

The State

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Is this the symbol of your economic future?

Hydrogen is the most abundant chemical in the universe.
South Carolina leaders are betting it will energize the state's economy.

By C. Grant Jackson
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USC president Andrew Sorensen's sleep is the sleep of the faithful, of a true believer in South Carolina's future.

In Innovista, USC's new research campus, Sorensen is convinced the school has a plan to help take the state not just into the 21st century but the 22nd. South Carolina is counting on Sorensen, and his counterparts at MUSC and Clemson, to be right.

The state has lost manufacturing jobs steadily over the past decade. To compete in the global economy, South Carolina has shifted from an almost complete reliance on pursuing smokestack industries. Instead, the state is investing millions in its research universities — to attract top professors and knowledge-based companies, with hopes they'll spin off even more companies.

It's a jobs strategy S.C. leaders have been slow to pursue while other states have been speeding along. What gives South Carolina the chance to catch up is that USC, Clemson and the Medical University of South Carolina long ago turned their attention to leading-edge science.

USC is especially strong in the area of hydrogen and hydrogen fuel cell research. If the university can sustain its edge and momentum, experts say, the promising "alternative fuels" technology could add thousands of high-paying jobs and transform South Carolina's economy.

Trying to guess which research field, such as hydrogen research, will be "hot" is a leap of faith. Everyone knows it.

But it's a calculated leap, South Carolina's leaders say, one the state can't



Chemical engineering students Masato Ohasi, left, and Konalayutt Punyawudho check out the hydrogen fuel cell next to the West Quad dormitory. Electricity and hot water for the dorm are generated partly by the fuel cell. Photo by Jeff Blake *The State*.

put off, and one that would benefit the entire state.

"The state will have three really strong economic development and research engines geographically located throughout the state," said Rick Kelly, USC's vice president for finance, who is shepherding Innovista's construction. "We will broaden the economic base of this state."

STEPPING OUT

Of the three research universities, perhaps making the greatest gambit is USC, which has plans that could eventually double the size of its campus.

And hydrogen research is what is putting the school on the national research map.

USC is focusing on four research areas: alternative energies, nanotechnology and the biomedical and environmental sciences.

But it is the school's work with the new energy sources of hydrogen and fuel cells that has captured the public's imagination.

The highly competitive field is also where USC and the state arguably have gained the most momentum. One Connecticut official recently described South Carolina to *The New York Times* as the most competitive of the two dozen or so hydrogen-focused states.

What You'll Learn

Think hydrogen technology is a thing of the future? Hydrogen fuel cells already help power a USC dorm and an ETV camera.

A USC professor is working to design and market the nation's first fuel cell-powered Segway personal transporter device.

Hydrogen boosters hope by 2009 to have a hydrogen-fueled bus on Columbia streets, refueling at a hydrogen "gas station."

Competing for space at the pump should be a BMW Hydrogen 7 luxury sedan that uses hydrogen and gas.

If true, it's no small feat. Hydrogen, and hydrogen-based fuel cells, could transform the economy the way the Internet did, experts say.

Fuel cells, battery-like devices that create energy by mixing hydrogen and oxygen, might one day power everything from laptops to cars, trucks, houses and businesses. And they could obviously lessen the country's vulnerability to the geopolitics of oil.

Larry Wilson, a member of the USC Research Campus Foundation Board, believes South Carolina can be to hydrogen what Texas was to petroleum, that Columbia could be the new Houston.

But the first companies USC will attract won't be fuel cell companies. Too few exist.

Many of the first companies are likely to be information technology or computer companies.

In fact, the first company USC has attracted is Duck Creek Technologies, a research-oriented insurance industry software company that Wilson is chairman of.

Duck Creek expects to have about 200 employees with an average salary of \$83,000 working on campus. It will be located in the first "private partner" building at Innovista, a sort of vertical research park.

Wilson's connection — and the fact that the company is a software developer instead of a fuel cell company — might have some people wondering.

But others say it's a natural progression toward attracting more advanced fuel cell- and hydrogen-oriented companies.

And already on campus are a dozen industry partners working with USC researchers in the National Science Foundation Industry/ University Cooperative Research Center for Fuel Cells.

Those companies — such as Boeing, John Deere, BASF and General Motors — can take discoveries gained through the center and turn them into products or services. The partners work in groups on projects and have access to patents developed.

BENDING EARS TO GET WHAT THEY NEED

For state leaders, including Sorensen, selling USC and South Carolina is an exercise in peddling the future. It means proselytizing about future jobs, yet-to-be created companies and research that might exist only in lab notes.

That puts Sorensen and his vice president for research, Harris Pastides, in the



USC President Andrew Sorensen, left, Rick Kelly, vice president of business affairs, and Harris Pastides, vice president for research and health sciences, attend a reception for Innovista director John Parks. Photo by Lindsay Semple *The State*

pulpit. It's a new role for university leaders, who over the years mostly watched while the state's politicians and business leaders worked to create jobs.

Pastides thinks it's a natural fit.

"Flagship research is not about the Ivory Tower. It's about Main Street," Pastides likes to say.

The country's use of technology is increasing, he said. But "that doesn't mean every research park in the country is going to make it. All you do is put a sign up and hope you can fill it."

But Pastides believes Columbia will make it and Innovista will make it. He and Sorensen tell that to every researcher and industry head they get on the university's plane to recruit, every congressman who will listen and every Rotary Club that will have them. USC's previous work will go a long way toward long-term success, Pastides said.

Top USC scientists have been working for years on fuel cells and related issues such as hydrogen production and storage.

When the NSF four years ago created the country's only industry university center for fuel cell research at USC, the university's "mission picked up momentum like a snowball rolling downhill," said professor John Van Zee.

"When Dr. Sorensen arrived, he saw the potential, and the snowball got bigger," said Van Zee, who first proposed the NSF center.

The school also now can hire researchers who are stars in their fields, thanks to \$30 million set aside by state lawmakers each year since 2003. The money pays for endowed chairs, which includes

higher salaries for professors, the salaries of the professor's research teams, expensive equipment and new labs.

State money, too — \$70 million in bonds so far — is going toward USC's buildings. Richland County and the city of Columbia are paying more than \$30 million for two parking garages.

Going up at the corner of Blossom and Assembly streets, in the Horizon Center complex, are two of the five buildings planned so far for Innovista.

The 125,000-square-foot academic building will house USC researchers in alternative fuels as well as in chemistry, engineering and nanotechnology. It will be home to NSF's fuel cell center.

The other building is for USC's industry partners. It's being built with private money by Craig Davis, who developed N.C. State University's Centennial Campus in Raleigh. The academic building also will house an incubator for start-up companies. EngenuitySC, a nonprofit dedicated to spurring a knowledgebased economy in the Midlands, is using a \$1 million federal grant to create the incubator, complete with lab space.

Pastides appreciates the help.

It's mission-critical, he said — that kind of lab space simply isn't available elsewhere at USC.

BUMP IN THE ROAD

Some folks are anxious that things aren't going faster for USC.

People in Columbia are impatient, said Davis, the N.C. developer, "but everybody has just got to calm down. It will all happen. It is just taking a little bit of time."

There was a bump in the road late last year, though. A big bump.

USC thought it had a home run in Project Genesis. Officials say they were well on their way to landing an unnamed Fortune 100 information technology company when the company backed out.

Business conditions were forcing the business to lay off thousands nationwide, Sorensen said. A company officer told Sorensen that company leaders couldn't announce layoffs on Monday, then turn around Tuesday and say they were investing millions in a Columbia facility.

The deal was incredibly close to happening, said John Lumpkin, a Columbia real estate consultant who was interim director of Innovista at the time. "The transaction was done, a lease was negotiated." The deal was headed to the company's board for "the final Good Housekeeping seal."

Genesis was to occupy nearly all of Davis' building, which was being designed specifically for the company. The enormity of the deal might have led USC to put too much emphasis on the project.

"Our regular Tuesday morning Innovista meetings became 90 percent about Genesis," Pastides said.

He said he worried then about neglecting other prospects.

"But there was just no time — this was so big. Basically, the prevailing attitude was, get this one, get the big kahuna, and others are gonna drop," Pastides said.

Genesis became a lesson learned. "The thing that I learned from that is that we don't go fishing with one pole," Sorensen said.

They had worked on Genesis for more than a year.

One of the biggest lessons has been the need to manage expectations. "We had a team meeting, and we recognized that we let Genesis get too far out ahead of us, and expectations got too high," said USC's financial officer, Kelly. "When that failed, it crushed (us)."

Since Genesis, John Parks, with the University of Kentucky since 2004, joined USC as executive director for Innovista and associate vice president for economic development.

Pre-Parks, the recruitment of possible Innovista tenants was coordinated by Lumpkin and split largely between Lumpkin, Davis, Sorensen, Kelly and Pastides.

Lumpkin gets credit for steering the

team through a learning curve. "There wasn't a recipe," he said. "We didn't open up a cookbook, and say, 'OK, recipe No. 4, let's go cook up a research knowledge economy.'"

Part of why USC went out and got Parks, Pastides said, was to become more focused on corporate recruiting and to learn from someone who has been doing it.

"Nobody in the country has a book on how to do that," Pastides said.

Sorensen, as he has been, will continue to be involved personally in much of the recruiting.

PROSPECTS

Word about Innovista is spreading, and Sorensen talks to prospects that are fuel cell-related and those that are not.

And not all the prospects want to lease space from Davis.

"I had a CEO and a vice president for financial affairs of a company that wants to build a 110,000-square-foot building in Innovista," Sorensen said.

Recently, he met with a fuel cell manufacturer. "I'm talking to people all the time," he said.

Davis has an office and a team of four in Columbia, plus a project manager who comes in regularly from Raleigh. Davis said he spends two to three days a week on Innovista, mostly on recruiting.

"There are over 20 prospects that I call real prospects, not suspects, that we are working closely with," Davis said.

