

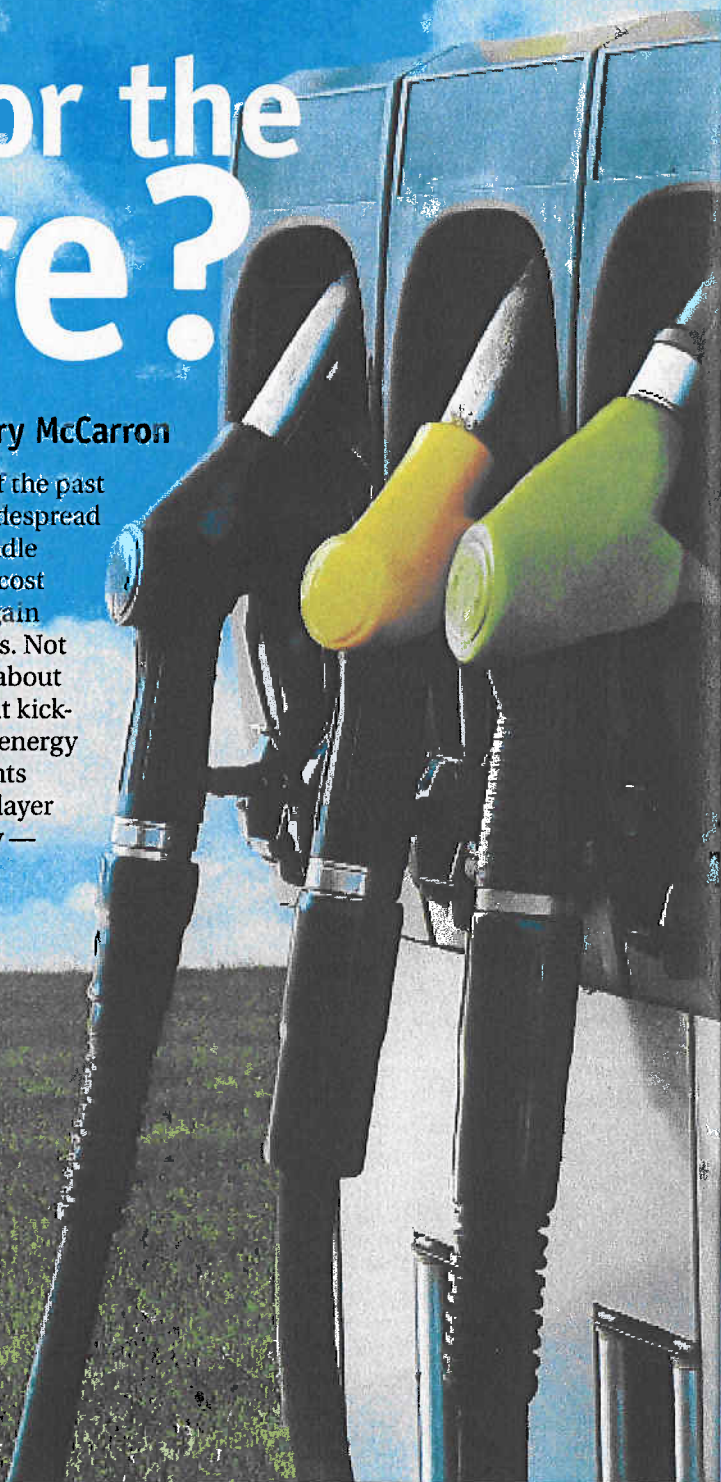
## FEATURE

Emerging technologies can use MSW and C&D wastes to produce cleaner, cheaper truck fuels. However, these technologies have yet to become available on a commercial scale.

