Finding Fissio

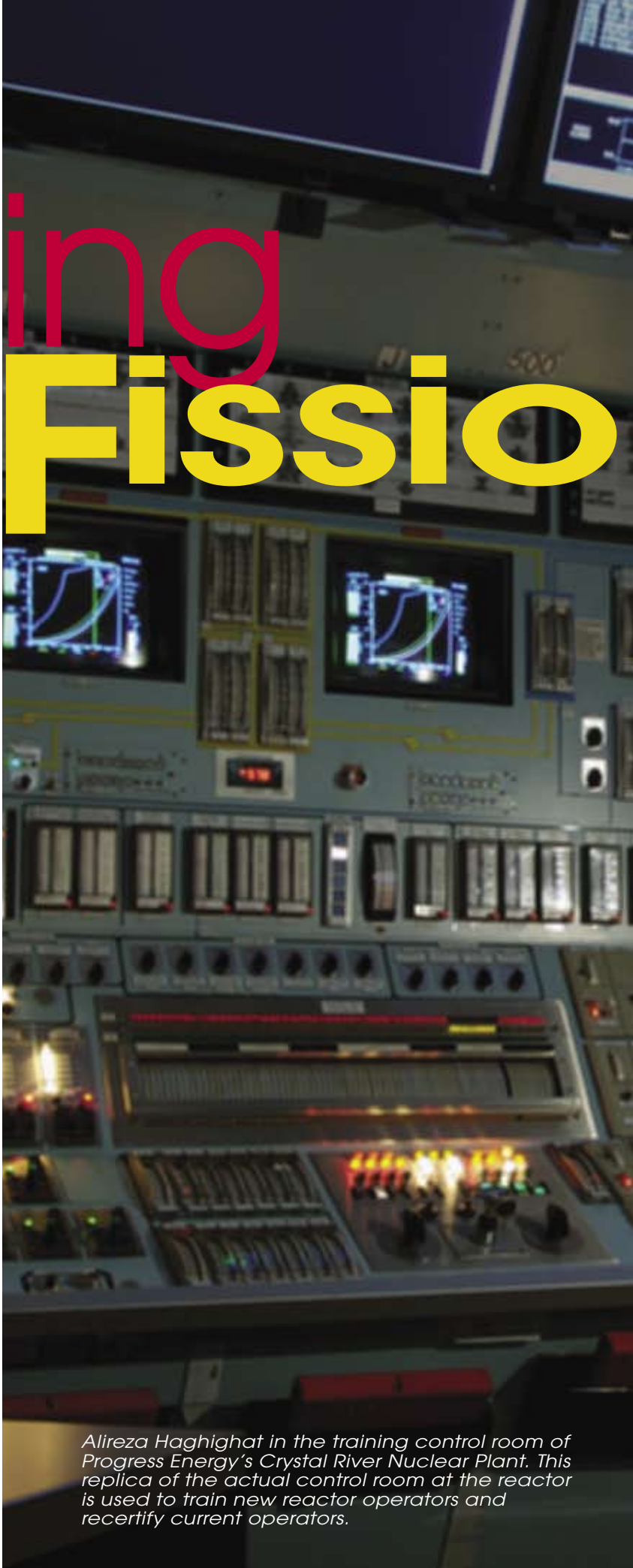
Soaring demand for electricity and concern about global warming have sparked new interest in UF's nuclear engineering program

By Aaron Hoover

As one of the nation's fastest-growing states, Florida's energy needs are ballooning. Policymakers estimate the state must boost electric generating capacity 58 percent by the year 2020.

A decade ago, public officials and utility leaders might have sought to address that looming demand primarily with new power plants fueled by natural gas or coal. But given soaring prices for natural gas and increasing concerns about fossil fuel emissions, a third option — new nuclear plants — appears more likely than at any time since the industry's heyday from the 1950s through the '70s. Across the nation, utilities are pursing at least 20 new nuclear plants, including Progress Energy's new facility planned on the west coast of Florida in Levy County.

"We're using the word 'renaissance' a lot with regard to nuclear power," says University of Florida Professor Jim Tulenko, an expert in nuclear fuels, former chairman of UF's nuclear and radiological



Alireza Haghighat in the training control room of Progress Energy's Crystal River Nuclear Plant. This replica of the actual control room at the reactor is used to train new reactor operators and recertify current operators.

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engineering department and past president of the American Nuclear Society.

