UNIVERSITY OF HOUSTON

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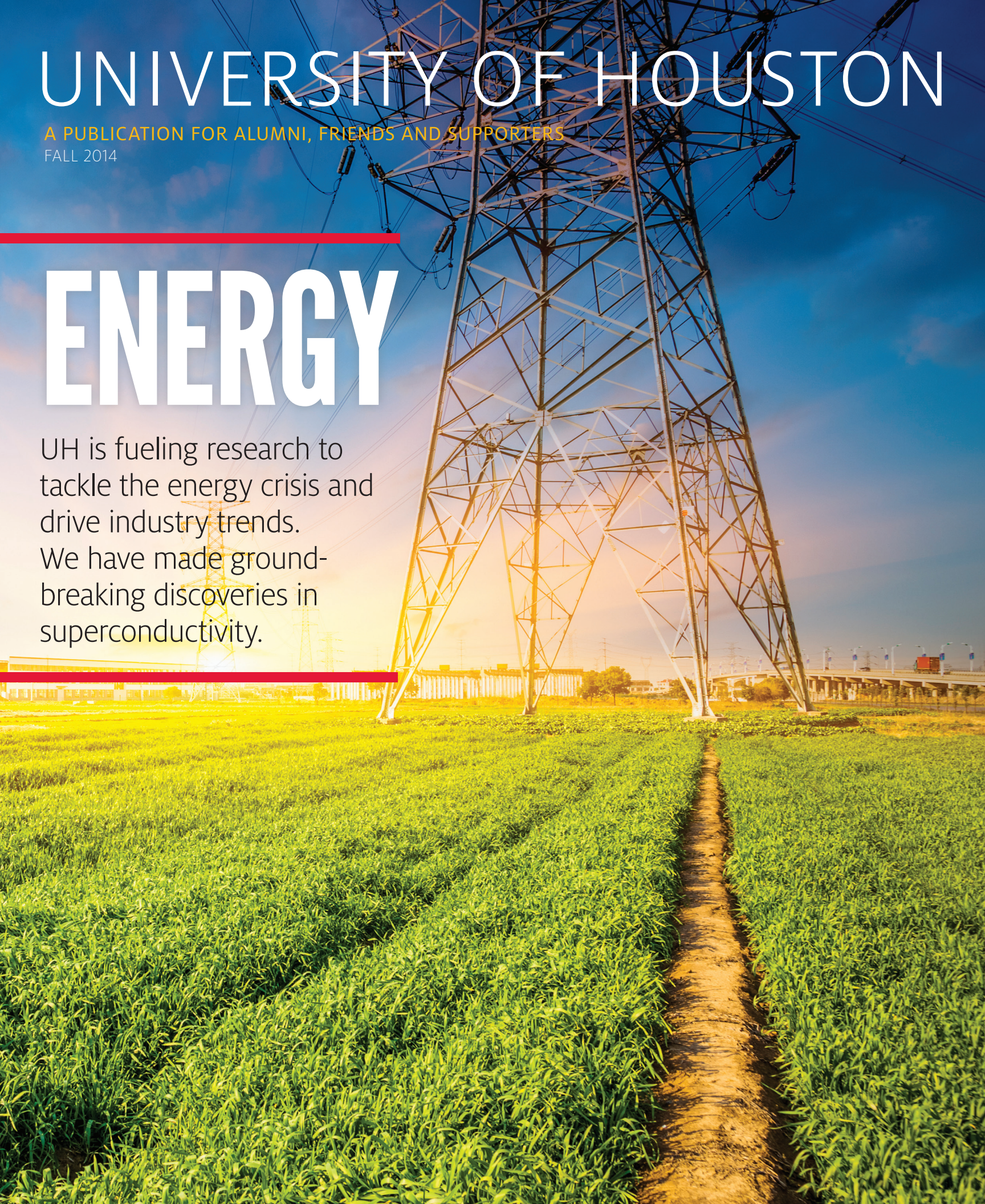
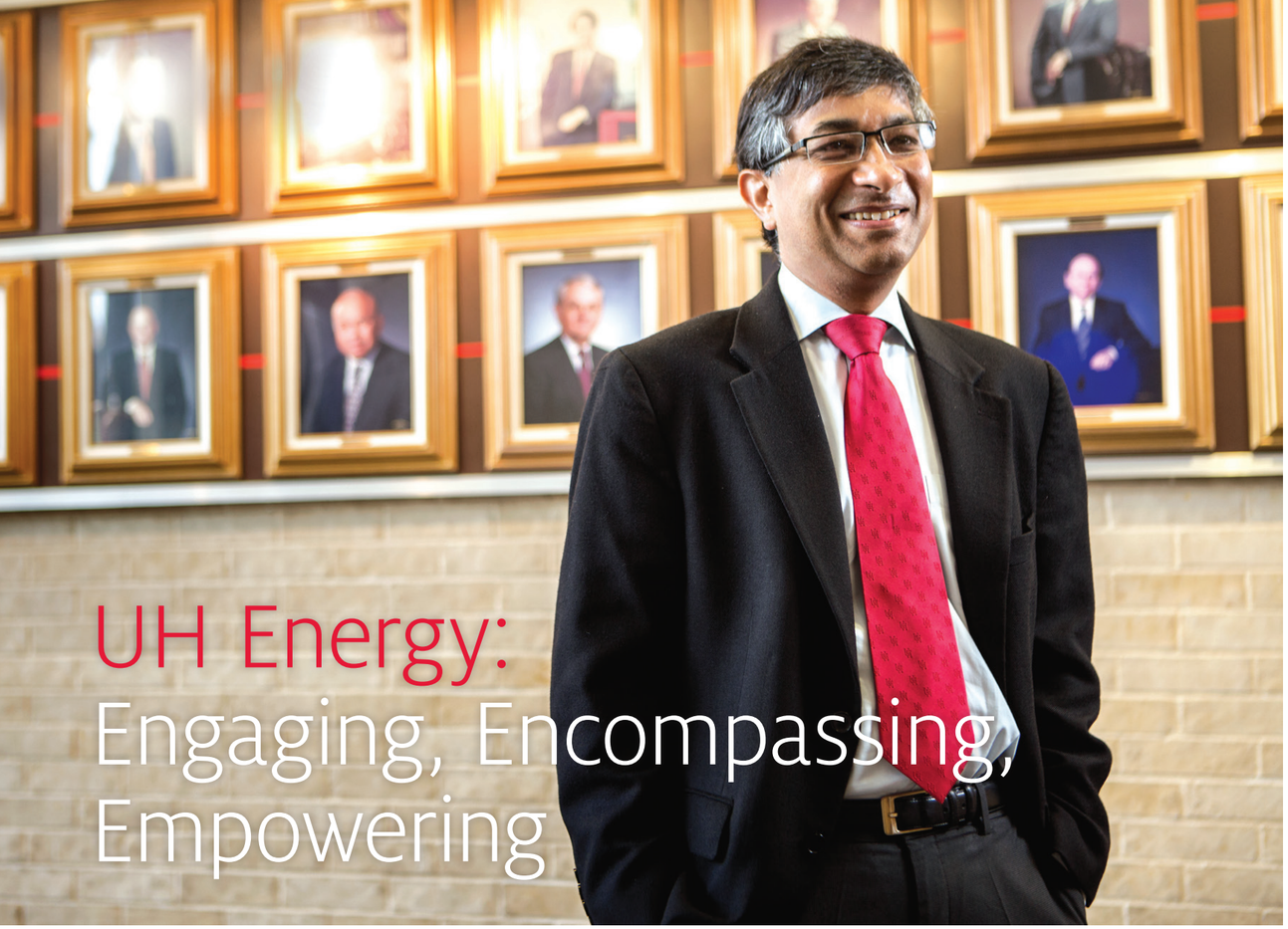
FALL 2014