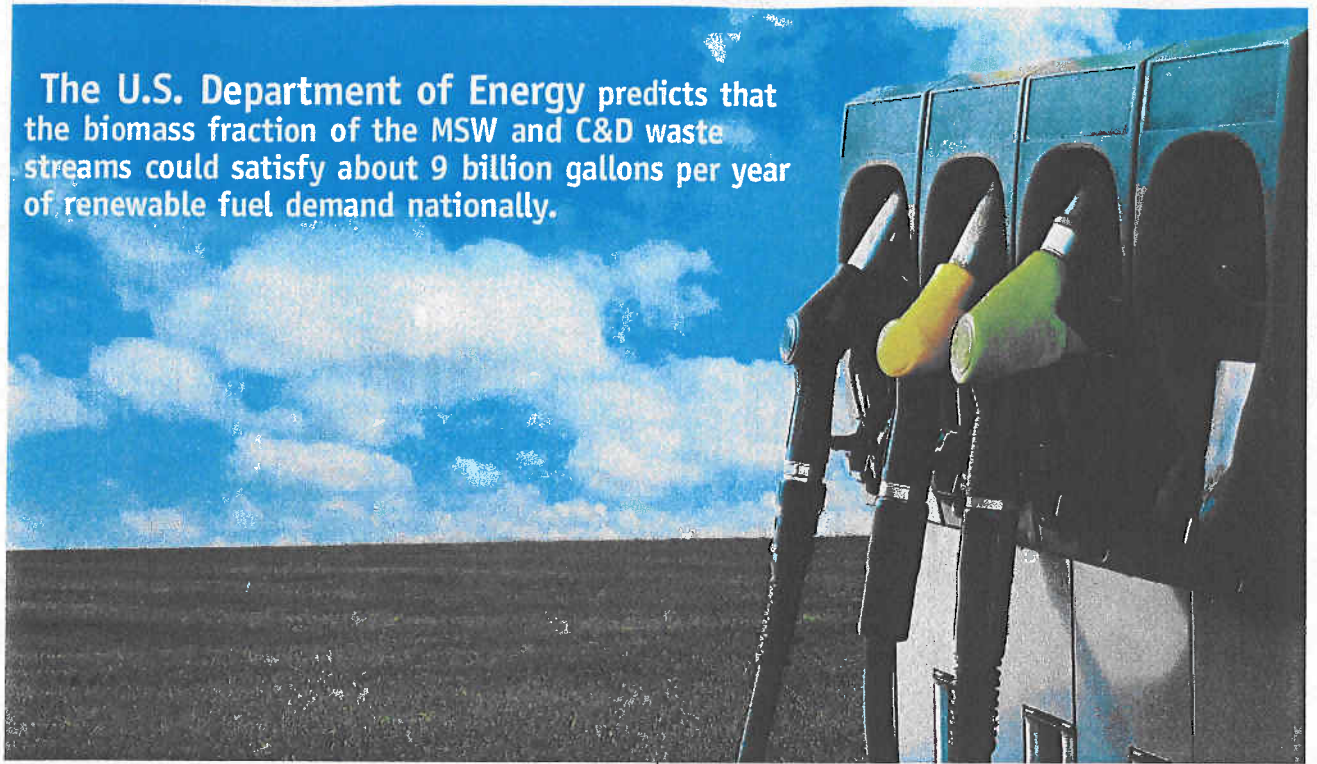
# Fuel for the Future?

BY Bruce Clark, Marc Rogoff AND Gregory McCarron

**W**ith the price spikes of the past few years and the widespread instability in the Middle East, the supply and cost of petroleum once again top national concerns. Not unlike the concerns about disposal capacity that kick-started the waste-to-energy (WTE) industry in the 1980s, these developments could very well spark interest in another player in the emerging waste conversion industry — the waste-to-vehicle-fuel plant.



The U.S. Department of Energy predicts that the biomass fraction of the MSW and C&D waste streams could satisfy about 9 billion gallons per year of renewable fuel demand nationally.



Renewable vehicle fuels can be produced from feedstocks such as:

- biomass, meaning harvested plants, agricultural and forest product residues; and certain solid waste streams, including wood from the construction and demolition (C&D) waste stream, and paper, cardboard, grass and other green waste, food scraps, and textiles from the municipal solid waste (MSW) stream; and
- fats, oils and grease residues from the food industry.

