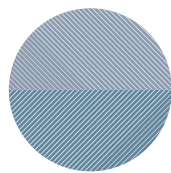


# UNDERGROUND SOLUTIONS

## CLOSING IN ON CARBON SEQUESTRATION BY AL SENIA

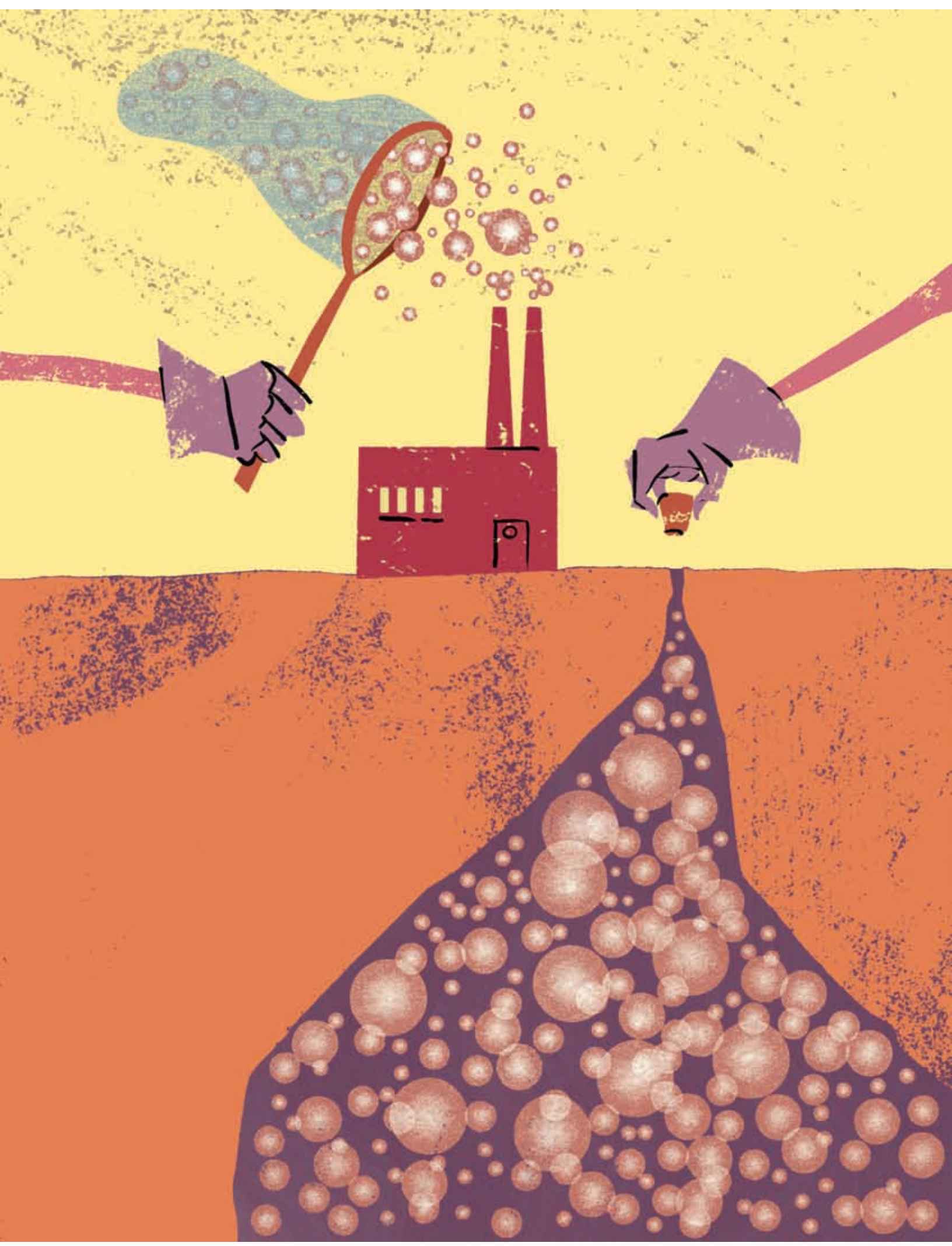
ILLUSTRATION BY JÜRGEN MANTZKE



**After years of debate and uncertainty, carbon sequestration technology** appears ready to play a central role in the effort to curb greenhouse gas emissions by capturing and storing noxious CO<sub>2</sub>. Many engineers and scientists are involved in a long-term, multi-stage multi-million-dollar effort in sequestration. They believe the technology for capturing carbon dioxide and placing it in temporary or permanent storage is a technology capable of moving into the mainstream. However, they caution that the technology's commercial prospects are more uncertain, which could delay large-scale implementations for 10 years or more.

"This is a really important technology," says David Ball, project program manager at Battelle Laboratories. "The idea of capturing CO<sub>2</sub> and injecting it in deep underground formations as a way of reducing CO<sub>2</sub> emissions ... is certainly intensifying at an exponential level. But there is still a lot of work yet to be done to be able to do this on a day-in, day-out basis." Ball believes "it could still take a few decades" to build an infrastructure sufficient for the technology to deliver on its promise, although the timetable could be speeded up if there were financial incentives put in place to encourage commercialization. The key challenge is to find a way to economically capture the carbon dioxide gas and store it underground.

Battelle is directing nearly 40 partners in its Midwest regional effort. It is part of a three-phase, multi-faceted research effort called the Plains CO<sub>2</sub> Reduction Partnership. The program, backed by the Department of Energy, involves universities, research institutes, energy companies, utility companies, government agencies and others throughout North



America. It seeks to understand the technical and economic feasibility of capturing and storing carbon dioxide from stationary sources. All told, the program encompasses seven different regional partnerships, all basically following the same timetable. The partnerships are managed by the Energy Environmental Research Center at the University of North Dakota.