Renewed interest in nuclear power has sparked a renaissance, too, in the Sunshine State's only academic unit devoted to nuclear research. UF's College of Engineering has seen a surge in students electing to major in nuclear engineering. Private as well as government research funding has soared. Administrators also have embarked on a makeover of the department's nuclear research reactor, the only such educational reactor in the Southeast. They want to widen access to the reactor not only to utilities, but also to medical researchers, nuclear security researchers, even anthropologists.

Coal, Nuclear and CARBON

"We will have an advanced, modern reactor that will be an excellent resource both within and outside the university," says department Chair Alireza Haghighat.

Not long ago, nuclear energy carried a black mark, the result of the 1979 and 1986 accidents at Three Mile Island and Chernobyl. The industry was moribund: No new plants have been ordered since 1978, and the last reactor to be completed was in 1996. And while other nations depend heavily on nuclear power — France, for example, gets 80 percent of its electricity from nuclear plants — the industry contributes only 19 percent of U.S. power. Coal, by contrast, provides 50 percent.

For skeptics with continued concerns about nuclear waste and the high cost of building nuclear plants, nuclear energy remains a poor choice. But others, including some former opponents, are concluding that it deserves another try.

That's partly the result of a looming national energy shortage. From 2005 to 2030, electricity demand is expected to soar 39 percent for homes, 63 percent for commercial real estate and 17 percent for factories and other industry, according to the government Energy Information Administration. Florida's electricity consumption, meanwhile, is expected to grow 30 percent in the next 10 years alone, according to state figures.

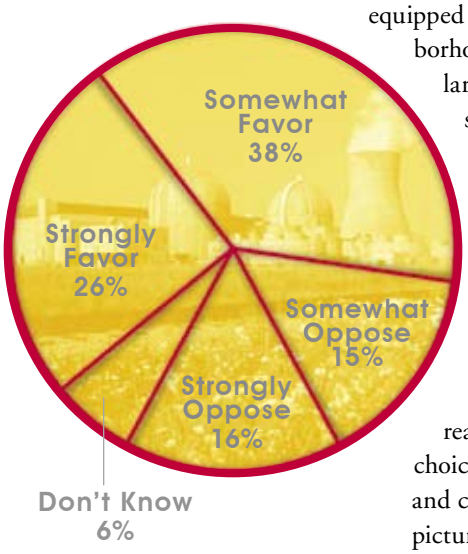
Many point to renewable technologies such as solar and wind power — as well as future renewable technologies such

This map illustrates the location of the 104 nuclear power reactors currently operating in the United States. Some locations have more than one reactor.

International Nuclear Safety Center at Argonne National Laboratory

as biomass — as offering hope for solutions. Indeed, Florida's 2006 energy plan emphasizes such renewable sources.

But today, renewable energies contribute only around 9 percent of total U.S. electricity, the bulk of that from hydroelectric plants, according to Energy Information Administration figures. With the exception of hydro, most renewable energies cannot provide a constant and uninterrupted power supply, say nuclear proponents such as Haghighat. That might be okay for solar-equipped homes or even neighborhoods. But a constant, large and reliable power supply is essential for large factories or facilities like airports, which require large amounts of power day and night no matter the weather.



A national survey by the Nuclear Energy Institute, an industry organization, found that 64 percent of respondents strongly favor or somewhat favor the use of nuclear power to provide electricity, compared to 31 percent who strongly or somewhat oppose it.

"For the base load, really, today the only choices we have are nuclear and coal. Gas is out of the picture because it's too expensive and its supply is unreliable," Haghighat says.

Coal-fired plants have a major shortcoming: They are huge emitters of carbon dioxide, the leading global warming gas. With the recent U.S. Supreme Court decision pushing the Environmental Protection Agency toward regulating carbon dioxide output, a pollution clampdown could make coal more difficult and expensive. Advocates say that gives a huge advantage to nuclear power, which emits no carbon dioxide.

"There is no carbon release. There is no harm to the climate," Haghighat says.

Opponents counter that carbon emissions from uranium mining, not to mention the resource-intensive process of building nuclear plants, offset gains realized from the plants' emission-free operations. The argument is one of many bound to be heard more often as the momentum for new plants builds.

Rapid GROWTH

Florida's energy plan urges fuel diversity, fuel supply reliability and energy security.

The state currently has five nuclear plants that produce about 13 percent of its power. In its promotional material for the new Levy County plant, Progress Energy, Florida's second-largest utility, calls nuclear energy a necessary part of a "balanced approach" to meeting the state's future energy needs.

Not only are those needs growing, but Florida's air quality is worsening. Global warming aside, coal-fired plants contribute to the state's high ranking in carbon monoxide, sulfur dioxide and nitrogen oxide emissions, all of which can have a health impact.