The production of vehicle fuel from MSW and C&D biomass offers the potential of alternative waste diversion opportunities for haulers and communities, as well as the potential for cleaner and cheaper fuel for their fleets. However, the technologies to produce vehicle fuels from MSW and C&D biomass are not proven on a commercial scale — although they are inching closer in Europe — and more widespread availability of such fuels is at least several years away in the United States.

### Background

Like their close cousins that focus on the production of electric power, steam heat and by-products that are converted to alternative building materials, some of these renewable fuel plants also employ technology that is not necessarily “new.” For example, decades ago, U.S. companies and research institutions invested in assessing the potential of converting the United States’ vast supply of coal to liquid fuels, employing a gas-to-liquid (GTL) technology based on the Fisher-Tropsch (F-T) synthesis reaction. The F-T synthesis reaction to produce diesel fuel from coal was developed in the 1920s and commercially applied in Germany for fueling vehicles in World War II and later in South Africa in the 1960s.

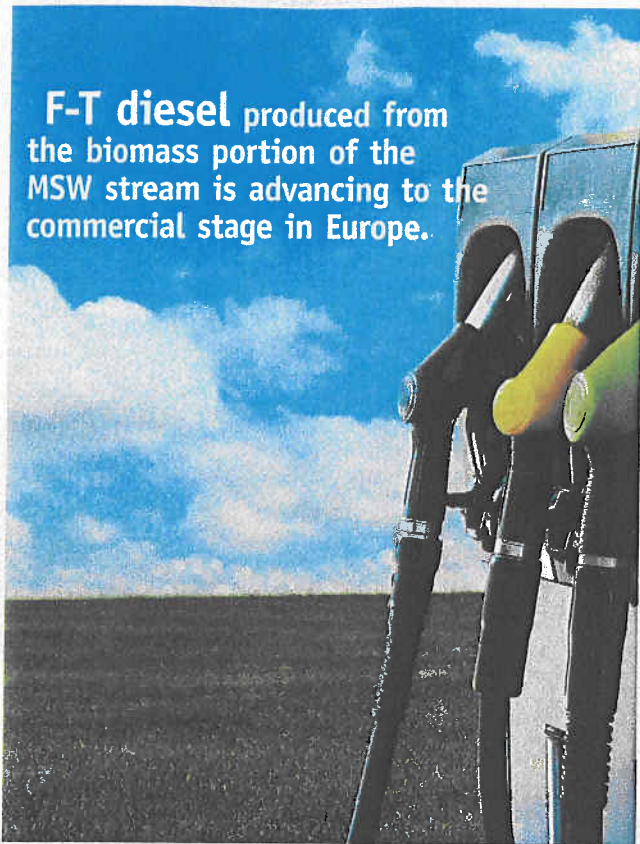
As the U.S. government’s emphasis faded, and foreign oil supply and prices remained relatively stable, further research and development on F-T diesel in the United States was reduced. It was not until the last decade or so — when rising petroleum prices, tighter air pollution regulations

and an intensified focus on greenhouse gases and climate change emerged as pressing national issues — that interest in producing diesel using the F-T synthesis process was renewed. Also, the United States’ potentially huge supply of non-food-crop biomass in virtually all regions could provide for the long-term, large-scale output of F-T diesel fuels and other fuel products. And, as you might expect with the driving factors aligning more recently, the interest in converting the biomass fraction of the MSW and C&D waste streams has been on the rise too. The U.S. Department of Energy predicts that the biomass fraction of the MSW and C&D waste streams could satisfy about 9 billion gallons per year of renewable fuel demand nationally.

The ready availability of biomass from MSW and C&D waste as a feedstock for F-T synthesis through established collection infrastructure and the revenue potential from lucrative tipping fees may be factors in this renewed interest, at least to some companies. Petrochemical companies, other energy companies and research institutions in Europe, Asia and the United States have been working on perfecting the production of F-T diesel from biomass feedstocks. This has come to be known as one type of biomass-to-liquids (BTL) technology.