The timetable involves a three-stage effort that began in 2003 and is now midway through its second phase, which began in 2006 and ends in 2009. This phase involves the actual test — injection of carbon dioxide several thousand feet underground. The partnership's third phase is expected to be funded within the next year and will extend at least until 2012. Ball, whose regional partnership involves an eight-state area ranging from Kentucky to Michigan, says his particular program won't commence actual underground test injection of CO<sub>2</sub> until this summer.

Other regional programs appear further ahead. For example, John Harju, associate director of the North Dakota center, which is managing that region's sequestrations study, says that based on what he has seen during the last 18 months of Phase 2 development, sequestration looks extremely promising. "Carbon sequestration technology is ready today," Harju says. "The technology is proven and ready to roll. From a technical perspective, all the elements are proven as capable."

Ed Steadman, project manager at the North Dakota center, says

"Carbon sequestration technology is ready today..."

there have already been four field validation tests studying the efficiency of CO<sub>2</sub> sequestration in the region. The demonstrations include injecting acid gas from natural gas-processing plants in northern Alberta, Canada into an underground pinnacle reef structure, and injecting carbon dioxide deep into a northwestern North Dakota oil field. The two other tests involve injection into an unmineable lignite seam in North Dakota, and a South Dakota effort to remove carbon dioxide from the air and store it in soil. The results will help "optimize CO<sub>2</sub> storage, monitoring and verification methods and facilitate the monetization of terrestrial carbon offsets in the region and elsewhere," Steadman says.

Despite the optimism, Harju concedes that there are economic barriers that stand in the way of widespread sequestration deployment, and that many of these won't be removed without stronger public and government support for greenhouse gas initiatives. He notes that the phase two effort already has produced "nice, little niche projects" for sequestration that are making a small profit. The real challenge is to extend that effort into a more centralized, less piecemeal approach. Harju adds that recent greenhouse gas initiatives in the northeastern and western United States could help build public and political awareness and support for similar efforts.

## THE FRONTIERS OF COAL

ILLINOIS PIONEERS NEW TECHNOLOGIES

BY LEE BUCHSBAUM



Illinois, with the second

largest amount of coal reserves in the nation, believes the future of coal rests with carbon sequestration.

