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THE ENERGY CHALLENGE

Fuel Without the Fossil

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DENVER — Mitch Mandich proudly showed off his baby, a 150-foot contraption of tanks, valves, hoppers, augers and fans. It hissed. It gurgled. An incongruous smell wafted through the air, the scent of turpentine.

Mr. Mandich's machine devours pine chips from Georgia and turns them into an energy-rich gas, a step toward making liquid fuels. His company, Range Fuels, is near the front of the pack in a technology race that could have an impact on the way America powers its automotive fleet, and help ameliorate [global warming](#).

"Somebody's going to hit a home run here," Mr. Mandich said. "We want to be first."

For years, scientists have known that the building blocks in plant matter — not just corn kernels, but also corn stalks, wood chips, straw and even some household garbage — constituted an immense potential resource that could, in theory, help fill the gasoline tanks of America's cars and trucks.

Mostly, they have focused on biology as a way to do it, tinkering with bacteria or fungi that could digest the plant material, known as biomass, and extract sugar that could be fermented into ethanol. But now, nipping at the heels of various companies using biological methods, is a new group of entrepreneurs, including Mr. Mandich, who favor chemistry.

They believe techniques borrowed from oil refining and other chemical industries will allow them to crack open big biological molecules, transforming them into ethanol or, even more interesting, into diesel and gasoline. Those latter fuels could be transported in existing pipelines and burned in existing engines without fuss. Advocates of the chemical methods say they may be flexible enough to go beyond traditional biomass, converting old tires or even human waste into clean transport fuel.

In Madison, Wis., a company called Virent Energy Systems is turning sugar into gasoline, diesel, kerosene and jet fuel, with the long-range plan of obtaining the sugars from biomass. In Ontario, Dynamotive Energy Systems is turning biomass into a form of oil, and in Chicago, a [Honeywell](#) subsidiary called UOP is doing something similar. In Irvine, Calif., BlueFire Ethanol is using acid to break down organic material for conversion to fuel.

Possibilities like these are coming to the fore at a time when rising oil prices have created an incentive to develop substitute fuels. Making them from biomass would be environmentally friendly in that, unlike standard gasoline or diesel, the fuels would not take long-stored carbon from underground and dump it into the air as carbon dioxide.

And unlike making ethanol from corn kernels, these techniques do not require significant amounts of natural

gas or coal. Carbon dioxide, emitted in large volume when people burn fossil fuels, is the primary culprit in global warming.

Lately, these factors have resulted in a flood of investment capital into both biological and chemical techniques for using biomass. Experts consider both approaches promising, and they say it is too early to tell which will win.

“It’s not obvious, and I don’t think it will be obvious for a very long time,” Andrew Karsner, the assistant secretary of energy for energy efficiency and renewable energy, said in Washington. His department is awarding grants to support both approaches.

Experts say it is possible that more than one type of plant will reach commercial success, with the ideal technique for a given locale depending on what material is available to convert to fuel.

Range Fuels favors pine chips and other waste from softwood logging operations, largely because there is so much of it. Logging in Georgia, for instance, leaves behind about a quarter of the tree. “Bark, needles, cones, we use all of it,” said Mr. Mandich, chief executive of Range.

Range is a privately held company whose chief scientist, Bud Klepper, has been working on the two problems, creating gas from biomass and then converting it to liquid fuel, since the 1980s. The company is heavily backed by Vinod Khosla, a Silicon Valley venture capitalist who has turned his focus to energy investments.

Range broke ground this week on the first full-scale biomass-to-fuel plant in the United States, in Soperton, Ga. “Today marks the beginning of a new phase of our effort to make America more energy secure,” the secretary of energy, Samuel Bodman, said at the event. The plant, its cost not publicly disclosed, is expected to produce 20 million gallons of ethanol a year, with more capacity to be added later.

In Georgia alone, enough waste wood is available to make two billion gallons of ethanol a year, Mr. Mandich said. If all that material could be captured and converted to fuel, it could replace about 1 percent of the nation’s gasoline consumption.

Biomass of various types is abundant in every state, some of it gathered daily by garbage trucks. A study two years ago by the Oak Ridge National Laboratory found that enough biomass is available in the United States to replace more than a third of the nation’s gasoline consumption, assuming the economics can be made to work.

The Bush administration is counting on biofuels to help limit the growth of petroleum demand, and environmentalists routinely include such fuels in their forecasts as a way to reduce carbon dioxide emissions. But to date, no one has shown that fuels from biomass can be made profitably, even when competing with gasoline at \$3 a gallon.

Daniel M. Kammen, director for the renewable and appropriate energy laboratory at the University of California, Berkeley, said, “I suspect we will have a trickle” of fuels from biomass in the next few years. But it will be only a trickle unless the government adopts quotas or offers additional support, he said.

Companies like Range that are trying to convert biomass by chemical methods follow one of two broad approaches. The first is to mix the material with steam to produce a gas known as synthesis gas, consisting of hydrogen and carbon monoxide. With additional processing, that gas can be converted to liquid fuels. The second technique does not break the material down as far, creating a product that resembles oil that can then be refined into liquid fuel.

Research papers and patents are flying these days as scientists struggle to improve these methods. As with oil refineries, the final stages typically produce a variety of chemicals, of varying value, and the trick is to maximize production of the desirable chemicals. “Everybody is dealing with a byproduct they don’t want,” said Arnold Klann, the chief executive of BlueFire.

Range Fuels is one of the companies that turn biomass into a gas before converting it to liquid fuel. The company wants to make ethanol, a form of alcohol, but its technique produces less valuable varieties of alcohol as well. Company scientists are tweaking their approach to maximize the ethanol yield.

The other day, laboratory technicians grabbed samples of a yellow liquid emerging from the machinery and swirled it like a suspect vintage of chenin blanc. An expensive chemical analyzer called a gas chromatography machine stood in the corner. By using it, engineers can calculate what changes in temperature, pressure and flow rates would work best to produce ethanol in a full-scale commercial venture.

Overseeing the operation, Mr. Mandich radiated confidence. “You can’t have so many people at bat without hitting something,” he said.

As the nation seeks to develop new types of fuel, Congress has leaned heavily toward ethanol made from corn kernels, and it is the only alternative fuel available today in large volume. Ethanol benefits from a tax break and a mandate that a significant amount of it be blended into gasoline.

Turning biomass into gasoline would be simpler, requiring no changes in the nation’s cars or pipelines, but federal policy is tilting many research programs toward ethanol.

Range, for instance, could make any of several types of fuel from its pine chips. Asked whether the company chose ethanol for the 51-cent-a-gallon tax break, Mr. Klepper declared: “It’s the American way.”

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