United States in 1992 by the National SoyDiesel Development Board (Now the National Biodiesel Board) which has pioneered the commercialization of biodiesel in the U.S. To his significant credit, Diesel invented the first biodiesel fuel as well as the first compression ignition type engine which now bears his name. Diesel engines are far more efficient than gasoline engines in that for every 100 gasoline miles a diesel engine delivers 170 miles with the same payload.

Biodiesel is a completely natural, renewable fuel which may be substituted wherever and whenever petroleum diesel is used. Even though diesel is part of its name, there are no petroleum or other fossil fuels in biodiesel. Biodiesel is 100% vegetable oil based and may be made from animal fats, recycled cooking oil, and all virgin vegetable oils. During the past decade this renewable biofuel has been gaining worldwide popularity as an alternative energy source because of its many performance and environmental benefits. It is formed by removing the triglyceride molecule from vegetable oil in the form of glycerin. The biodiesel molecules are very simple long chain hydrocarbons which contain no sulfur, ring molecules, or aromatics associated with fossil fuels. Biodiesel is made up of almost 10% oxygen making it a naturally "oxygenated" fuel. At this time the marketplace price of biodiesel is about twice that of petroleum diesel. Its use is therefore limited to the blend market which consists of a 2-20% blend of biodiesel with petrodiesel to improve the environmental performance of the combined fuels. In order for biodiesel to compete head on with petroleum diesel its marketplace price must be reduced substantially below that of petroleum diesel.

The efficiencies of vegetable oil farming and biodiesel refining are eligible for enormous improvements by adopting a comprehensive holistic approach to both. It is the combination of these improvements which can lead to a fivefold decrease in its marketplace price, or less than half that of petroleum diesel. Here's how.

Multistory greenhouses

Vegetable oil farming can be significantly improved by utilizing multistory greenhouses and artificial lighting. The greenhouse environment enables complete control of soil matrix, humidity, lighting, temperature, ventilation, nutrient additions, soil moisture, pests, and weeds. The result is four or more crops/year in the case of soybeans with virtually no vegetable oil loss due to growing conditions. Pesticide use can be totally eliminated as a practical matter. By utilizing economical multistory concrete construction, the volume of vegetable oil may be increased as desired by adding more floors. After each soybean harvest, significant quantities of agricultural debris remain as solid wastes. If the soy oil is extracted utilizing steam, highly efficient vegetable oil extraction is achieved. Steam extraction produces a high organic strength liquid waste stream. A 100 acre 12-story greenhouse would support the production of about 225,000 GYP of biodiesel and the generation of about 10,000 kWh/day of excess electricity to place the technology into economic perspective. Larger greenhouses would tend to be more productive and efficient because of the economies of scale.

Biodiesel refining can be immediately started with the already hot vegetable oil thus eliminating a heating step. After refining, the 20% remaining glycerin represents a waste stream as there is already a growing worldwide glut of this byproduct. The Btu content of the hot biodiesel can be captured for greenhouse heating purposes.

A soy bean crop. (Photo: Don Farrall/Getty Images)

Sustainable processing

The Institute of Gas Technology (now known as the Gas Technology Institute, see **www.gri.org**) is the organization that first developed two-phase anaerobic digestion technology. Two-phase anaerobic digestion produces the three co-products of methane gas, carbon dioxide gas, and organic fertilizer. WaterSmart Environmental further improved two-phase anaerobic digestion by adding the two co-products of liquid fertilizer concentrate and reverse osmosis permeate water. Making electricity, steam, methane gas, and water is achieved by the two-phase anaerobic digestion of the agricultural debris and already hot high organic strength liquid waste stream from vegetable oil farming and the already hot glycerin from biodiesel refining