Competing with Texas to land the FutureGen project, Illinois' leaders also hope that by employing other emerging clean coal technologies and strict emissions controls, they will lay the groundwork for revitalizing their struggling coal mining industry and transform the state into an energy innovation center.

A recent environmental study by MIT concluded that power plants combining integrated gasification combined cycle (IGCC) technology with carbon sequestration, such as the proposed \$1 billion Department of Energy sponsored FutureGen project, are key to the future of coal's role as a large-scale baseload energy source.

A decade after the Clean Air Acts devastated Illinois' mining industry, the state's governor, Rod Blagojevich, is walking a fine line between being pro-Illinois coal and "green." Throughout his administration, Illinois has put tremendous research dollars into advancing and often fast-tracking various clean coal initiatives. Now, after years of politicking and planning, FutureGen's showcase technology will be sited in one of four communities, two of which are in Texas and two in

# Bechtel: Coal-Fired Power



For over half a century, Bechtel has set the pace in the power industry. We've built more than 500 power plants on six continents in 30 countries, including massive facilities able to light entire cities. And when it comes to designing and building coal-fired power plants, no one can match our more than 60-year record of commitment and success with more than 135 completed units—it all adds up to safe reliable facilities and superior financial returns.

Bechtel delivers value. Innovative technology. Proven construction techniques. Experienced project management. Maximum procurement leverage. Environmental expertise. And, a safety program second-to-none.

**Global commitment. Global success.  
Coal-fired plants from Bechtel Power.**

**BECHTEL POWER** Frederick, MD, USA ♦ 1-301-228-8609 ♦ [www.bechtel.com](http://www.bechtel.com)

San Francisco ♦ Houston ♦ London ♦ New Delhi ♦ Shanghai



Illinois. While a decision won't be made until fall, many across Illinois are becoming hopeful.

Still on track to be built by 2012, this cutting-edge 275-megawatt power plant will be capable of capturing and storing underground more than a million tons of CO<sub>2</sub> a year in a deep saline geologic formation while employing IGCC technologies, said FutureGen CEO Mike Mudd. "The multi-partner FutureGen Alliance has recently completed a conceptual design for the FutureGen facility. We are now in the process of hiring an engineering construction manager," he said. Likewise, requests for proposals for major equipment systems at the plant will be issued this year.



▲ Battelle researchers drill a 9,200-foot-deep sequestration test well at an American Electric Power generating plant in New Haven, W.Va.

◀ Drilling of a deep test well to determine carbon dioxide storage potential at the FirstEnergy's R.E. Burger plant in Eastern Ohio.

PHOTOS COURTESY OF BATTELLE

"There is no commercial-scale IGCC plant in the world with capture and sequestration, period," said Ken Humphreys, a FutureGen technical support manager for Battelle. "You have got all these novel technologies and you have got to integrate them."

Moreover, according to John Mead, Director of Southern Illinois University's Coal Research Center, the project will also serve as both a test bed and proving ground for other projects. "FutureGen, wherever it is finally sited, will provide significant scientific and research information useful from a confidence-building and understanding perspective as well," Mead said.

Key to the siting decision is Illinois' geography in terms of both its rich coal supplies and sequestration regions. Tuscola and Mattoon, the two Illinois site candidates, are, according to Mead, very close to the ejection points for sequestration. "For one it's on the site, for the other it's just a few miles away. So it wouldn't be necessary to move the CO<sub>2</sub> very far," he said. The sites also have good rail transportation for shipping Western coal and Eastern and Northern Appalachian products, though long-term commercial operations will most likely take advantage of Illinois' reserves.

But, said Mead, ultimately "it's going to come down to two factors: which site offers the best value to build

Panasonic recommends Windows Vista™ Business.



It's not just a laptop. It's  
**locating and mapping  
downed power lines**  
with superior GPS technology.



