



BRAZIL

Race for Cellulosic Fuels Spurs Brazilian Research Program

CAMPINAS, BRAZIL—The ambition of plant biologist Marcos Buckeridge is echoed in the works he listens to during his commute to a new research laboratory here in Brazil's sugar-cane country. Right now, he's into *American Prometheus*, a biography of J. Robert Oppenheimer, father of the Manhattan Project; next, a history of the U.S. space program.

Buckeridge is hoping to keep Brazil in another international technology race. He is the scientific director of Brazil's Bioethanol Science and Technology Center (CTBE), a \$40 million facility inaugurated on 22 January. His task: to organize a world-class research program. "The Americans are spending more money," says Buckeridge, "but if we succeed, we will be regarded like Pelé, and scientific discovery will be treated as an act of heroism in Brazil." At stake is Brazil's position as the world's most efficient producer of ethanol.

Brazil got its start running cars on ethanol during a 1970s oil-independence push. These days, nearly every new car sold in Brazil can run on it. The country's sugar-cane mills make ethanol for half of what it costs in the United States, where ethanol is made from corn. Exports have surpassed 3 billion liters per year.

Keeping that lead won't be easy. Although Brazilian sugar cane is the most competitive ethanol feedstock today, the United States and Europe are investing heavily in next-generation approaches. In 2009, the U.S. Department of Energy alone budgeted more than \$325 million for biofuel science and demonstration plants. Much of that effort is aimed at "cellulosic ethanol," or how to obtain fermentable sug-

ars cheaply from straw, wood chips, and other plant material normally considered waste (*Science*, 16 March 2007, p. 1488).

CTBE represents Brazil's big bet to keep pace in cellulosic technology. Construction has started on a \$12 million pilot plant, where scientists from across Brazil will study how to use enzymes to break down and access sugars that normally remain trapped in sugar-cane straw and processed stalks, known as bagasse. "Not



Raising cane. President Luiz Inácio Lula da Silva and plant biologist Marcos Buckeridge at the inauguration of Brazil's national Bioethanol Science and Technology Center last month.

investing would be a very big risk," says Marco Aurélio Pinheiro Lima, a theoretical physicist who is CTBE's director. "Brazil would end up having to purchase technology in areas it has always led. The government is very aware of that."

Until now, Brazil's biofuel research has had a strongly practical bent. Industry agronomists developed new cane varieties, and steam-power experts taught sugar mills how to burn cane waste and make electricity. Engineers in Brazil also led the development and launch of flex-fuel vehicles that burn both ethanol and gasoline. Since 1975, the amount of ethanol squeezed from each acre of sugar cane has

more than doubled.

Given that track record, not everyone in Brazil is convinced by the new cellulosic push. "The view I defend is that the first-generation technology still has space to improve," says José Goldemberg, a professor at the University of São Paulo and former education minister. Goldemberg thinks that ethanol production can be vastly increased by expanding sugar-cane agriculture and introducing genetically modified crops, all well before cellulosic ethanol reaches economic viability. And because many Brazilian mills already burn cane waste to make electricity (producing about 3% of the country's electricity), there's competition for cheap cellulose. Suani Teixeira Coelho, director of the Brazilian Reference Center on Biomass at the University of São Paulo, thinks the new national lab represents "a kind of megalomania. They are thinking if we don't dominate the technology, someone else will."

Buckeridge says it's critical that Brazil play a role in developing next-generation technology. He notes that about two-thirds of sugar cane's sugars remain trapped in straw and bagasse in forms that ethanol-producing yeast can't digest. Using conservative estimates, he calculates that cellulosic technology could increase per-acre ethanol production by 40%. "I don't think you're going to get that with the first-generation technology," he says.

CTBE grew out of a study commissioned by Brazil's Ministry of Science and Technology in 2005 that concluded that the country needed an internationally competitive national lab to coordinate its growing research efforts. Although precise figures are not available, public-sector funding for biofuel research has grown in Brazil by some 500% during the past decade and now totals about \$90 million per year, says Carlos Henrique de Brito Cruz, scientific director of the State of São Paulo Research Foundation. "The main change in Brazil's



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strategy in bioethanol is making it much more science-based," says Brito Cruz. That's a recognition that the competition comes from "countries that use a lot of science to improve their technology."