ENERGY

UH is fueling research to tackle the energy crisis and drive industry trends. We have made ground-breaking discoveries in superconductivity.





UH Energy: Engaging, Encompassing, Empowering

by Ramanan Krishnamoorti

UH Energy as a formal entity is fairly new – President Renu Khator introduced the idea of making energy a primary focus for the University of Houston in 2008 – but its roots go back decades.

UH Energy brings together faculty, students and industry to meet a number of key goals: providing a trained workforce and technical leadership, researching and developing hydrocarbons and alternative energy sources, setting regulatory and public policy, and devising commercialization pathways and other business practices, as well as promoting technology incubation.

UH is best known for its technical energy-related educational and research programs, which began almost as soon as the University was founded.

The Cullen College of Engineering was created in 1941, and its engineering programs – including chemical engineering, petroleum engineering and graduate programs in subsea engineering, well completions and interventions, along with well design engineering – maintain UH's standing as a leading academic institution for the development of unique educational programs that target the energy industry.

Those programs, coupled with geoscience programs in the College of Natural Science and Mathematics and related certificate and degree programs, including construction management and petroleum technology in the College of Technology, are just part of the array of academic programs that make up the UH Energy Initiative.

The Global Energy Management Institute at the C. T. Bauer College of Business, along with its Executive MBA programs aimed at energy executives, contribute to the goal, as do energy and environmental law programs at the Law Center. Similarly, educational and research programs in architecture, history, economics, political science and international politics have focused on policy issues in energy and environment.

An interdisciplinary minor in energy and sustainability, launched in 2013 under the guidance of UH Energy, now provides students in all fields of study an introduction to the topic.

Many of these programs, and much of our research, are driven by our beneficial partnership with industry – we work with industry to better understand both their workforce needs and their technical challenges.

Industry's commitment to the growth and success of energy-related programs at UH can be recognized through the outstanding corporate leaders on the UH energy advisory board. The continued vibrancy of UH Energy will be achieved by addressing regional, national and global needs for the sustained development of energy resources.

We are gearing up to address these challenges.

Just a few examples: the growth of the Allied Geophysical and Well-Logging Laboratories and, more recently, the Unconventional Resources Center of Excellence have mirrored the growth of the oil and gas exploration and production industry and the increased interaction between our University and industry on critical issues in research and development.

You can add to that the recently started bachelor's degree programs in petroleum engineering and master's degree programs in subsea engineering, along with more specialized master's degree programs, all at the request of industry.

These programs grew from the University's foundations in energy research. In the early 1970s, the chemistry and chemical engineering programs developed research strengths in organic and inorganic synthesis, catalysis and reaction engineering to complement the growth of the chemical refining industry in the Houston area, becoming global leaders in downstream hydrocarbon processing.

In the 1980s UH researchers, led by physicist Paul Chu, investigated pioneering materials capable of exhibiting high temperature superconductivity and established the University as the leading academic entity to advance the science and technology required for the development of high-temperature superconductors.

The Energy Research Park, a 74-acre industrial park purchased by the University in 2009, has helped take those accomplishments to a new level. The establishment of the Texas Center for Clean Engines, Emissions and Fuel, the Energy Device Fabrication Laboratory, the Applied Research Hub for the Texas Center for Superconductivity and the National Wind Energy Center take advances in fundamental science and engineering and develop impactful technologies.

'UH IS BEST KNOWN FOR ITS TECHNICAL ENERGY-RELATED EDUCATIONAL RESEARCH PROGRAMS, WHICH BEGAN ALMOST AS SOON AS THE UNIVERSITY WAS FOUNDED.'

That important work continues, even as we plan for the future.

Programs focused on conventional energy will continue to remain important to UH Energy, including critical issues in nuclear and pipeline infrastructure, safety programs addressing research and training, cybersecurity and analytics research to ensure responsible energy production. But alternative energy — including innovations in solar energy technologies, thermoelectric materials and advanced energy storage, as well as research to rethink urban development and ensure access to clean water — is also a critical part of our mandate.

Taken together, those pathways will not only define UH Energy during the coming years but will also change the world in the process.

Krishnamoorti, chief energy officer at the University of Houston, is a professor of chemical and biomedical engineering.