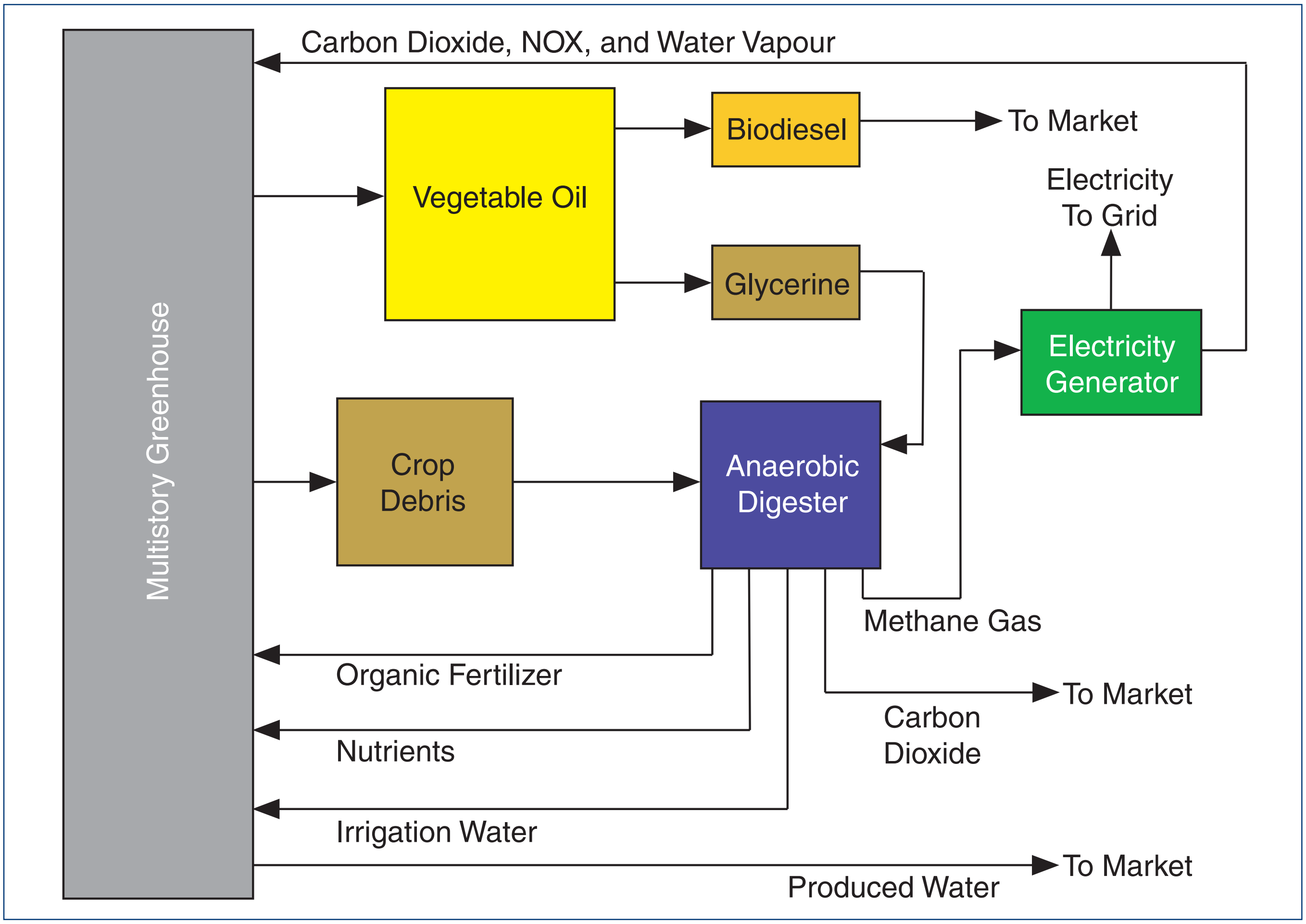
The methane is used to generate electricity and to fuel the steam boiler. The waste heat from the electricity generator is beneficially utilized to make additional steam. Before using the steam for oil extraction it is routed through a steam turbine generator to make additional electricity thus accomplishing highly efficient combined cycle electricity generation. The liquid fertilizer concentrate is beneficially utilized by recycling it back to the vegetable oil farm. If soybeans are grown as the vegetable oil crop the ammonia-nitrogen is stripped out and sold since soybeans fix their own nitrogen requirements. The pathogen free organic fertilizer is recycled as soil matrix. The hot carbon dioxide gas is beneficially used for greenhouse heating and to enhance plant growth. The hot exhaust gas from the methane gas generator is routed though catalytic converters to oxidize the carbon monoxide to carbon dioxide. The hot CO_2 and NO_x gases are beneficially used for greenhouse heating and to enhance plant growth.

