

Zygourakis: Think small for biofuels success

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Rice University professor pushing for distributed use of renewable fuel

BY ERIC LIDJI FOR GREENING OF OIL

The federal government wants domestic biofuel producers to think big in the coming decade. Kyriacos Zygourakis, a professor at Rice University, wants them to think small.

(Start the conversation. See comments section at bottom of page.)

Biofuels, liquid fuels made from crops like corn or switchgrass, are the most widely used renewable fuel in the country, and growing. Federal mandates in place for several years would expand their use to 36 billion gallons in 2022 from 11.1 billion gallons in 2009.

Zygourakis believes that expansion would do more harm than good. "My opinion about the biofuels has evolved over the years. I don't believe any more that we will be able to meet the very large fraction of our needs for liquid transportation fuel," he said.

Instead, Zygourakis thinks biofuels should be used in more limited and focused capacities specifically aimed at improving more modest uses within the domestic energy mix.

A student in the crisis years

Zygourakis came to the United States from his native Greece in the 1975, as oil embargoes shifted public discourse about energy use toward increasing domestic supplies.

As a young chemical engineer, Zygourakis became interested in energy, but eventually his research and academic life spun off to include other areas of his field.

His focus drifted back toward energy in recent years, as high oil prices and increased tension with oil producing countries reignited debates over domestic fuel production.

"It was only natural for me to go back and see how things have changed and look at what our options are now," Zygourakis said.

He graduated from the National Technical University in Athens, Greece with a degree in chemical engineering in 1975, and received his doctorate from the University of Minnesota in 1981. He is currently a professor of bioengineering and the chair of the Department of Chemical and Biomolecular Engineering at Rice University in Houston.

Obstacles to major biofuels use

Zygourakis began focusing on biofuels as their profile was growing. The Energy Policy Act of 2005 and the Energy Independence and Security Act in 2007 set specific goals to increase biofuel production in the United States, including the goal of 36 billion gallons by 2022.

Zygourakis said he was originally optimistic about the idea of using crops for fuel, but his research into what he calls fundamentals, such as energy balance, changed his mind.



Kyriacos Zygourakis: "We have to look at how we can produce biofuels in a distributed fashion."

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"But, still," he said, "biofuels can play a very important role in the future economy if we move away from a decentralized model, like we have now for gasoline, to a more distributed, localized, on-demand production of biofuels."

Corn ethanol a losing proposition

Like many critics, Zygourakis now questions whether biofuels, particularly those made from corn, generate enough energy to justify the energy needed to make them. When you take into consideration the land, irrigation and fertilizer needed to grow corn and convert it into a fuel that works in existing engines, Zygourakis said the energy balance is "at best even."

"Corn ethanol is basically a losing proposition and we shouldn't be doing it," he said, a claim disputed by the U.S. Department of Energy, which says ethanol has a "positive energy balance," meaning it contains more energy than it takes to produce.

Despite DOE's position biofuels are moving toward cellulosic sources, such as switchgrass, different types of grasses and corn stover, the leaves and stems left over from a corn harvest.

Soil a very large reservoir for CO2

That's just the energy angle, though. Biofuels are also seen as a way to reduce emissions.

Zygourakis, however, questions that benefit, saying policymakers aren't considering the emissions that come from changing so much farmland over to ethanol producing crops.

"Soil actually is a very large reservoir" for carbon dioxide, he said.

A large-scale change in land use could release that CO2, Zygourakis said. According to his research, in some cases that release could be great enough to make the total emissions from biofuels production and consumption greater than that of gasoline.

Zygourakis believes research is showing that the energy balance of cellulosic ethanol is not as high as once thought, and he doesn't believe the United States can set aside the millions of acres of farm land needed meet the public demand for liquid fuel.

And cellulosic fuels don't eliminate Zygourakis' concern about land use changes.

Fertilizer run-off creates "dead zones" in waterways

Even if farmers can increase feedstock harvesting while maintaining crop diversity, growing enough fuel to satisfy the United States would require tremendous amounts of water.

Zygourakis also worries about fertilizer run-off creating "dead zones" in nearby waterways. Dead zones are areas where reduced oxygen in the water harms marine life.

The federal government is considering some of those issues.

A major U.S. Government Accountability Office report on biofuels released late last year noted the absence of any mechanism to measure the effect of land use changes that come from increased biofuels production. It also noted the strain on water supplies and the need to diversify crops.

Twenty-one billion gallons of the 36-billion-gallon goal for 2022 has to come from biofuels that are not derived from cornstarch. The Obama Administration also recently required all renewable fuels to reduce emissions 20 percent more than oil-based gasoline or diesel.

Looking at innovative applications

Despite his skepticism, Zygourakis doesn't think biofuels are a lost cause.

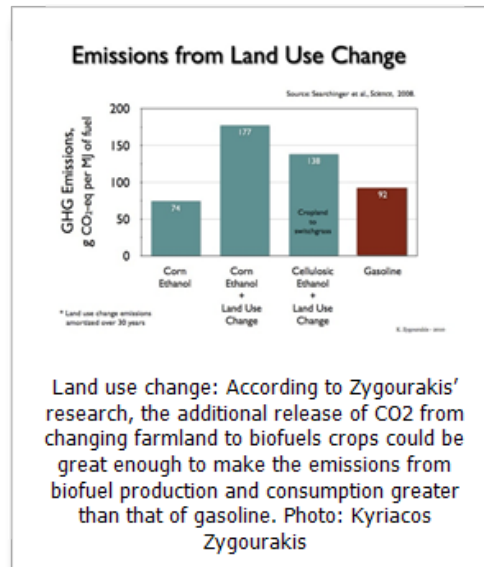
"We have to look at how we can produce biofuels in a distributed fashion," he said.

One smaller application, he said, is harvesting.

Zygourakis believes biofuels could be used to power the giant machinery used to reap crops. Electric or hybrid combines may not be practical, and using biofuels locally eliminates concerns about incompatibility with existing infrastructure, like pipelines.

As a renewable hydrocarbon, he thinks biofuels could solve a problem that nags anyone who imagines a post-oil world: how to make petroleum-based byproducts, such as plastic.

"The technology is already here. The economics just don't work," Zygourakis said. "It is still cheaper to



produce this from oil, but if the price of oil goes up we can go back to this technology again."

As for the federal biofuels goals, Zygourakis said the problem doesn't come from the limits of technology, but the limits of resources: "If we had an inexhaustible supply of water, which we don't, and if we produced fertilizer with no energy inputs, which we can't, we could possibly see a way of producing a very large amount of biofuels."

Looking to improve efficiencies

Zygourakis' research focuses on making biofuels more efficient.

His group at Rice is studying ways to improve small-scale biofuels production, facilities that make biofuels in batches instead of continuous, larger-scale production.

The group is also studying ways to make fuel from biomass that can't be converted into sugars, which Zygourakis calls "the linchpin for the commercial success of cellulosic ethanol plants."

The research is looking at combined heat and power plants, or CHP, that make electricity by burning biomass not converted to ethanol through fermentation.

The research also looks at using steam to run the fuel production process and separate ethanol from water, a step of the biofuel process that is particularly energy intensive.

Links of interest

[Kyriacos Zygourakis' page at Rice University](#)

[Zygourakis on the deployment of biofuels in Texas](#)

[Zygourakis on the obstacles facing biofuels \(2007\)](#)

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