1941 — **Courses** in electricity, diesel motors and aircraft engines for **WWII workers**

1957 — **Cullen Family** donates $5 million for first **Engineering Building**

1963 — **Doctoral programs** in chemistry, physics, electrical, chemical and mechanical engineering approved by state

1987 — **Paul Chu** makes high temperature superconductivity breakthrough

1991 — **Physics Department** named one of 10 most **influential in America by Science magazine**

2001 — **Global Energy Management Institute** founded

2003 — **Texas Center for Clean Engines, Emissions & Fuels** opens

2009 — One of country's first courses in **carbon trading** offered

2009 — **74-acre Schlumberger property** becomes **UH Energy Research Park**

2009 — Undergraduate degree in **petroleum engineering** begins

2010 — DOE funds **National Wind Energy Center** at UH

2013 — **Master's degree** program in **subsea engineering** launches

GOING DEEP ... UH INSTITUTE SAFEGUARDS OFFSHORE ENERGY EFFORTS

by Jeannie Kever

One of the most chilling assessments in the reams of reports that have followed the 2010 oil spill in the Gulf of Mexico came this summer, when investigators for the Chemical Safety Board said it could happen again. With energy companies moving to more challenging environments to explore and produce hydrocarbons over the next decades, the challenges and risks continue to grow.

The Subsea Systems Institute is designed to lower the risk.

The institute, led by the University of Houston, will be a go-between for industry and government regulators, testing and validating equipment, setting safety standards and other best practices, developing new materials and science-based policies, as well as overseeing workforce training. Rice University and the Johnson Space Center are also involved.

Federal regulators have promised more oversight since the oil spill. Brian Salerno, director of the Bureau of Safety and Environmental Enforcement, the top offshore regulator, told an audience at the Offshore Technology Conference in Houston last spring that safety is more crucial than ever because the BP oil spill made Americans wary of expanding drilling in the Atlantic and Alaskan Arctic.

Ensuring Safety

Ramanan Krishnamoorti, chief energy officer for UH, said a neutral third party operating as a public-private partnership can ensure that technologies needed for safe and environmentally responsible operations in such an environment are tested and validated, and that policies required for a decreased risk of failure are developed and implemented.

The Institute could certify that the most effective safety regulations and standards are developed and shared with industry, building upon previously established relationships.

UH began building those relationships years ago, working with industry on research and offering workforce training. It restarted the University's undergraduate petroleum engineering program in 2009 and a master's program in subsea engineering in 2013, both at the urging of industry. The UH Energy advisory board is filled with executives from global energy companies, most of them based in Houston.

Partners With UT, A&M

Last fall, UH joined with Texas A&M University and The University of Texas at Austin to form the Ocean Energy Safety Institute, a five-year, $5 million collaborative created by the Bureau of Safety and Environmental Enforcement to provide both government regulators and industry with the latest safety information about offshore drilling.

The Subsea Systems Institute will go beyond that, Krishnamoorti said, not only setting safety standards but also offering testing of equipment and conducting research to promote safety and efficiency in the ultra-deep Gulf of Mexico and the Alaskan Arctic. In those deep waters high pressure and high temperature pose technical challenges members of the partnership are well-suited to address. It also will oversee workforce training programs, both through community colleges and area universities.

Darrin Hall, executive director of governmental relations at UH, said some research could focus on reasons for safety equipment failures, to reduce future failure rates.

"You always should have a plan if a spill occurs, but what if a spill never happens?" he asked. "You should always have a remediation plan, but what if you could avoid it?"

Much of the testing and related research will be conducted at labs that will be built at the UH Energy Research Park, just a few miles from the main campus. Each of the three partners brings special expertise: In addition to its subsea engineering program, UH has master's engineering degree programs in well design and well completion, along with expertise in offshore composites, superconductivity and safety protocols, including a graduate certificate course in upstream energy safety that will start in January.

Rice University offers expertise in nanotechnology and materials corrosion, computational science, energy policy and visualization and imaging. NASA's Johnson Space Center has additional testing facilities, including the neutral buoyancy labs, remotely operated vehicles, and expertise in risk assessment and in high pressure-high temperature materials.

Unique in the U.S.

The Institute will be unique in the United States, formed in response both to the catastrophic Gulf oil spill that continues to play out in courtrooms and across Gulf shores and wetlands, and to the relentless push by energy companies to move forward.

Krishnamoorti said while the Institute is geographically near the Gulf of Mexico, which accounts for about 23 percent of all crude oil produced in the United States, it also will work with companies exploring in the Alaskan Arctic and the North Sea.