Whether the energy and pollution concerns will add up to new plants remains an open question. New plants remain incredibly expensive, with construction costs easily reaching $2 billion for large ones. But there's no question that the timing appears to be right. Contrasting the chilly, if not angry, reception it might have received in years past, Progress Energy's plant announcement was met with enthusiasm by local officials and most residents. In Florida generally, says Tulenko, "the population is very pro-nuclear."

Nuclear Energy Institute

Florida Power & Light's St. Lucie Nuclear Power Plant consists of two reactors located on Hutchinson Island about 12 miles southeast of Fort Pierce.

Certainly, UF's nuclear engineering department is feeling the enthusiasm. The numbers tell the tale. In 2001, there were 39 undergraduate and 35 graduate students in nuclear engineering. In 2006, those enrollments had grown to 115 and 79, respectively. In 2001, the department netted about $2.5 million in research awards. Its faculty capture almost double that amount today. *U.S. News and World Report* ranked nuclear engineering in the top 10 in the nation this spring, continuing a tradition the department shares with only one other in engineering, materials science and engineering.

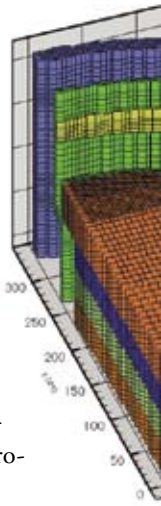
"We have grown significantly," Haghighat says, adding that graduates with bachelor's and master's degrees often work for reactor vendors, government agencies, the military, and nuclear utilities, while those earning doctorates go on to other universities, national labs and reactor vendors.

Research is on the upswing as well. UF nuclear engineers are continuing to expand their efforts in at least two broad areas for which they have a national reputation — simulation and nuclear fuels.

Because new plants are so expensive, simulating new equipment design and operations is the only option in many cases — and almost always the cheapest.

"When we build these devices we want to already know what we're building. Here, with computer codes we are developing for operation on high-performance PC-clusters, we can basically simulate the whole plant," Haghighat says.

As for nuclear fuel, as with other power plants, the most efficient nuclear plants burn the most possible fuel while drawing out the maximum useable energy. Over the years, Tulenko's research has led to major improvements in the so-called "burn up" rate of nuclear fuel. Several of his more than one dozen research projects focus on the next generation of plants as well as "Generation IV" plants several decades in the future.



"Those reactors will use plutonium that we now consider nuclear waste," Tulenko says. "Down the road, when we process this fuel, rather than put the plutonium into Yucca Mountain, we'll use it to produce energy for us."

A more useful RESEARCH REACTOR

Nuclear and radiological engineering faculty and other researchers at UF and beyond have a major resource at their disposal: a nuclear research reactor.

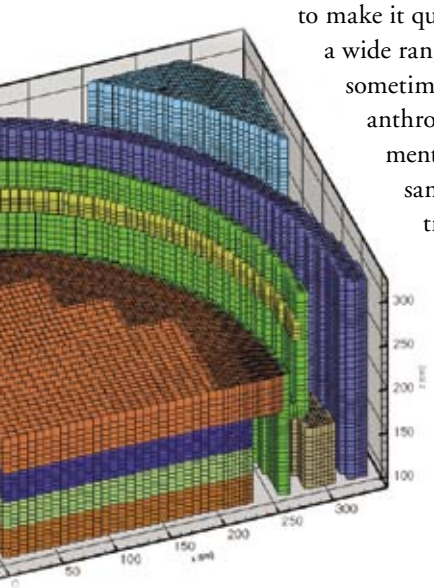
Built in 1959, the reactor was the first in Florida and is the only one in the Southeast, with its nearest counterpart at North Carolina State University in Raleigh. Last year, its fuel was converted from highly enriched uranium to low enriched uranium under the Department of Energy's Global Threat Reduction Initiative, a program aimed at reducing the presence of harmful nuclear material. Nearly all of the analysis, benchmarking and licensing that went into the project was done by NRE faculty and graduate students in a record time of 15 months. Haghighat led the project, with Associate Professor Glenn Sjoden, Assistant Professor Jim Baciak, 10 graduate students and numerous staff contributing.

Haghighat says that although the reactor was heavily used in its early decades, it has not reached its full potential in recent years. One of his main goals is to revamp it into a central statewide research facility.