Pastides and Parks both talk about the

need to follow up with prospects every day. Success doesn't come overnight, they say. "I think you are always thrilled to hit a home run," Parks said. But "sometimes it can take two to three years to get from the initiation of a project to getting a presence."

The hydrogen and fuel cell piece of Innovista, especially, is a long-range proposition.

The S.C. Hydrogen and Fuel Cell Economy Strategy, crafted in 2005 by scientists and state business, university and community leaders, lays out a 20-year plan.

It calls for landing the first hydrogen and fuel cell companies between now and 2010. Growth would accelerate from 2011 to 2015, bringing 2,000 to 3,000 new jobs and 40 to 50 new companies.

Between 2016 and 2025, the state should have a mature industry, with 8,000 to 12,000 jobs and an equal number of supplychain and secondary service jobs.

Those connected with Innovista frequently cite Harvard professor Michael Porter's comment about reinventing South Carolina's economy: "This is a marathon, not a sprint."

But things are going well, USC officials say. There are a lot of prospects, Parks said.

"When I got to Kentucky, I hit the ground standing," he said. There was no activity. Only inertia. He had to get things going.

"Here, I liken it a little more to hopping on a galloping horse," Parks said.

Companies Already Here

South Carolina is already home to at least six hydrogen and fuel cell start-up companies, with the majority in Columbia. Registered with the S.C. Secretary of State's office are:

Hydrogen Mobility LLC Columbia-based, started by USC professor John Wiedner. Working on a fuel cell-powered Segway, a personal transporter

Palmetto Fuel Cell Analysis & Design Started by USC professors John Van Zee and Sirivatch Shimpalee. Involved in writing software for fuel cell and fuel cell system designers

Palmetto Fuel Cell Technologies Hardware company seeking the next generation of fuel cell design. Founders are Van Zee and Tom Militello, a Columbia-based entrepreneur and executive director of FuelCellSouth, a nonprofit organization working to grow the industry.

Palmetto Fuel Cell Group Inc. Business development company started by Militello, associated with Palmetto Fuel Cell Analysis & Design and Palmetto Fuel Cell Technologies

DEnergy Working on compact, economic storage of hydrogen gas for fuel cells. Principals include USC researcher Thomas Davis, chemical engineering professor Michael Matthews and USC mechanical engineering alumnus Walker Rast.

Microbial Fuel Cell Technologies LLC MUSC microbiologists Charles Milliken and Harold May discovered a pollution-eating bacteria that releases electricity as a by-product. Charleston company formed to commercialize their research

Hydrogen Fuel Cell Infrastructures LLC Registered agent is Robert P. Dennis-Leigh, West Columbia. No information available on the company's activities

It's not just the job ... it's the lifestyle

Expanding the Vista and building a riverfront park could transform the downtown, attract bright minds.

By JEFF WILKINSON
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Downtown Columbia has a lot to offer the budding young researcher – a college vibe, beautiful rivers, a growing number of decent restaurants, affordable housing and a healthy supply of bars and clubs.

OK, and it's an hour and a half from the mountains or the beach.

But it needs more, boosters say, to attract Mr. Big Researcher Dude and his brilliant MIT-educated associates when they're looking for a place to hunker down and win the Nobel Prize for nanotechnology.

The university is in a cutthroat competition for those researchers, and lifestyle is a huge part of the game.

Downtown is improving, but boosters know it's no San Francisco, or Boston or Austin.

Cola 29201 is still hot as blue blazes in the summer. It's slap ugly in sections. It's woefully lacking in high-end retail and small specialty shops. It needs a more engaging music scene.

This humble burg has an excitement gap. Its hip quotient needs a multiplier.

That's where the Vista comes in. That's why it's the back half of "Innovista," the name for USC's research campus.

While everyone acknowledges the Vista is a work in progress, it presents an opportunity not many cities have.

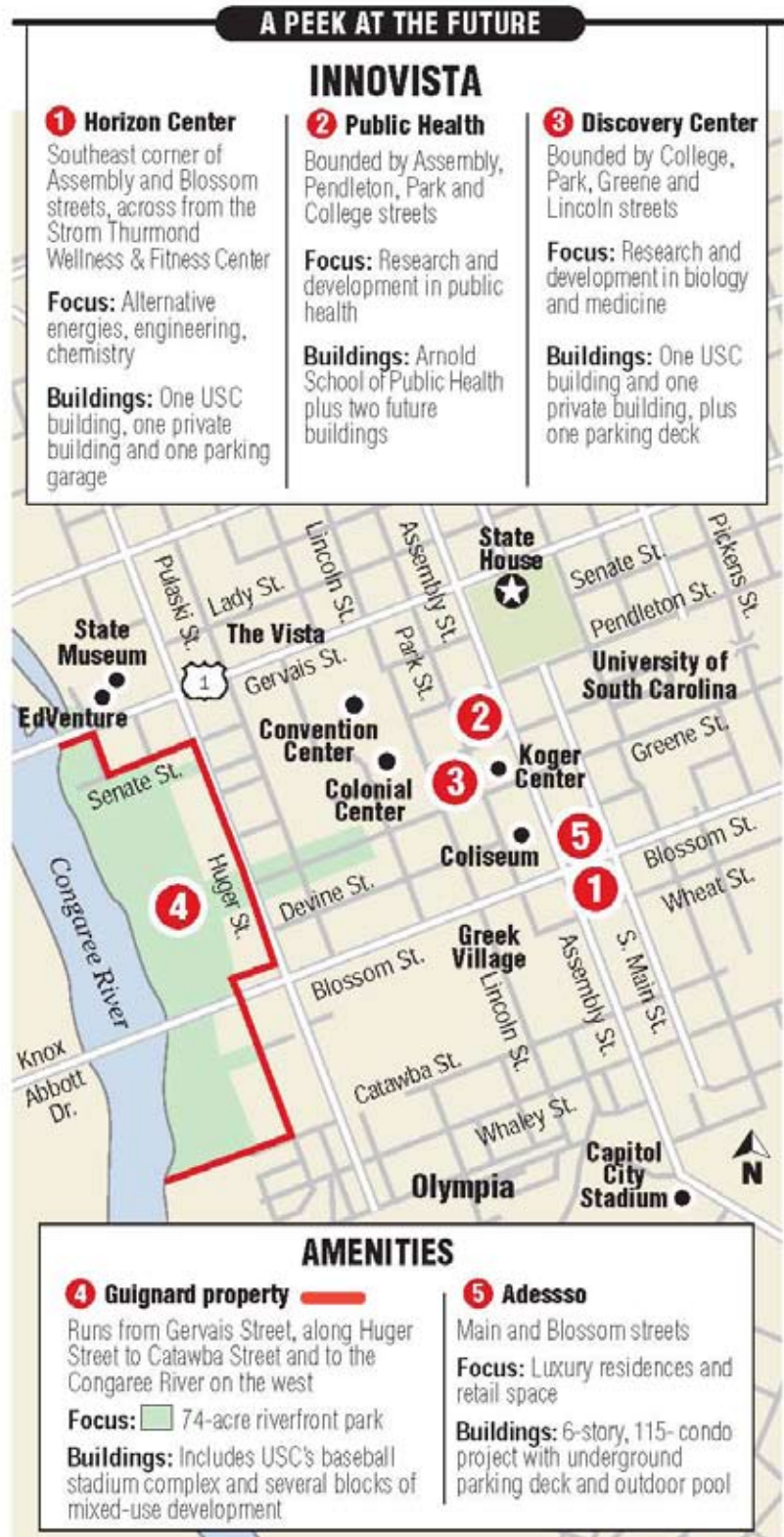
In theory, this will be Columbia's competitive advantage: Most research campuses, like the N.C. Research Triangle, are suburban and separate from their sponsor campuses and host cities. They are isolated office buildings surrounded by a sea of parking lots.

But USC's research campus will be "as much a part of city as it is a part of the university," says Harris Pastides, USC's vice president for research.

Researchers will live, work and play in the same compact area. A laboratory upstairs, coffee shop downstairs and condo around the corner. The favorite restaurant will be down the block and the weekend watering hole, a short walk away.

The research end of USC's new campus is the Innovation District. The other, lifestyle component is the Waterfront District.

Together, the two districts comprise a 30-



block chunk of downtown anchored by USC’s 200-year-old Horseshoe to the east and, to the west, a sprawling \$77 million, 74-acre park.

The park will be built on the bank of the Congaree River, stretching from Gervais Street south to Granby Village. Condos and apartment buildings – most with ground-floor retail – will ring the park and stretch back to Assembly Street. Walking will be the way people get around.

Once completed, according to USC’s planners, Sasaki Associates, Columbia should have a vibrant, upscale downtown attractive to the vaunted “creative class.”

“It will make all the difference in the ability to hire the best and brightest,” said attorney Bill Boyd, chairman of the committee charged with making the Waterfront District happen.

But there are challenges beyond the theory.

THE PARK

Start with \$77 million for the park, which Boyd calls “the jewel in the crown.”

Boyd and his 21-member committee of regional leaders have been meeting with the area’s congressional delegation.

The goal is to get the federal government to pick up the tab for the park through Water Resources Development Act grants managed by the Army Corps of Engineers, or other sources.

Federal grants have paid for a portion of the waterfront parks in cities such as Charleston, Cincinnati and Wheeling, W.Va.

And “there are parks where the feds have paid 100 percent,” such as in Indianapolis, said Lee Bussell, with the Chernoff Newman public relations firm and a waterfront committee member.

MARSHALING LANDOWNERS

The second challenge is getting private developers to conform to Sasaki’s vision.

About 65 percent of the land in the district belongs to someone other than USC or its riverfront partner, the Guignard family.

The stick will be a zoning overlay to be adopted at some point by the city. The carrot would be that if the plan is followed, in theory, everyone’s property values, and profits, would rise.

“The message is: Your property will be worth more together than individually,” said Mike Dawson, executive director of the River Alliance, which helps guide development along the city’s rivers and is the body applying for the federal park grants.