While generating electricity, carbon dioxide and water are always combustion products in the ratio of 1 mole of methane (or its chemical equivalent) to 2 moles of water. This is the equivalent of 1 gram of methane to 2.25 grams of water. The capture of water through dehumidification equipment makes each biodiesel production facility water independent on a sustainable basis. Each one megawatt of electricity generation (24 MWh/day) permits the capture of about 3,200 gallons/day of combustion produced water vapour. Some of the carbon dioxide gas is used as a refrigerant for cooling purposes. Every co-product from two-phase anaerobic digestion and electricity generation is beneficially used. None are discharged to the environment or wasted. As an approximation, the energy attributable to electricity generation is about five times greater than that represented by the finished biodiesel. Each biodiesel refining facility therefore becomes a significant generator of electricity on a distributed basis.

Other benefits

The same greenhouse complex may be expanded to grow a variety of vegetables and flowers; for fresh water fish farming; and for pigs, dairy cows, beef cattle, and poultry production. Required odour control is easily achieved by using the odour laden air as combustion gas intake air thus accomplishing thermal destruction of all odours. Reverse osmosis permeate water is recycled as excellent livestock drinking

The greenhouse environment enables complete control of soil matrix, humidity, lighting & temperature



Comprehensive holistic material processing

water. Biodiesel refining site animal food processing may also be accomplished since 100% of the associated waste products may be added to the anaerobic digestion process. Lastly, portions of the same greenhouse may be dedicated for employee housing since all utilities are readily available from the biodiesel refining process to achieve total climate control. Sufficiently expanded into produce, fish, and animal production, distributed biodiesel refining facilities may be viewed as providing food independence as well as energy and water independence.

Prime real estate is never ever required as the biodiesel refining facilities may be located on the high plateaus of Tibet, within the jungles of Bangladesh, and at landfills in Europe, the United States, and elsewhere. The only geographic consideration is the necessity to install power transmission lines to transport the generated electricity to a utility grid and access roads to transport the biodiesel and food to the marketplace. Once the electricity, biodiesel, and food satisfy the market demand within the country of use, excess electricity, excess biodiesel, and excess food may each be managed as quite profitable export products.

The way forward?

Anaerobic digestion is old technology having been around for several centuries, especially in China. The cited improvements in this article coupled with the beneficial, comprehensive, and holistic management of waste products are cumulatively responsible for achieving energy independence on a sustainable basis. All of the supporting science already exists. Likely future development of this technology will likely consist of constructing a 100 acre two-story demonstration greenhouse to establish the validity of all pertinent features, i.e., four crops/year, recycling of nutrients, carbon dioxide, NO_x, and irrigation water. Electricity generation and biodiesel yield/acre will also be established along with construction costs and facility operational expenses. This size facility will also establish the feasibility of adding additional future floors to increase production. Ten to fifty story greenhouses of 1km x 1km in area are viewed as a minimum size because of the economies of scale. After the demonstration facility establishes technology viability, additional development will likely be pursued rapidly by many countries.

The proposed energy independence, in turn, can wholly support the future massive industrial growth that is now trying to occur throughout Asia. Compliance with the Kyoto protocols occurs automatically as the biodiesel refining and electricity generation technologies are both environmentally benign. Significant permanent jobs are created and export opportunities are created. Governmental subsidies are not required as the technology manifests an excellent return on investment. There are no political, environmental, or economic downsides that have been identified. The proposed energy independence technology will be marketed on design-build-operate (dbo) and design-build-own-operate (dboo) bases depending on the country of use. The proposed technology is expected to be fully operational in the United States within three years.

Contact: Chuck Steiner, WaterSmart Environmental Inc., PO Box 26346, Shawnee Mission, Kansas 66225-6346, USA. Tel: +1 913 897 2727; Fax: +1 913 897 1902; H2Osmart@ix.netcom.com; www.watersmart.com