With that in mind, he recently persuaded Progress Energy to donate $425,000 — money that will be matched

by the state — to renovate the reactor's control room. His goal is to make the control system the first in the country to be completely digital, which would make it a good testing facility for new nuclear power plants seeking digital control systems, he says.

Haghighat also wants to broaden the reactor's capabilities to make it quickly and easily available to a wide range of researchers and other, sometimes surprising users, such as anthropologists and law enforcement authorities. That's because samples bombarded with neutrons in the reactor give off unique signatures that can shed light on their origins. In past years, for example, anthropologists have used the reactor to determine where native pottery was made, enabling them to trace ancient trade routes.



This three-dimensional computer model of a boiling water reactor helps engineers determine neutron and gamma radiation fields throughout the reactor core.

Law enforcement officers, meanwhile, have convicted at least one person based on information on the origins of marijuana that was gleaned from using the reactor. The revamped reactor, says Haghighat, will make these and other applications much easier.

"The goal we have is to build different types of experimental stations at each access port of the reactor," he says.

For Haghighat, the reactor's broad applications are indicative of the power of nuclear technology in many areas, from energy to security to medicine.

"Nuclear engineering appears to be critical to solving major problems facing mankind in the next 50 years," he says. "Our goal is play a major role in helping to make that happen."

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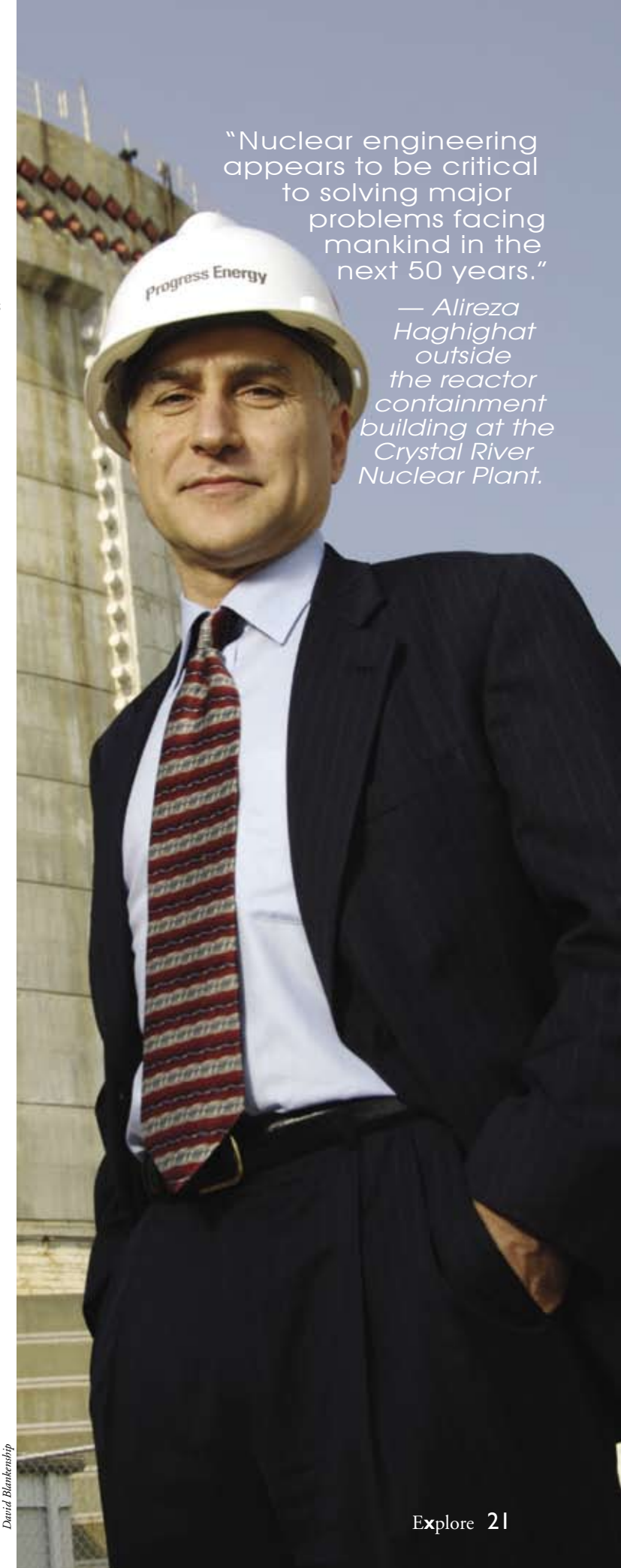

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— Alireza Haghighat outside the reactor containment building at the Crystal River Nuclear Plant.

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