“If you opt in,” Dawson said, “the benefit will be greater.”

TIME

The final challenge is time. Right now, Columbia is selling a vision leaders hope researchers will buy. And by their own admission, Boyd’s team is challenged with putting meat on the plan’s bones.

The first attraction will be USC’s baseball stadium going in at Blossom Street and the river.

But boosters say it still could take a decade for the district to build out.

“It’s a matter of how quickly we can accelerate the process,” Bussell said.

Hydrogen 101

Educating the public about what fuel cells can do is just as important as the research, advocates say. Before people will buy hydrogen-powered gizmos, they have to understand them and be comfortable with the technology. But learning about the science is getting easier in Columbia.

Helping out are:

The Science Cafe, patterned after gatherings that began in Europe, introduces Midlands residents to a wide variety of edgy science, including hydrogen and fuel cell technology.

The cafe, organized by USC’s Chris Toumey, allows nonexperts to gather for informal presentations by experts. The monthly meetings in local restaurants are coordinated by EngenuitySC.

To reserve a space or for more information, e-mail Tory Sojourner at tsojourner@sagaciouspartners.com.

The EdVenture children’s museum offers a hands-on learning project. The museum received a grant from the Greater Columbia Fuel Cell Challenge to develop an interactive exhibit about alternative sources, including fuel cells.

EngenuitySC’s S.C. Citizens School on Hydrogen and Fuel Cell Technology introduces curious Midlands residents to the world of hydrogen and fuel cells during a set of six weekly seminars.

The 50 slots available for the first six-week session filled up just days after registration opened. Officials put another 25 people on a waiting list for the next time the school is offered. Cost is \$30 for the sessions, which were started with a grant from the Greater Columbia Fuel Cell Challenge.

A limited number of seats are available for the next session. To enroll or for more information, call (803) 777-2221 or e-mail toumey@sc.edu.

By the numbers

\$70 million Amount of state money so far going to build USC’s research campus

\$30 million Amount set aside annually since 2003 by state lawmakers for S.C.’s three research universities to hire superstar researchers

20 Number of prospects N.C. developer Craig Davis says he has for his private industry building on USC’s research campus

16 Number of USC’s private-industry partners at the National Science Foundation Industry/University Cooperative Research Center for Fuel Cells

2,000 to 3,000 and 40 to 50 Number of new jobs and new companies, respectively, expected at USC’s research campus by 2015

200 Acres in downtown Columbia planned for USC’s new campus

1 Wet labs planned for USC—labs that are much more advanced than the regular scientific lab

USC's Partners

Sixteen companies have joined the National Science Foundation Industry/University Cooperative Research Center for Fuel Cells at USC.

Boeing, the aerospace giant, is among those working at the center, the nation's only federally sanctioned cooperative for public-private fuel cell research.

Each member company pays an annual fee of \$35,000 and is expected to remain in the center for a minimum of two years.

The members make up the center's Industrial Board, which makes recommendations on projects if research is done jointly.

Patents that come out of the center's research are owned by USC. But members can obtain a royalty-free license to use the research in developing their own products or services.

The members are:

Air Liquide: A French industrial gas company, specializing in industrial and medical gases, including hydrogen. Working with the French Nuclear Research Agency (CEA) on hydrogen supply systems and hydrogen storage

BASF-AG: A German-based multinational whose portfolio includes chemicals, plastics, tailor-made products and application processes, agricultural products and crude oil and natural gas exploration and production

Boeing: Chicago-based aerospace company and the world's largest manufacturer of commercial jetliners and military aircraft

Bulk Molding Compounds Inc.: A privately owned company located in West Chicago, Ill., that makes unsaturated polyester molding compounds.

Columbian Chemicals Co.: Georgia-based developer of carbon-supported platinum and platinum-alloy electrocatalysts for proton-exchange membrane, direct methanol and phosphoric acid fuel cells

Dana Corp.: Toledo, Ohio-based automotive parts supplier. Develops and manufactures fuel cell and fuel processor components

Dow Corning Corp.: Michigan developer of silicon-based materials technology. Has provided silicon materials to fuel cell developers since the early days of the U.S. space program

Entegris: A Minnesota-based materials management company providing advanced fuel cell materials, components, sub-assemblies and services

General Motors: Detroit-based, global automobile manufacturer, working to develop hydrogen fuel cell-powered vehicles

Hydra Fuel Cell Corp.: Beaverton, Ore.-based subsidiary of American Security Resources Corp., working on the development of proton-exchange membrane fuel cell systems

John Deere ePower Technologies: Division of Moline, Ill.-based manufacturer of lawnmowers and agricultural equipment. Developed a fuel cell-powered Gator utility vehicle

LG Electronics: South Korean electronics and small-appliance manufacturer. Developing design concept for a fuel cell-powered notebook computer

Millennium Cell Inc.: New Jersey-based company developing battery technology that stores and delivers hydrogen energy to operate portable devices

Plug Power Inc.: Publicly traded fuel cell company located in Latham, N.Y., working on products for the mass residential market. Now integrating fuel cell technology into backup power products for telecommunications, utility and uninterruptible power supply applications

Savannah River National Laboratory: Applied research and development laboratory at the U.S. Department of Energy's Savannah River Site. Specializes in developing hydrogen storage technology

W.L. Gore & Associates: Most commonly known for its Gore-Tex fabrics. Manufactures membrane electrode assemblies for the proton-exchange membrane fuel cell industry

– C. Grant Jackson

5 things that give South Carolina an edge

Fuel Cell Research

South Carolina has an impressive advantage in its quest to be a major fuel cell research center, experts say.

1. USC is home to the country's only **National Science Foundation center** for joint industry-university fuel cell research. The four-year-old center uses federal dollars to bring together the best entrepreneurial research efforts from the public and private sectors.
2. The state's former nuclear weapons plant, the **Savannah River Site**, has been named a **national laboratory**. The site – 310 square miles in Aiken and Barnwell counties – has 50 years of experience in producing and storing hydrogen. The designation brings increased visibility and prestige and the chance to compete for a broader range of Department of Energy missions.
3. **Clemson's automotive research campus**, CU-ICAR, in Greenville, is preparing for a range of auto systems research. It could provide a **ready-made test lab** for any number of auto-related hydrogen innovations.
4. An unusual level of state, city and university **cooperation**, combined with the vocal support of U.S. Sen. Lindsey Graham and U.S. Rep. Bob Inglis. Researchers moving here have repeatedly cited this multitiered cooperation as a key component of South Carolina's attraction.
5. **National buzz**, which in part has led to Columbia's selection as **host** for the annual meeting in 2009 of the **National Hydrogen Association**.

A peek at the future

FUEL CELL RESEARCH

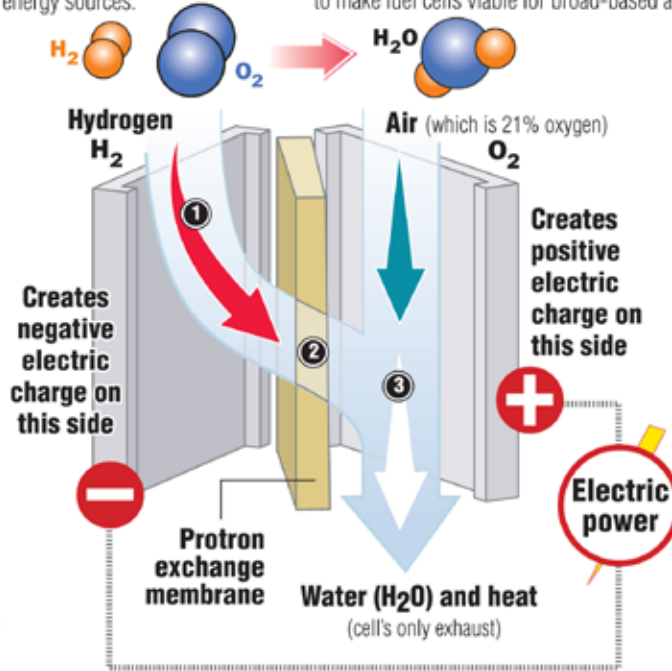
If you are the average person, the term "fuel cells" registers somewhere in your mind alongside the words "hybrid" vehicle and maybe "eco-friendly" or even "global warming". Rising gas prices and lingering questions about the future of the oil industry have opened the doors to the development of alternative energy sources.

Fuel cells take the simple elements of hydrogen and oxygen and change them into water. This chemical conversion produces energy that scientists have figured out how to "capture" and use to operate engines and other energy-requiring devices. Still, there are many obstacles to overcome to make fuel cells viable for broad-based applications.

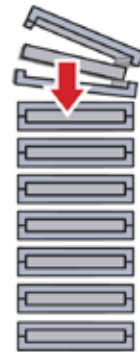
How a fuel cell works

A fuel cell is made like a battery, with two electrodes and a proton exchange membrane sandwiched between them. Like a battery, a fuel cell uses a chemical reaction to create an electric current.

- ① Hydrogen fuel flows into one electrode that is coated with a catalyst that breaks the hydrogen into electrons and protons. The movement of the electrons generates electricity.
- ② The protons pass through the proton exchange membrane to the other electrode.
- ③ Oxygen flows into the second electrode, where it combines with the hydrogen ions to produce a water vapor, which is emitted as a byproduct.



A single fuel cell produces about enough power, 0.7 volts of electric current, to light a light bulb. But fuel cells must be stacked in a series to produce enough power to move a car.