There are also a few BTL plants, using other technologies in development, that will use MSW feedstock to produce ethanol for blending with gasoline. These are significant but likely to mostly serve the car and light-duty truck markets. These are not to be confused with another (non-MSW and non-C&D waste processing) technology — esterification — that emerged in the 1980s and is used to produce biodiesel from oil seed plants (i.e., canola, soy bean, etc.) and post-consumer oils (i.e., cooking oil). There are several large biodiesel refineries currently operating in the United States that use the esterification process. A small biodiesel plant operated for a few years and provided fuel for the Denton, Texas, municipal fleet. It stopped operation in 2009 as a result of difficulty obtaining quality feedstock at a competitive price.

**F-T diesel** produced from the biomass portion of the MSW stream is advancing to the commercial stage in Europe.



### The F-T Process

The overall process of converting biomass such as that found in the MSW and C&D waste streams to fuel using F-T synthesis employs a series of processes that begins with gasification of the biomass. A gasifier decomposes the biomass in a vessel using high heat, pressure and limited air introduction, and reforms it by mixing it with steam to produce "biosyngas" composed mostly of carbon monoxide and hydrogen. The biosyngas is cleaned and conditioned and sent into a vessel where the F-T synthesis takes place, which results in the conversion of the biosyngas into a liquid.

The liquid is upgraded and then refined in a final step to produce diesel. The F-T synthesis also can produce jet fuel, kerosene and fuel oil, and other useful products such as paraffin and glycerin for the petrochemical and manufacturing industries. Electric power also can be produced from the capture of waste heat and residual exhaust gases generated from the process. The advantage of the BTL route lies in the ability to use almost any type of biomass, with little pre-treatment other than moisture control.

Positive attributes in federal government tests of F-T diesel include low emission rates of sulphur, nitrogen oxides and particulates, very low aromatics, and excellent compatibility with petroleum diesel and existing storage and distribution equipment. Thus, it can be used in traditional diesel-fueled trucks. Additives are used to provide lubricity. Life cycle carbon dioxide emissions are 90 percent lower than with petroleum diesel. An environmental issue with F-T diesel focuses on total energy production requirements, which may not be any better than petroleum diesel. Also, F-T diesel from biomass has not yet



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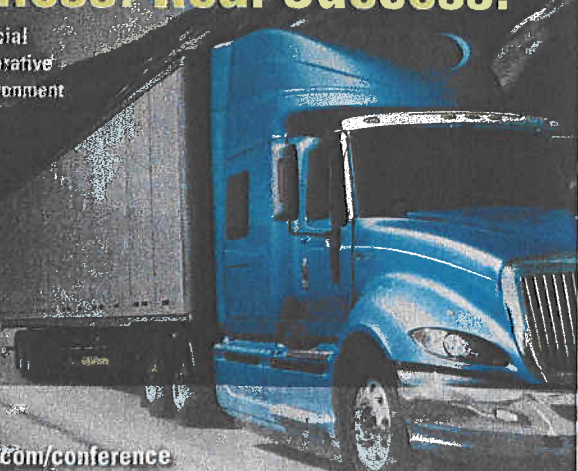
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been recognized as an alternative fuel by the U.S. Environmental Protection Agency (EPA).

### Overseas

Large-scale F-T diesel plants using certain biomass feedstock are operating in Europe. A plant developed by Choren Industries in Freiberg, Germany, the world's first, processes approximately 68,000 metric tons of woody biomass. Liquid fuel output reportedly is approximately 78 U.S. gallons per ton of waste. F-T diesel produced from the biomass portion of the MSW stream is advancing to the commercial stage in Europe. Solena Group Inc. is in the site selection process for a plant in London, England, that the firm says will divert up to 500,000 metric tons of MSW per year from landfills and produce up to 16 million gallons of jet fuel for the British Airways fleet, 9 million gallons of naphtha (a chemical feedstock for producing high-octane gasoline) and 20 megawatts (MW) of net electric power. Start-up is slated for 2014. Carbon reduction resulting from use of the fuel is estimated to be 550,000 metric tons annually when compared to the use of petroleum-based jet fuel. The facility and associated industry are expected to create up to 1,200 new jobs (200 of which will be permanent). The plant is anticipated to save local authorities the equivalent of about \$50 million in landfill disposal costs.