Brazil's government has been anxious about losing ground. In 2008, science minister Sérgio Rezende publicly complained when Monsanto paid \$290 million to acquire two homegrown biotech start-ups, Allelyx and Canavialis, then developing new sugar-cane varieties. Rezende lamented the loss of two domestic technology "jewels" to "foreigners." Yet Monsanto turned out to be only among the first in a wave of multinationals looking for footholds in Brazil. This month, Royal Dutch Shell agreed to a \$12 billion joint venture with Brazil's largest ethanol producer, Cosan. As part of the deal, Shell contributed its stake in two cellulosic ethanol start-ups, indicating that it planned to apply the technology first in Brazil.

"Everyone wants to play in Brazil because of the cheap sugar. The technology is going to come whether Brazil develops it or not," says Carl E. Pray, an economist at Rutgers University, New Brunswick, who

BIOFUELS PAPERS

Rank	Nation	Citations	Papers	Citations per paper
1	U.S.A.	5143	498	10.33
2	Turkey	864	158	5.47
3	China	442	145	3.05
4	India	1076	139	7.74
5	Sweden	608	135	4.5
6	Germany	501	118	4.25
7	Japan	879	117	7.51
8	England	502	92	5.46
9	Spain	552	90	6.13
10	Canada	622	87	7.15
11	Brazil	345	80	4.31
12	Greece	245	55	4.45
13	Taiwan	247	55	4.49
14	Finland	215	52	4.13
15	Italy	306	52	5.88
16	Netherlands	317	47	6.74
17	France	150	46	3.26
18	Poland	25	38	0.66
19	South Korea	167	35	4.77
20	Belgium	314	33	9.52

During the period 1998–30 April 2008

has been studying international aspects of biofuel R&D. Pray thinks Brazil stands to reap the benefits first no matter where cellulosic technology is developed: "Stuff that is developed in a lab in the U.S. is moving

to Brazil that night by e-mail."

For Brazilian academics, the growing interest in sugar cane is a chance to forge new international relationships. Last year, Brazil's federal science agency issued a joint call for proposals to develop cellulosic ethanol with the European Union. For its part, CTBE signed a cooperation deal with the U.S. National Renewable Energy Laboratory. "We each work on our own feedstock but then trade notes," says Pinheiro Lima.

So far, CTBE's offices and laboratories are mostly empty. But equipment has begun arriving, and the center plans to have 170 scientific and technical staff by 2013. The laboratory will focus on some immediate problems, such as developing farm machinery that uses GPS to run along trails and avoids compacting soil. But cellulosic technology remains the top goal. Starting next year, the lab will carry out what it terms "mega-experiments" to test ideas from researchers across Brazil in the pilot plant's fermentation tanks and enzyme chambers. "For Brazil to have a role in this technology, we will have to work together," says Pinheiro Lima.

—ANTONIO REGALADO

U.S. CONGRESS

Ehlers's Retirement Called 'Big Loss' for Science

Vernon Ehlers, a staunch supporter of science and one of three physicists in the U.S. House of Representatives, is retiring after 17 years in Congress.

His announcement last week, which came as Washington, D.C., grappled with a historic blizzard, was characteristic of the soft-spoken, self-effacing former college professor. The 76-year-old Republican from central Michigan has been a quiet but insistent force on the House science committee, working with both Democratic and Republican chairs on legislation to improve U.S. science and math education and bolster federal investments in research. His retirement at the end of the year will strip the science committee of arguably its two most influential members following a similar



"Mr. Science." Ehlers hopes to stay involved in science policy.

decision by its chair, Representative Bart Gordon (D-TN), not to seek reelection after 26 years in the House.

"It's a big, big loss," says Sherwood Boehlert, a former chair and a moderate Republican who retired in 2006. "He was Mr. Science in Congress, and he was my go-to guy whenever I had a question about research or science education."

Although Ehlers told *Science* that he felt "it was time to move on," his retirement won't quench his lifelong passions. "I hope to stay involved," Ehlers said. "I've spoken to some of the powers-that-be in Washington, and I think I can still play a role." Ehlers said he couldn't talk yet about his new gig, noting only that "I won't be doing it for the money." He also wants to become

"an elder statesman" on behalf of continued federal support for research.

Not one to toot his own horn, Ehlers nevertheless says he's concerned about the continued vitality of the science committee with his and Gordon's departure. "That was actually the biggest factor in my mind against retiring," he explains, noting that he considered retiring 2 years ago but changed his mind. "I recognize the role I've played on the committee over the years. But there are still some good people there who care a lot about science."

David Goldston, a longtime aide to Boehlert and former committee staff director, describes Ehlers as "thoughtful and independent, ... willing to work with anybody who takes these issues seriously." Now head of government affairs for the Natural Resources Defense Council, Goldston says Ehlers "is the kind of member that Congress needs more than ever these days." —JEFFREY MERVIS

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