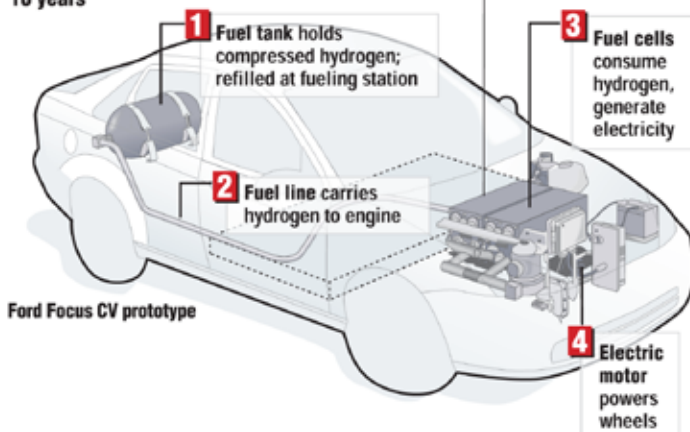
NOTE: One prototype vehicle plans to use 200 individual fuel cells wired in a series.

Alternative to gasoline

- Why use fuel cells in cars?**
- Extremely low emissions; produces only water and heat
 - Fuel efficiency as much as twice that of conventional gas engine
 - Does not require recharging like a battery-powered car

Widespread use of fuel cell cars is expected to take 10 years

Ford prototype has fuel cells under hood; DaimlerChrysler design locates them under front seats



A peek at the future

South Carolina research: The hydrogen triangle

GREENVILLE

Clemson University and its key private-sector partner, the German auto giant BMW, are attracting international attention. The university is building a campus in Greenville for its new graduate student program in automotive studies. The school's research is focused on automotive systems integration. But Clemson's labs could help test hydrogen and fuel cell innovations developed elsewhere.

The campus boasts:

- \$50 million from BMW and another



AIKEN

Aiken is home to two hydrogen and fuel cell initiatives.

■ Scientists at the **Savannah River National Laboratory**, the former nuclear weapons plant, have 50 years of experience under their belt working with hydrogen. Scientists there now are doing much of the same work as university and private sector scientists. But hydrogen has some hurdles to be overcome before it can be used efficiently, especially in vehicles. Today, the pressurized tanks necessary to contain it in large quantities are too

- \$40 million in state tax credits the company is forgoing.
- \$96 million in construction planned
- Several top-tier researchers, with others expected to be announced
- 380 nonconstruction jobs so far, with a goal of 445. Average salary: \$85,000
- 400 acres on which to grow

Under construction there:

- The Carroll A. Campbell Graduate Engineering Center, the campus's primary academic building
- The BMW Information Technology Research Center, to be owned by Clemson and used by BMW

heavy. SRNL scientists hope to solve that problem.

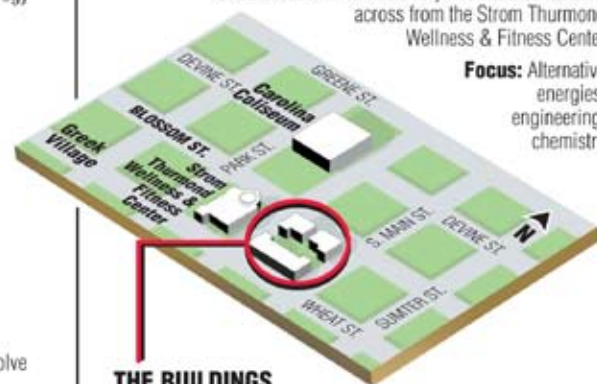
■ SRNL and Aiken officials have collaborated to create a technology center outside the fence of the former weapons plant. Researchers from academia and industry work at the **Center for Hydrogen Research**. The center also is attracting other private-industry partners doing their own hydrogen-based research. The goal is to take the innovations made at SRNL and adapt them to the marketplace. Toyota is the center's biggest research partner so far.



USC CAMPUS: THE HORIZON CENTER

Southeast corner of Assembly and Blossom streets, across from the Strom Thurmond Wellness & Fitness Center

Focus: Alternative energies, engineering, chemistry



THE BUILDINGS

- **USC building:** 125,000-square-foot wet lab/dry lab research building
Estimated cost: \$26.6 million, plus \$5 million in federal funding for lab equipment. Financed by state research infrastructure bonds
- **Private building:** 110,000-square-foot office/dry lab building
Estimated cost: \$13.2 million. Privately financed. Will house private companies and federal government tenants collaborating with USC researchers
- **Parking deck and plaza:** 1,000-space parking deck and adjoining plaza
Estimated cost: \$15.5 million; financing by the city of Columbia and Richland County

SOURCES: Staff reports; University of South Carolina; McClatchy-Tribune graphics; www.beginnersguide.com; Department of Energy; LOGANEnergy Corp

HELPING HANDS

Key organizations helping South Carolina move into the hydrogen economy:

South Carolina Hydrogen and Fuel Cell Alliance

www.schfca.org

An organization coordinating hydrogen initiatives around the state. Founding members include USC, Clemson, S.C. State University, the Savannah River National Laboratory and the Center for Hydrogen Research in Aiken. Housed in, but is not part of, the S.C. Department of Commerce. **Executive director: Shannon Baxter-Clemmons**

EngenuitySC

www.engenuitysc.com

A strategic leadership group dedicated to spurring the creation and expansion of knowledge-based companies in the Midlands. The non-profit is using a \$1 million federal grant to create the National Institute of Hydrogen Fuel Cell Commercialization at USC. The institute will be a business incubator with a wet laboratory. EngenuitySC also has awarded project grants for: a backup power system at Benedict College, a hands-on exhibit at EdVenture children's museum, portable batteries for ETV cameras, a power pack for Columbia emergency officials, a citizens school at USC and a USC project involving Segway personal transporters. **Executive director: Neil McLean**

S.C. Research Authority

Since 1983, this state agency has helped meet the physical needs of technology-based companies as they move to South Carolina. It also manages some research parks that are home to technology-oriented companies. About 40 firms employ 6,000 people in parks near Clemson University, USC and MUSC. **Executive director: Bill Mahoney**

USC-Columbia Fuel Cell Collaborative

www.fuelcellchallenge.com

The collaborative was formed in 2005 by USC, the city of Columbia, EngenuitySC and the S.C. Research Authority to help make the Midlands a leader in fuel cell innovation. The collaborative has issued the Greater Columbia Fuel Cell Challenge to attract demonstration projects to the city before the 2009 National Hydrogen Association meeting.

Center for Hydrogen Research

www.scch2r.org

Opened in February 2006, the 60,000-square-foot laboratory is located near the Savannah River National Laboratory in Aiken County. Researchers from academia and industry, including Toyota, work there, as well as about 50 researchers from SRNL. **Director: Fred Humes**

New Carolina

www.competesc.org

A public-private partnership formed in 2004 as the S.C. Council on Competitiveness. New Carolina helps develop "clusters of innovation" — groups of companies in a similar line of business that collaborate to build and expand their products and services.

Executive director: George W. Fletcher

FuelCellSouth

www.fuelcellsouth.com

A Columbia-based collaboration of researchers, entrepreneurs and industry players that supports the Southeast's growing fuel cell and hydrogen economy. People from 11 states will converge on Columbia May 2-4 for FuelCellSouth's fourth annual expo.

Executive director: Tom Militello

ON THE WEB

ONE TO WATCH: House speaker Bobby Harrell, USC president Andrew Sorensen and USC biomedical professor Richard Swaja talk about recruiting star researchers. On www.thestate.com

THE HYDROGEN RESEARCHERS

Here are some of the scientists at USC, Clemson University and the Savannah River National Laboratory working to make the state a leader in hydrogen fuel-cell commercialization. USC's faculty has been doing hydrogen research for two decades and so includes two generations of academic mentors. Ralph White was John Van Zee's doctoral adviser at Texas A&M. At USC, Van Zee was adviser to John Weidner, Sririvatch Shimpalee and Shannon Baxter-Clemmons, who moved from California to be the director of the S.C. Hydrogen and Fuel Cell Alliance.



MICHAEL AMIRIDIS

Amiridis, 44, is dean of USC's College of Engineering and Information Technology. The native of Greece is an expert in microscopic catalysts, vital to fuel cells' operation. He has published 67 scholarly papers and holds a patent for a process that reduces sulfur in gasoline. He has long collaborated with industry.



BRANKO POPOV

Popov, 66, is director of USC's Center for Electrochemical Engineering. His research is funded by various federal agencies and private industries. In 2003, his team won a DOE grant to develop catalysts for fuel cells. He has published 161 scholarly articles and worked on 45 funded research projects. His research seeks new materials for batteries, capacitors and fuel cells.



BILL SUMMERS

Summers, 58, is a Savannah River researcher and a USC adjunct professor. He is an expert in producing hydrogen from nuclear reactors. During his 25 years at Westinghouse and Savannah River, he developed the storage system used in the nation's first hybrid hydrogen-electric bus, operated in Augusta, Ga., and John Deere's "Gator" vehicles.



DON ANTON

Anton, 52, joined Savannah River in 2005 after 20 years leading hydrogen storage studies at United Technologies Research. He leads a program involving national laboratories from Germany, Japan, Canada and the United States in a study of whether new solid-state materials are safe for hydrogen storage.



KENNETH REIFSNIDER

Reifsnider, former director of the Connecticut Global Fuel Cell Center, is one of USC's latest recruits and its only member of the National Academy of Engineering. Reifsnider, 67, aims to make fuel cells an economical substitute for fossil fuels. He works with solid-oxide fuel cells, which convert chemical to electrical energy — like batteries, except they don't lose power. Applications include power distribution for cities, rural areas and industries and power for homes.



MARK THIES

Thies, 52, is a professor of chemical engineering at Clemson. He studies ways of splitting water into oxygen and hydrogen. Thies heads the leading U.S. team seeking a safe casing for the chemical reaction.



YUH J. CHAO

Chao, 53, is a professor of mechanical engineering at USC. He studies failure, fracture and fatigue of materials necessary for the manufacture of fuel cells.



JAMES RITTER

A professor of chemical engineering at USC, Ritter, 46, has published almost 100 academic articles. He studies the scientific phenomena behind hydrogen storage, separation processes and materials science.



JOHN WEIDNER

Weidner, 44, is professor of chemical engineering and interim associate dean for research in USC's College of Engineering and Information Technology. His research group is working to develop electrocatalysts that might contribute to a thermo-chemical cycle to generate pure hydrogen.