### Other BTL Technologies

Other technologies can be used to produce renewable fuels from MSW feedstock. In 2008, Green Power Inc. constructed in 2008 a pilot-scale plant in Washington state for producing 12,000 gallons of diesel fuel supplement from 150 tons of

unsorted MSW. The MSW was mixed into a hot oil bath with an unknown catalyst which released hydrocarbons that are further refined into fuel. State regulators forced the plant to stop operation in 2009 over air pollution violations after only a brief run. It is not clear if the plant will be operable again.

### Smaller Scale F-T Synthesis Fuel Plants

Current barriers to F-T diesel production for smaller-scale, localized plants that are compatible with the solid waste collection and disposal systems of many communities include optimizing the F-T reactor and catalyst performance, and increasing efficiencies to reduce relatively high production costs. To that end, Oxford Catalysts Group, based in England, has been working on a novel catalyst and a modular, smaller-scale F-T synthesis reactor. Oxford Catalysts news indicates that a commercial plant that will produce about 1,000 gallons per day of F-T diesel has been shipped for assembly to SGC Energia, a Portuguese bioenergy company. Scaled-down commercial plants (i.e., those that produce from 25,000 to 250,000 gallons per day) to serve U.S. municipalities could be available in several years. ■

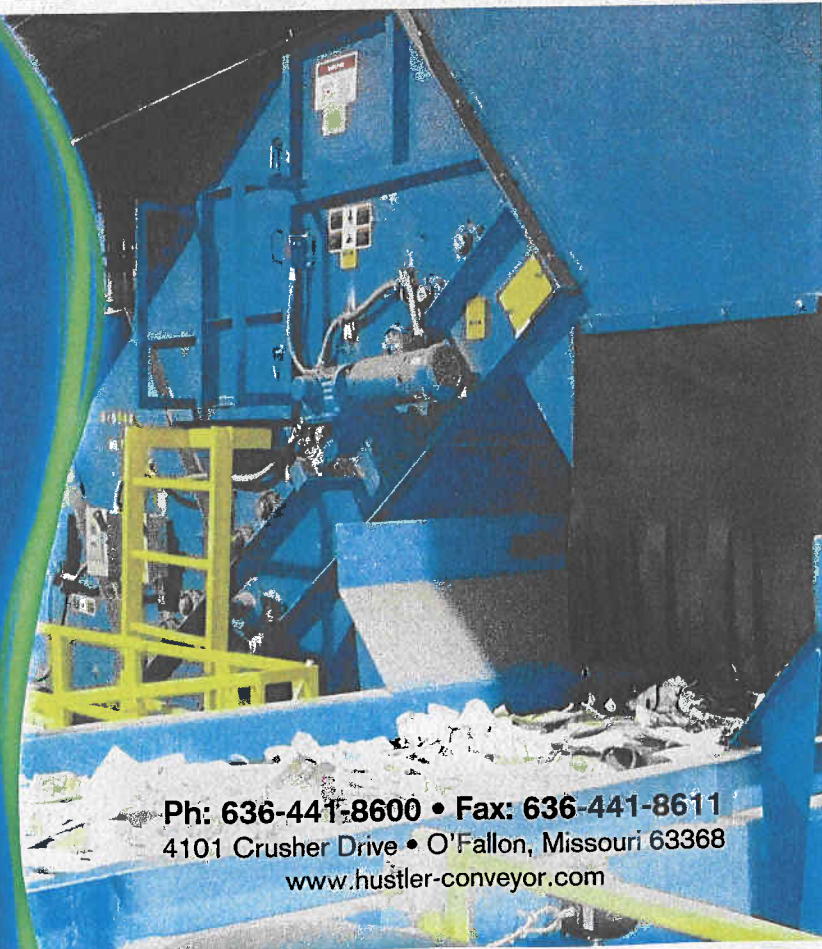
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