When it's your job to report downed power lines so critical infrastructure can get full power restored, you need precise technology. Introducing the Toughbook® 30, Panasonic's latest rugged and reliable laptop for power and utility professionals. With available WAAS-enabled GPS for precise x and y coordinates, plus the world's first 1000 nit daylight-readable LCD for a crisp, clear readout even in bright sunlight. And optional embedded wireless WAN for a reliable connection no matter where your work takes you. The new Toughbook 30. **Work anywhere. Risk nothing.**

1.800.662.3537, option 5  
[panasonic.com/toughbook/utilities](http://panasonic.com/toughbook/utilities)



The **NEW** Toughbook 30

**Panasonic ideas for life**

**TOUGHBOOK®**

Intel, Intel logo, Intel Centrino, Intel Centrino logo, Intel Inside, Intel Inside logo and Pentium are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries. Toughbook notebook PCs are covered by a 3-year limited warranty, parts and labor. To view the full text of the warranty, log on to [panasonic.com/business/toughbook/support.asp](http://panasonic.com/business/toughbook/support.asp). Panasonic Vista™ upgrade program will begin as of June 2007. Please consult your Panasonic representative prior to purchase. ©2007 Panasonic Corporation of North America. All rights reserved. PowerLines\_UTEC\_Cable\_FY07-1

# Protecting Planet Earth

Less is more!

A typical 300+ MW PRB coal boiler would significantly improve efficiency, burning 4,100 less tons of coal annually, by using the SHOCKSystem™ online detonation boiler cleaner.

This efficiency improvement in turn would produce:

- 240 *less* tons ash
- 3.5+ *less* tons of NOx
- 11+ *less* tons of SOx
- 5,750+ *less* tons of CO<sub>2</sub>

The SHOCKSystem™  
Bringing *more* efficiency, availability, reliability, and profitability to your coal boiler – with *less* environmental impact.

## ONLINE BOILER CLEANING

[www.shock-system.com](http://www.shock-system.com)  
425-278-2448



**Pratt & Whitney**  
A United Technologies Company

performance • innovation • opportunity • responsibility • results

CO<sub>2</sub>

the project within budget, and which has the superior location to assess the success of sequestration.” Projected construction costs have gone up since the project was announced in 2003, and there is a long history of innovative energy projects that have exceeded original budget expectations. “If we can build and operate cheaper here than in Texas, that’s to our advantage; but the DOE studies on sequestration are really crucial. With CO<sub>2</sub> being discussed in terms of any new coal project, FutureGen is going to provide information and results that are vital to almost all future project planners,” Mead said.

In addition to FutureGen, the state is supporting several other gasification and engineering studies while also imposing some of the strictest mercury emission statutes in the nation. Recently, Illinois came to various agreements with existing power suppliers, such as Midwest Generation, to retire some older units that burn Wyoming coal and help equip others with scrubbers so they can use Illinois coal, while paving the way for an expansion of Midwest’s generation fleet by building an Illinois coal-burning IGCC plant. Gov. Blagojevich initially called for a 90 percent reduction in all mercury emissions by June 30, 2009, but his administration has negotiated deals with utilities that offer to reduce other emissions in exchange for more time to meet that goal. Recently, Ameren and Dynegy have agreed to deals that allow them more time to cut mercury emissions in exchange for cutting soot and other pollutant emissions.

There are also several mine-mouth IGCC projects in the works,

...FutureGen is going to provide information and results that are vital to almost all future project planners.

such as the ERORA Group’s Taylorville Energy Project. Illinois is also working on building CO<sub>2</sub> pipelines to facilitate carbon management by pumping the gas into declining oil wells in the southeastern part of the state. Additionally, in East Dubuque, Rentech has been granted several state and local permits to convert an existing ammonia fertilizer plant from a natural gas feed to a coal gasification feed. Not only will the plant eventually use Illinois coal to create agricultural fertilizers, but it will also demonstrate coal gasification and liquefaction on a commercial scale, while generating almost 50 megawatts of additional power. ☺