STEVE CREAGER

Creager, 46, is a chemistry professor and associate dean of Clemson's graduate school. He works with four professors, including Darryl DesMarteau and Dennis Smith, and 15 graduate students and postdoctoral scientists. They are working to develop fuel cell membranes that can withstand temperatures greater than 110 degrees centigrade.



SIRIVATCH SHIMPALEE

Shimpalee, 36, teaches mechanical engineering at USC. A modified version of software developed during his USC doctoral research was licensed to a New York company. With the help of the USC technology transfer office, he started Palmetto Fuel Cell Analysis & Design LLC, which has expanded and issued new versions of his software.



RALPH WHITE

Former USC engineering dean Ralph White, 64, develops models to predict performance in batteries. He has \$5.7 million in active research grants. White has published 278 scholarly papers and has 41 book contributions to his credit.



DARRYL DESMARTEAU

DesMarteau, 66, is a Clemson partner with Steve Creager and Dennis Smith in federally funded fuel cell research. The researchers won a DOE \$1.5 million, five-year grant to develop polymer membranes, necessary for fuel cells to generate electricity to power cars.



DENNIS SMITH

Smith, 41, is a Clemson professor of organic chemistry and a research partner of Steve Creager and Darryl DesMarteau. He is part of a DOE project to create a fuel cell using highly conductive and durable plastic that will last the life of a car. He did post-doctoral work in France and Germany and with the Dow Chemical Co.



JOHN VAN ZEE

Van Zee, 54, teaches chemical engineering at USC. He is the founding director of America's only National Science Foundation center for joint industry-university fuel cell research, located at USC. Van Zee's team is working to scale up designs from laboratory-size reactors to full-scale fuel cells and batteries.



MICHAEL MATTHEWS

Matthews, 50, chairs USC's Department of Chemical Engineering. An expert in hydrogen storage, Matthews and John Weidner are being supported by the National Science Foundation and the U.S. departments of defense and energy. He is studying the synthesis of specialty chemicals.



RAGAIY ZIDAN

Zidan is one of world's top solid-state hydrogen researchers. His work at Savannah River has changed the direction the world is taking in hydrogen storage materials research. Among his developments is a patented process that produces novel storage materials. Zidan was previously at the University of Hawaii.

NANOSCIENCE RESEARCH

What is it?

The nanosciences study materials and particles that measure a nanometer in size. A pin head is about a million nanometers wide. Materials behave differently at such a small scale, leading scientists to imagine new substances and products.

USC's work could help fuel cells work more efficiently and more cheaply. Polymer nanocomposites could add value to the S.C. plastics industry, which employs about 26,000 people.

How much has been spent or committed thus far?

\$4 million for an endowed research chair in the field of nanoelectronics; with a required match in federal, institutional or private funds.

\$3.5 million, with a required match, for an endowed chair in polymer nanocomposites.

\$2.8 million in federal grants to 20 USC faculty members and 10 student researchers led by Davis Baird, dean of the Honors College. The professor of philosophy is studying the ethical, legal and social implications of nanoscience research, funded by the federal government at about \$1 billion a year.

\$1.4 million from the National Science Foundation over five years to examine the role of images in communicating about nanotechnology and how the research is changing the methods of the researchers.

\$800,000 from the W.M. Keck Foundation, with the Scripps Institute, for the establishment of the W.M. Keck Open Laboratory for BioNanoparticles.

\$4.4 million in annual income generated by the center.

What has happened thus far?

Richard Webb, a physics professor specializing in nanoscale electronics, is expected to jump-start USC's nanoscience research. Webb was lured from the University of Maryland to hold USC's first endowed chair.

USC hired Thomas Vogt, a researcher in chemistry, physics and hydrogen storage at Brookhaven National Laboratory in New York, as director of its NanoCenter.

The NanoCenter is spread across several buildings. USC is not yet ready to build a free-standing nano research center.

What's next?

USC is recruiting a researcher for the endowed chair in polymer nanocomposites. The field likely will be the NanoCenter's first area of study that becomes self-supporting.

ENVIRONMENTAL RESEARCH

What is it?

USC is tackling some of the state's thorniest environmental problems: water quality and management of the soaring demand for the state's relatively small river resources.

That research doesn't always grab headlines, said USC president Andrew Sorensen, but it's crucial to the state's continued growth and quality of life.

A key player in the growing field is USC's Madiyn Fletcher, dean of the School of the Environment. She coordinates research across various colleges and departments, as the school has no faculty of its own.

How much has been spent or committed thus far?

\$2 million from the Legislature last year, which came with a major mandate. The money will create an Genomics Center to study the microscopic organisms of the state's rivers and streams. It also will help recruit four to six faculty members with the expertise to support the research.

\$1.1 million from the National Oceanic and Atmospheric Administration to help water resource managers in the Carolinas make better use of climate data to lessen the effects of drought.

What's next?

The school is seeking an additional \$2 million from the Legislature for the Genomics Center.

USC scientists have some exciting ideas about how to extract sulphur from water and improve water quality in the Congaree River as it flows to Lake Marion and the Atlantic Ocean, Sorensen said.

BIOMEDICAL RESEARCH

What is it?

This area of research involves all three research universities. South Carolina's large hospitals and medical schools are collaborating under the name Health Sciences South Carolina. The goal is to make the state competitive for federal grants with research giants such as Johns Hopkins and Duke universities.

How much has been spent or committed thus far?

\$64.5 million in state lottery money for seven endowed professorships in biomedical field since 2002, including \$10 million each for the Center for Clinical Effectiveness and Patient Safety, the Center for Regenerative Medicine and for brain research and imaging; the three research schools must match the state funds with private or federal grants.

\$21 million announced in August from the Duke Endowment to Health Sciences South Carolina.

\$33.9 million for USC's Discovery Plaza, a biomedical research complex under construction in the Vista.

\$220 million for Health Sciences SC facilities, half from the institutional partners and half from the General Assembly. Includes \$70 million in state funds for three research buildings at MUSC, to be matched by private and federal grants.

\$504 million between June 2005 and June 2006 in combined federal and private research grants among the six partner institutions in Health Sciences SC.

What has happened thus far?

The consortium initially linked USC, MUSC, Columbia's Palmetto Health system and the Greenville hospital system. It now includes the Spartanburg hospital system and Clemson University.

What's next?

The big payoff — attracting research-generating companies and jobs — remains in the future. N.C. developer Craig Davis says he plans to break ground in about a year on his private-partner building on the Discovery Center block. And state lawmakers are expected to approve another \$30 million this year for endowed chairs; it's too early to know how much will be for biomedical studies.

State positioning itself to win in the hydrogen world

By James T. Hammond
jhammond@thestate.com

In trying to build the best hydrogen fuel cell research team in America, South Carolina has taken a page from George Steinbrenner's playbook for building a great baseball team: Hire your competitors' best players.

And, like the flamboyant New York Yankees owner, South Carolina has gotten good at it.

■ The S.C. Hydrogen Coalition, which promotes the hydrogen economy in the state, hired as its new director Shannon Baxter-Clemmons, hydrogen fuel cell adviser to California Gov. Arnold Schwarzenegger.

■ To manage its new technology campus, which will be home to the hydrogen fuel cell team, USC lured John Parks away from a successful run as manager of the University of Kentucky's technology park.

■ USC this spring hired Kenneth Reifsnider, director of the Connecticut Global Fuel Cell Center. Reifsnider has strong ties to United Technologies Corp., a fuel cell innovator with a huge interest in how hydrogen might hit the marketplace: Its subsidiaries make Carrier heating and air conditioning systems, Otis elevators and Pratt & Whitney aircraft engines.

Reifsnider's departure created a bit of a buzz for South Carolina – and some panic in Connecticut.

When the news slipped out, Joel M. Rinebold of the Connecticut Hydrogen-Fuel Cell Coalition told *The New York Times* that South Carolina fuel cell education and training are tops in the nation.

But can South Carolina attract the right brainpower to become a leader in the "hydrogen economy"? To be to hydrogen what the Silicon Valley is to computers?

It doesn't hurt that South Carolina has a growing economy – and yes, the weather is nice.

But there are other reasons South Carolina's high-stakes gambit might succeed:



Carl Smith, deputy director of the fuel cell research area of USC, explains the fuel cell to students in the Citizen's School of Fuel Cell and Hydrogen Technology.

PHOTOGRAPHS BY RICH GLICKSTEIN THE STATE

■ South Carolina's approach is a statewide one, with public and private cooperation.

■ USC researchers have been breaking ground in hydrogen fuel cell research for several years.

■ USC for four years has been home to the country's only National Science Foundation Industry/ University Cooperative Research Center for Fuel Cells.

USC's School of Engineering has as many as 20 researchers at the center conducting cutting-edge research. And big-name industries are signing on as corporate partners.

The center's mission is to hit the industry's multibillion-dollar home run: Develop the technology to make fuel cells commercial – useful in everyday life – possibly even replacing electricity, batteries and gasoline as energy sources.

■ The state has something few others have – a former nuclear weapons plant with 50 years of experience in producing and storing hydrogen. USC and the Savannah River National Laboratory near Aiken are sharing technology and expertise. And Aiken County has built a center just outside the plant to help transfer technology developed in the public sector to the private sector.

■ Clemson University's automotive research campus in Greenville, CU-ICAR, is getting ready to provide real-world testing for fuel cells developed for automobiles, thanks in large part to industry giant BMW, whose only North American plant is a dozen or so miles away.

■ Clemson scientists have contributed major breakthroughs in improving membranes necessary for fuel cells.

■ The state's fledgling endowed chairs program is providing the real money it takes to attract more top researchers.

"If we are going to win, if we are going to move the university forward, we don't just need a few stars, we need a constellation," said John Van Zee, a core driver of USC's fuel cell efforts and director of

What You'll Learn

South Carolina is considered a serious contender for attracting top jobs in the hydrogen-based economy.

South Carolina's statewide approach wows researchers and industry leaders alike.

In the world of hydrogen, producing and marketing new products – entrepreneurship – will be as lucrative as making early scientific breakthroughs. South Carolina is positioning itself to do both.

It was Harris Pastides, then public health dean, who suggested to USC officials that University of Alabama president Andrew Sorensen might be interested in a move to USC. Sorensen has been USC's president now for almost five years, and is a key driver in the state's research push; Pastides is his vice president for research.

the National Science Foundation center. “That’s part of what we are trying to create here with these endowed chairs.”

MORE THAN ONE WAY TO WIN

Getting the science right will not be enough to make the state a world leader in an emerging industry.

Granted, whichever state makes the big breakthrough in the commercialization of hydrogen will attract researchers, federal dollars, private industry and jobs like a flame draws moths, like California attracted gold diggers in 1849.

But converting the science into products and services is another way to become a major player in a hydrogen-driven world.

To boost the state’s chances in finding applications for hydrogen, Clemson has brought in David Bodde, a former executive with the National Academy of Sciences and an expert on entrepreneurship. Bodde in February participated in a National Academy conference on the future of the hydrogen economy.

“I think we can win in this independent of where the breakthrough comes from in the science,” Bodde said. “We’d like it to happen here, of course. But the entrepreneurship will be key to economic success.

“(Clemson is) a player. We don’t have a huge lead. We are kind of small in the game, but we have some advantages,” Bodde said.

Bodde cites a \$2 million grant Clemson received from the Department of Energy to study the effects of impurities in hydrogen fuels. “If we weren’t getting these types of awards, we’d have to question our ability to play. But we are getting them.”

USC has received similar grants, including \$2 million from the Department of Energy to collaborate with industry on high-temperature membranes, new catalysts and gaskets and seals, and \$1.7 million from DOE for research on non-platinum catalysts.

Tom Vogt, director of the USC NanoCenter, also expects his department to be a player in the commercialization of fuel cells.

“As an incubator (for new businesses), the question is always: What is the big picture? What is the end game?” Vogt said.

“The end game is that you become a sustainable entity, I mean scientifically, with world renown, and financially self-



Students Guy Jones, left, of Columbia, and Matt Yow of Blythewood look at a fuel cell during a tour at USC. Photo by Rich Glickstein *The State*

supporting,” Vogt said.

USC’s challenge, Van Zee said, has been to single out one or two fields of study with major commercial potential, and to excel in those areas.

“We can’t be excellent in everything,” Van Zee said.

The National Science Foundation endorsement has given the state great momentum. And it, in particular, has helped create a national buzz about fuel cell research in South Carolina.

But South Carolina has serious competition.

Ohio has invested more than \$40 million in 30 fuel cell-related projects throughout the state. Last December, Rolls-Royce PLC, a British maker of power systems worldwide, announced it would build the U.S. headquarters of its fuel cell subsidiary in Ohio.

And California has been very successful in attracting private investment when the state has primed the pump. In just four southern California counties, \$11 million in state incentives has generated \$100 million in private investments.

But Bodde says those investments in current technology don’t necessarily rule out South Carolina as a player in future breakthroughs. One major scientific milestone could make all that investment in transitional technology obsolete, he said.

A LONG-TERM VISION

Most marketplace applications are years away. In South Carolina, the gains being made now are small but significant.

The state has not yet produced its own Bill Gates, the chairman of Microsoft, or Steve Jobs, who runs Apple Computer. But Van Zee believes the culture being created in Columbia could lead to an emerging company with a scientific breakthrough that will lead the transition to a hydrogen-fueled economy.

“We hope, with these endowed chairs and with the education our students are getting, to create some of those types of companies,” Van Zee said. “We are beginning to see some of our young Ph.D. graduates file for corporate charters with the state.”

“I think this is a real change for Columbia, for such companies to grow out of this university,” Van Zee said.

Vogt, the USC NanoCenter director, cautioned that the goal of economically sustainable industries built on academic research will be a multigenerational effort.

“Rarely do you have the people who have the vision and can then implement it,” Vogt said. “It is a different set of skills, a different culture even.”

“So I look at this as a very long ball game, and the guys who are on the mound pitching now will have made their contribution to the ballgame. And when you walk off in the ninth inning, even the guy who pitched in the first inning did his part,” Vogt said.

Players

Some of the people helping USC and the state build a hydrogen economy.

Shannon Baxter- Clemmons, S.C. native and director, S.C. Hydrogen and Fuel Cell Alliance. Wants South Carolina to craft more detailed blueprint for hydrogen economy. Formerly assistant secretary for hydrogen and alternative fuel policy at California Environmental Protection Agency; led development of California Hydrogen Blueprint Plan for Gov. Arnold Schwarzenegger.

Lee Bussell, CEO of Chernoff Newman marketing firm and chief consultant on marketing for USC's Innovista campus. Firm shapes communication plans for high-tech businesses and hones the Innovista brand.

Bill Boyd, head of Waterfront District Steering Committee. Leads committee working to secure public funding for a \$77 million riverfront park that will extend USC's Innovista to the Congaree River.

Reinhardt Brown, interim director, James C. Clyburn Transportation Center at S.C. State University in Orangeburg. Leads institution's research on mechanics of fuel cells and making better containers for liquid hydrogen fuel.

James Clyburn, Democratic majority whip, U.S. House. Holds key congressional power to back federal funds for South Carolina's hydrogen fuel cell initiatives. Legislative patron of Clyburn Transportation Center, a partner in state's fuel cell development.

Bob Coble, Columbia mayor. Shaping Columbia's vision of itself as a world center in the emerging hydrogen economy.

Craig Davis, developer of N.C. State's Centennial Campus and USC's lead private development partner. Contracting to build two private-sector research buildings as match for two statefunded USC research structures.

Lindsay Graham, U.S. senator. Exhorting state leaders to present a common front in campaign to make South Carolina a world center of hydrogen fuel cell development.

Guignard family, longtime owners of largest undeveloped property in Columbia's Vista. Partnering with USC to plan development of 500 acres from USC's Horseshoe to the Congaree River, complete with a riverfront park with condos at its edge.

Bobby Harrell, S.C. House speaker. Carries banner of hydrogen fuel cell advocates in General Assembly, saying it is one of his most important priorities. Sponsor of state incentives for hydrogen fuel cell companies that locate in state.

Fred Humes, director, Center for Hydrogen Research, in Aiken County, adjacent to the Savannah River National Laboratory. Spearheads county-owned center that works to transfer government-funded research to the private sector. Early advocate of collaboration between USC, Clemson and the Savannah national laboratory

Bob Inglis, U.S. House member from Greenville. Conceived national "H" Prize, an award for breakthroughs in hydrogen fuel cell research. Leads efforts to make hydrogen fuel development a priority in the U.S. House.

Rick Kelly, USC vice president of business affairs. Juggles USC's research campus construction within a hefty list of 21 USC projects worth \$315 million. Builds on experience managing renovation of the State House while with the State Budget and Control Board.

John Lumpkin Jr., senior consultant for Consera Healthcare Real Estate Services. Continues to advise hydrogen advocates after serving as Innovista interim director. USC vice presidents Harris Pastides and Rick Kelly asked him to step in as a bridge to the private sector until an Innovista director was hired.

Neil McLean, executive director of EngenuitySC, a strategic leadership group dedicated to building Columbia's high-tech economy. Secured \$1 million federal grant to create the National Institute of Hydrogen Fuel Commercialization, an Innovista incubator for startup research companies.

John Parks, executive director of Innovista. Newest member of the USC team, he brings a track record of luring private industry to the University of Kentucky.

Harris Pastides, USC vice president for research and health sciences. Knocks on doors in Washington offices of National Science Foundation and National Institutes of Health. Recruits star researchers from competing institutions.

Andrew Sorensen, USC president. Takes office declaring he'll make USC a premier research institution. Forges working partnerships with Clemson University president Jim Barker and Medical University of South Carolina president Ray Greenberg.

Samuel Tenenbaum, retired Lexington businessman. Early and ardent advocate of a lottery-funded endowed chairs program to attract academic stars to South Carolina. Inaugural member and chairman of state board that awards endowed chair grants.

Board members of the USC Research Campus Foundation, which helps oversee campus growth. Chosen for their ability to open doors nationally and internationally. Serving with Larry Wilson are: **Ray Greenberg** of Charleston, president of MUSC; **Don Herriott** of Florence, head of Roche Global Chemical Manufacturing; **Pike Powers**, of Austin, Texas, an attorney considered a driving force behind Austin's shift to a knowledge-based economy in the 1980s; and **Mack Whittle** of Greenville, chief executive of The South Financial Group and former chairman of USC's trustees.

Sonny White, president of Midlands Technical College. Pledges his two-year college will supply lab technicians to staff Innovista. The school also plans to build an incubator for startup companies producing fuel cell components.

Larry Wilson, Columbia venture capitalist, board member of the USC Research Campus Foundation and early vocal advocate of a research campus. Chairman of Duck Creek Technologies insurance software company, Innovista's first tenant.

Todd Wright, director, Savannah River National Laboratory near Aiken. Guides nation's newest national laboratory in partnership with USC to exploit and commercialize 50 years of federal scientific research with hydrogen.

A new economy

S.C. leaders want to encourage research that creates knowledge-based, high-tech companies, then convince the companies to keep their headquarters—and their jobs—there. The path so far:

NOV. 7, 2000

S.C. voters approve a state-operated lottery that earmarks profits for education.

SPRING 2001

Midlands leaders begin to talk about a research initiative paid for with lottery profits. Sen. Tommy Moore, D-Aiken, proposes using \$6 million a year to attract top researchers to USC, Clemson and MUSC.

FEB. 21, 2001

Mayor Bob Coble convenes about 200 city and business leaders for what will become an annual technology summit. They pledge to develop a technology-based economy for the Midlands, in part through local incentives.

SEPTEMBER 2001

Gov. Jim Hodges' Technology Transition Team, headed by Harry Lightsey III, president of BellSouth-South Carolina, unveils a new state economic development strategy. The plan urges attracting more investment capital and setting up "endowed chairs" for luring world-class research scientists. Similar proposals have fallen short. But Lightsey says this one marks "a turning point."

OCTOBER 2001

State politicians, university presidents and business executives visit N.C. State University's Centennial Campus in Raleigh to gather ideas for a catch-up strategy in the research race. "There's no reason why South Carolina can't do this," says House Speaker David Wilkins.

JANUARY 2002

USC president John Palms and Westinghouse's Savannah River Technology Center sign an agreement for collaborative hydrogen research.

EARLY 2002

When USC trustees call for nominations for a new president, Harris Pastides, dean of the public health school, quietly submits suggested search committee chairman William Hubbard the name of a former colleague, University of Alabama president Andrew Sorensen.



Ming Au, a principal scientist at the Savannah River National Laboratory in Aiken, measures hydrogen emissions at different temperatures. He does most of his work in the inert argon atmosphere of a glove box. Photo by Tim Dominick *The State*

MAY 2002

Legislators authorize \$200 million over several years, beginning in 2003, for endowed research chairs at Clemson, USC and MUSC. The grants must be matched with private, school or federal money.

JULY 1, 2002

Sorensen declares on his first day on the job that his main focus will be making USC a premier research institution. He touts public-private partnerships he helped forge at the universities of Alabama and Florida. He boosts Pastides to interim vice president for research.

SEPTEMBER 2002

BMW Manufacturing, the Upstate arm of the German luxury carmaker, pledges \$10 million to help create an automotive research center for Clemson in Greenville. The move jump-starts a project conceived as a wind tunnel lab for NASCAR.

DECEMBER 2002

Pastides says USC must focus on fewer areas of research, saying nanotechnology and biomedical research look promising. Some liberal arts professors question the increased focus on the sciences.

FEBRUARY 2003

At the city's annual technology summit, Coble launches an ambitious plan to reshape the Midlands economy by recruiting emerging technologies. Sorensen announces USC wants to build a massive downtown research campus, using a study provided by Craig Davis. Davis developed N.C. State University's Centennial Campus in Raleigh, a 1,300-acre research park with 60 tenants and 1,500 employees.

JUNE 2003

City leaders establish the Columbia Regional Technology Council, 11 people dedicated to making the region a hub of high-paying, high-tech jobs.

JUNE 2003

The National Science Foundation selects USC's engineering college as the only NSF-designated Industry/University Cooperative Research Center for Fuel Cells. The center will develop technology to commercialize fuel cells.

JUNE 2003

Clemson demands and receives half of that year's \$30 million for endowed chairs. President Jim Barker and board chairman Bill Amick tout their automotive project's momentum and its sponsor, BMW. In a Solomonlike gesture to USC and MUSC, the endowed chairs board reaches into the next year's allotment for \$11 million more.

SEPTEMBER 2003

USC hires Davis to develop its research campus. He will build space for private industry next to USC's research buildings and help the school recruit private investment and tenants for those buildings.

NOVEMBER 2003

Sorensen names Pastides to the new position of vice president for research and health sciences.

DECEMBER 2003

USC hires away from the University of Maryland a top-tier physics professor to hold its first endowed chair. Richard Webb, courted by USC for more than a year, is expected to jump-start the school's fledgling nanoscience program.

FEBRUARY 2004

Clemson hires Robert T. Geolas as director of its International Center for Automotive Research (ICAR) in Greenville. Geolas is a past coordinator of Raleigh's Centennial Campus.

FEB. 19, 2004

Greenville-based Michelin North America says it will give Clemson \$3 million for a professorship in vehicle electronic systems integration.

MARCH 2004

The Legislature approves the Life Sciences Act, which creates a \$50 million state-run venture capital fund and reserves up to \$220 million to build research facilities at USC, MUSC and Clemson if the schools provide matching funds. The law also makes it easier to partner with private developers. Republican Gov. Mark Sanford vetoes the bill, but lawmakers override him.

APRIL 2004

Greenville Hospital System and Columbia's Palmetto Health join USC and MUSC to form Health Sciences South Carolina. The goal is to attract major research grants that none could hope to win alone.

MAY 2004

The U.S. Department of Energy designates the Savannah River Technology Center a national laboratory, a status that could convert the former atomic weapons plant into a magnet for hydrogen fuel research.

MAY 10, 2005

USC unveils plans for three research buildings, two private buildings and two parking garages as Phase I of a research campus. The \$141.2 million plan includes Foundation Square, across Lincoln Street from the Colonial Center, which Pastides calls "the town square of the whole research campus."

MAY 24, 2005

Sen. Lindsey Graham, R-S.C., worries the cacophony of S.C. voices coming to Washington for assistance with hydrogen fuel cell research is eroding the state's effectiveness. He summons more than a dozen leaders and forcefully encourages them to work together.

JUNE 28, 2005

Rep. Bob Inglis, R-S.C., forms the U.S. House Hydrogen and Fuel Cell Caucus.

JULY 2005

Clemson hires Thomas Kurfess, a mechanical engineering professor at Georgia Tech, to fill the BMW endowed chair and serve as director of the Carroll A. Campbell Jr. Graduate Engineering Center.

SEPTEMBER 2005

USC unveils a new name and concept for its 200-acre campus in Columbia's Vista. "Innovista" is a unique urban model, Pastides says. Most research parks are separate from main campuses and have restricted access. USC's campus "will be as much a part of city of Columbia as a part of the University of South Carolina," he says.

SEPT. 15, 2005

Toyota Motor Corp. partners with the Center for Hydrogen Research in Aiken County, adjacent to the Savannah River National Laboratory, to develop a lightweight, affordable fuel storage system for future hydrogen-powered autos.

SEPT. 16, 2005

The state's research infrastructure panel approves \$10.8 million for USC's NanoCenter. It gives Clemson \$24.6 million for various research facilities, and Health Sciences South Carolina, \$4.5 million.

NOVEMBER 2005

The J.E. Serrine Textile Foundation, a donor to higher education since 1944, liquidates itself, giving its \$5.6 million to Clemson for two endowed chairs in advanced fibers research. The move is rich in symbolism – a passing of the torch of economic power from the state's textile barons to new sciences and technologies.

MARCH 2006

USC wins the elite Carnegie Foundation designation as an institution of "very high research activity." The moniker goes to 62 public and 32 private U.S. research institutions.

APRIL 2006

USC and Columbia's Guignard family unveil a master plan for 500 acres in downtown Columbia, including Innovista's 200 acres, with a large riverfront park at its core. USC says the plan, a guide for developers, would create a modern urban environment to attract world-class scientists and their assistants.

JUNE 2006

EngenuitySC and USC announce plans for an incubator for fuel cell companies in Innovista. EngenuitySC, a strategic leadership group, will use a \$400,000 federal grant to build the specialized wet-lab required.

AUGUST 2006

The Duke Endowment announces a \$21 million, three-year grant to Health Sciences South Carolina. It is the largest grant ever made by the endowment's \$2.7 billion health care division and is viewed as an affirmation of the state's decision to develop its health sciences.

OCTOBER 2006

The Ohio-based Timken Co. opens a \$30 million research center in Greenville expected to employ nearly 200 local workers within months.

NOVEMBER 2006

USC takes a blow when an unnamed Fortune 100 company that was to take over a large part of Innovista's first privately developed building pulls out.

DECEMBER 2006

House Speaker Bobby Harrell, R-Charleston, proposes \$15 million in state grants and credits go to companies conducting hydrogen fuel research in the state and partnering with S.C. institutions. Harrell also proposes boosting the state's LIFE and Palmetto Fellow college scholarships for students studying math, science or engineering. LIFE grants would rise to \$7,500; Palmetto grants, to \$10,000.

JANUARY 2007

USC recruits the head of the University of Connecticut's fuel cell center to direct its new solid oxide fuel program. Kenneth Reifsnider praises the state's research assets, state lawmakers' commitment and the high level of cooperation between the business sector, research institutions and local governments.

JANUARY 2007

USC announces the appointment of John Parks, director of the University of Kentucky's Coldstream research park, as executive director of Innovista.

JANUARY 2007

"The Greater Columbia Fuel Cell Challenge," an alliance of the city's hydrogen-friendly organizations, calls for proposals to build a hydrogen fueling station in Columbia by July 1, 2008. The station, and a hydrogen-fueled bus for USC's campus, would be in place for the annual convention in Columbia of the National Hydrogen Association in Spring 2009.

Sizing up the competition

Five states are South Carolina's main competitors in the race to develop fuel cell technology and a hydrogen-based economy.

CALIFORNIA

In anticipation of hydrogen-powered cars hitting the market, California Gov. Arnold Schwarzenegger launched a \$90 million program in 2004 to build a "Hydrogen Highway," dotted with 24 fueling stations, by 2010.

The project is a partnership of state agencies, universities, commercial automakers and energy companies and will receive at least \$35 million from the U.S. Department of Energy.

Government and private agencies are working together under a plan called the Hydrogen Highway Blueprint.

FLORIDA

H2 Florida, a program to accelerate the commercialization of hydrogen, was launched in 2003 as a venture between industry, local governments and universities.

The state has committed \$21 million in the past two years. And Florida has designated the hydrogen technology industry eligible for tax incentives.

The Florida Hydrogen Business Partnership is developing a private-public strategy to bring hydrogen energy technologies to market as rapidly as possible.

MICHIGAN

The nonprofit NextEnergy center started in 2002 with \$30 million from the Michigan Economic Development Corp.

The center is charged with accelerat-

ing research, development and manufacturing of alternative energy technologies. Michigan, for decades the heart of the auto industry, will give NextEnergy \$52.5 million over the next three years.

Most major automakers are making major investments in developing hydrogen fuel cells, which could begin appearing commercially within two decades.

NEW YORK

The New York State Hydrogen Energy Roadmap provides the state a strategy for developing a hydrogen-based fuel economy.

The goal is for hydrogen by 2020 to serve as a fuel for vehicles, buildings and power plants.

Wide-ranging initiatives, including tax credits, incentives and state purchasing programs, encourage hydrogen power. The governor and the state's energy research agency have committed more than \$50 million so far.

OHIO

The Ohio Fuel Cell Initiative is a \$103 million effort to promote fuel cell technologies.

The Initiative is part of the Third Frontier Project, a \$1.1 billion program to create jobs and bring new products to market.

In late 2004, Ohio released the Ohio Fuel Cell Roadmap, a five-year strategic guide to maximize the involvement of Ohio companies in the fuel cell industry.

How South Carolina Ranks

The Kaufman Foundation ranked South Carolina's "new economy" against other states on a variety of factors as to how well it is able to attract high-wage, knowledge-based economy jobs.

Overall: 39	Entrepreneurial activity: 39
Foreign investment: 1	Work force education: 40
Exporting a focus of manufacturers: 15	High-tech jobs: 40
Technology in schools: 24	Scientists and engineers: 42
E-government: 28	Venture capital: 44
Broadband telecommunications: 30	
Fastest-growing firms: 33	

Imagine a world where nothing is plugged in

Columbia might get glimpse into future when it becomes Hydrogen City USA

By C. GRANT JACKSON
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Here's a peek at the future Cars and buses fueled by hydrogen cruise Columbia's streets, stopping at a local hydrogen filling station to "gas" up.

Police officers patrol the Vista on hydrogen fuel cell-powered Segway personal transporters designed by a USC professor.

Fuel cells, looking like oversized air-conditioning units, perch on scattered downtown rooftops, powering some USC buildings, downtown condos and apartments.

Even the scoreboard at USC's new baseball stadium is powered by fuel cells.

The gee-whiz applications are windows into the future – ideas of how much the technology could change modern life.

There still are plenty of scientific and technical hurdles that need to be overcome. But hydrogen and fuel cell technology could reverberate through our lives and our economy.

"It could be so revolutionary that it's hard for a scientist to think about the possibilities without feeling like he's dreaming," said John Van Zee, director of the National Science Foundation center for joint industry-university fuel cell research, located at USC.

The target date for at least demonstrating the innovations above – some of which are already up and running – is the 2009 National Hydrogen Association meeting to be hosted by Columbia.

For at least that weekend, Colatown will become Hydrogen City USA and an international showcase for fuel cell technology.

Some call the event Columbia's technology Olympics.

"This convention will be the most significant event in Columbia's economic history," said Mayor Bob Coble. "This is the largest convention we have ever had, and the most important."

TOOLING AROUND TOWN

Local leaders gearing up for the conference have launched the Greater Columbia Fuel Cell Challenge, asking companies for demonstration projects the city can show off.

Fuel cells are clearly still a nascent



John Parks, left, executive director of USC's Innovista, Mayor Bob Coble, and Richland County Councilman Joe McEachern tour the Innovista construction site where Duck Creek Technologies will become the first-private sector tenant. Photo by Tim Dominick *The State*

commercial market, and the USC-Columbia Fuel Cell Collaborative, which is sponsoring the challenge, is offering money to the products' developers.

The biggest project on tap for 2009 is a hydrogen refueling station that would serve the 40 futuristic cars expected to roll in as part of the conference.

Having the "gas" station pumping by July 1, 2008, is a top priority for the city.

What could pull up to the pumps first? How about a Beemer?

South Carolina, of course, is home to BMW's only U.S. plant.

During last week's national hydrogen conference, in San Antonio, the company introduced the Hydrogen 7, the world's first hydrogen-powered luxury car. (European journalists test-drove the car in December in Germany.)

Limited editions of the car will be built in Europe and eventually sold in the United States. But it will be a decade or more before hydrogen-powered vehicles made by BMW or other companies are common, experts say.

The Hydrogen 7 is a bi-fuel car, burning hydrogen or gasoline. When running on hydrogen, it produces no greenhouse gases or toxic emissions, only water and heat.

Also by the spring of 2009, a hybrid-electric fuel cell bus should be cruising

USC's campus.

The bus is part of the National Fuel Cell Bus Program. Bringing it to Columbia is a joint venture of USC, the S.C. Research Authority and the Central Midlands Regional Transit Authority.

The 37-passenger bus should run campus and city shuttle routes for up to a year.

And it will, in all likelihood, be the first opportunity for many people to ride in a hydrogen-powered vehicle.

The coolest hydrogen-powered ride in town, however, could be an H-powered Segway.

John Weidner, a USC professor of chemical engineering, is working on a

What You'll Learn

1. Academics and politicians, in a new show of solidarity, are working together to retool South Carolina's economy.
2. The state is spending hundreds of millions to position itself in the new knowledge-based economy. Leaders say it's a gamble that has to be taken—and now.
3. USC scientists excelled at hydrogen fuel cell research decades before state leaders saw it as a way to create jobs.
4. A Connecticut state official recently described South Carolina to *The New York Times* as the most competitive of the two dozen or so hydrogen-focused states.
5. USC has a key leg up in the work of fuel cell research: It is home to the nation's only National Science Foundation sponsored fuel cell cooperative. It allows industry and academia to share ideas, federal grants – and patents.



USC professor John Weidner holds a hydrogen canister used in a fuel cell. He's trying to develop a fuel cell supply source for Segway Personal Transporters. Lindsay Sample *The State*

demonstration project to put fuel cells in the trendy personal transporters.

The two-wheeled, mechanized scooter hit the market in 2002 and is already being used by police departments in cities such as Asheville, N.C.. Using fuel cells rather than electric batteries could give the transporter a larger range.

By 2009, Weidner hopes to have six fuel cell Segways to be used around the USC campus.

And he has turned the project into a business, so there could be orders for more.

Former graduate student Vijay Sethuraman worked with Van Zee on the project and earned a doctorate in chemical engineering in December. Sethuraman decided to stay in Columbia because of the buzz created by USC's focus on fuel cell research and development. Weidner thought that was perfect.

"Part of the challenge was to start businesses based upon our research," Weidner said. "He wanted to know if there was a way to start a business and stay in the area and work on fuel cells. I

told him that was exactly what Innovista (USC's research campus) is trying to do – to keep our talent base here."

Spinning off companies also can mean money for USC, which can share in the licensing or profits of the technology or the product developed.

PORTABLE POWER

While cars are the first thing people think of when they think of hydrogen, the earliest and most widespread use of fuel cells will likely come in a smaller package.

Portable power in the form of battery packs is expected to be among the first commercially viable uses.

Two projects are already under way in Columbia.

ETV is using hydrogen-powered batteries instead of conventional battery packs in a couple of video cameras. The hydrogen batteries are lighter and can be recharged more rapidly than the conventional packs.

ETV has used the cameras to cover a number of events, including a news conference at the State House. A crew recently used one of the cameras while shadowing state education Superintendent Jim Rex.

The Columbia Department of Homeland Security also has a fuel cell emergency power system, essentially a portable generator, for first-responders and police.

Everyday use, though, is still a high priority for researchers. Think small electronic devices: laptop computers, cell phones and Black-Berry devices.

"I actually think this new generation of information-on-demand will mean more than just better batteries," Van Zee said. "Most of us are looking for a way to free ourselves from the electrical outlet. Fuel cells have the possibility to do that."

HOMES AND OFFICES

Fuel cells also could transform the way people power their homes, severing their relationship with power companies.

Fuel cell systems the size of typical heat pumps, using hydrogen stored in a vessel resembling a propane tank, could produce enough electricity to run everything from washing machines to plasma TVs.

The only reason a hydrogen house would be on the power grid would be to sell electricity back to the utility company – a concept called net metering.

The same concept can apply to the workplace.

Benedict College soon will have a 5-kilowatt hydrogen fuel cell backup power system at its Project Sustain community center near the campus.

The unit also will be used as a teaching tool by Benedict faculty.

USC, since Fall 2004, has had a 5-kilowatt fuel cell in use, providing some of the power for USC's Green Dorm, in the West Quad on Sumter Street.

USC president Andrew Sorensen has challenged faculty, staff and students to come up with one fuel cell or other alternative energy project a year.

The first such project could be the scoreboard at USC's new baseball program – a key entertainment venue for the Innovista campus and the city's waterfront district near the Congaree River.

Hydrogen could be what makes the scoreboard flash.

But what hydrogen means to South Carolina can't stop at the glitz and gee whiz.

"The vision also must include new opportunities for people to work in South Carolina," Van Zee said. "That will be the means for economic growth in the future."

Staff writer James T. Hammond contributed.

Killed by the internal combustion engine ...

The surprisingly long history of fuel cells

William Grove, a Welsh judge, inventor and physicist, invented the fuel cell in 1839. He mixed hydrogen and oxygen in the presence of an electrolyte and produced electricity and water.

In 1889, researchers Charles Langer and Ludwig Mond coined the term "fuel cell" while trying to engineer the first practical fuel cell using air and coal gas. Little energy was generated.

From 1889 until the early 20th century, many people tried to produce a fuel cell that converted

coal or carbon directly to electricity. The development of the internal combustion engine set aside further work on fuel cells.

In 1932, Francis Bacon, a direct descent of Sir Francis Bacon, developed the first successful fuel cell. He used hydrogen, oxygen, an alkaline electrolyte and nickel electrodes. In 1952, he produced a 5-kilowatt system.

A large boost came from NASA in the late 1950s. NASA needed a compact way to generate electricity for space missions. Nuclear was too

dangerous, batteries too heavy, and solar power too cumbersome. NASA since has funded 200 fuel cell research contracts, and fuel cells were used on Apollo, Gemini and space shuttle missions.

Researchers now are working mainly to develop power systems for vehicles, as an alternative to gasoline. The fuel cells must be small and affordable and give off more energy than they use.

SOURCES: SAE international, the Smithsonian, fuelcelltoday.com, inventors.about.com