The Institute, which hasn't yet received funding, is modeled in part on a similar project in Bergen, Norway, where drilling in the North Sea has spawned world-renowned technology centers in conjunction with Bergen University College. The subsea engineering program there is affiliated with the program at UH, which began offering a graduate certificate in 2011 and a master's degree less than two years later.

The UH program joined with Bergen and those at the National University of Singapore, Federal University of Rio de Janeiro in Brazil and Curtin University in Perth, Australia, to form the International Subsea Engineering Research Institute earlier this year. That will allow the group to provide "one-stop shopping" for companies looking for institutions to provide testing or research in specific areas, said Matthew Franchek, founding director of the UH subsea engineering program and director of the international research institute.

Like the testing facility in Bergen – which Krishnamoorti said has a 2½ year waiting period for its testing facilities – the planned facility in Houston will take advantage of geography: With more than 3,600 oil and gas companies in the metropolitan area and an estimated statewide economic impact of $308 billion, Houston is an obvious choice, Krishnamoorti said.

"A center focused on prevention is the right thing to do," he said. "A center in Houston is the right place to do it, and UH, Rice and NASA is the right team."

UH SUBSEA ENGINEERING JOINS GLOBAL ALLIANCE

by Jeannie Kever

As employers increasingly seek workers with global experience, an international network of subsea engineering programs will allow University of Houston students to study with experts around the world.

Still others may work from a laptop while on a break from their job on a rig in the Gulf of Mexico, now that the UH subsea engineering program is fully online.

"Two-thirds of the earth is covered in water – and oil is everywhere," says Matthew Franchek, founding director of the University's graduate program in subsea engineering.

Franchek and leaders of five other subsea engineering programs presented plans for the Global Subsea University Alliance at the 2014 Offshore Technology Conference. Led by UH, it includes Bergen University College in Norway, Curtin University in Australia, Federal University of Rio de Janeiro, National University of Singapore and the University of Aberdeen in Scotland.

The first step was to standardize curriculum across the six universities, says Franchek, who started UH's subsea engineering program as a graduate certificate program in 2011. It became a full-fledged master's degree program in 2013, and remains the only subsea engineering program in the United States. One alliance goal is to encourage additional universities to offer the courses.

"This is a very serious need," Franchek says. "We have to generate a new workforce."

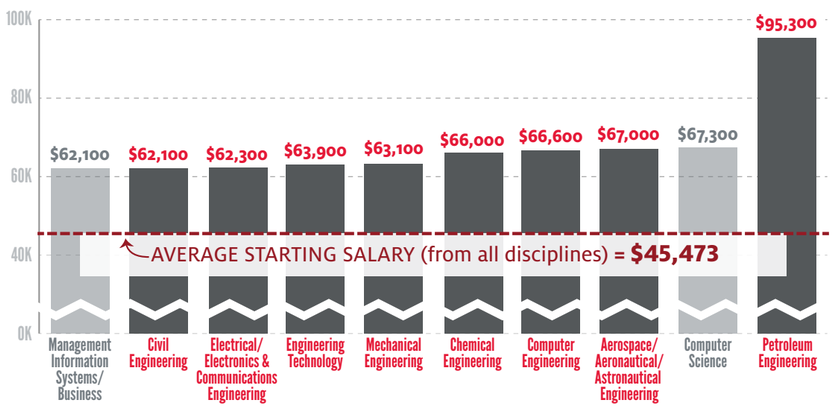
UH Energy Symposium Focuses on Big Ideas

UH Energy addresses the top issues facing the industry today during its "Critical Issues in Energy" upcoming symposium series. Now in its second year, this series features four discussions:

- U.S. Energy Independence: Is it good for the nation? – Sept. 30
- America's Energy Transportation Infrastructure: Is it safe? – Nov. 11
- Private Profit vs. Public Good: Do energy companies have a social responsibility? – Feb. 10
- Our Next Energy Workforce: Where will It come from? – March 31

The moderated debates, followed by a question-and-answer session, are held at the University Center Theater. They begin at 5:30 p.m. This year's series is presented by Chevron. For more information, see the UH Energy website, www.uh.edu/energy.

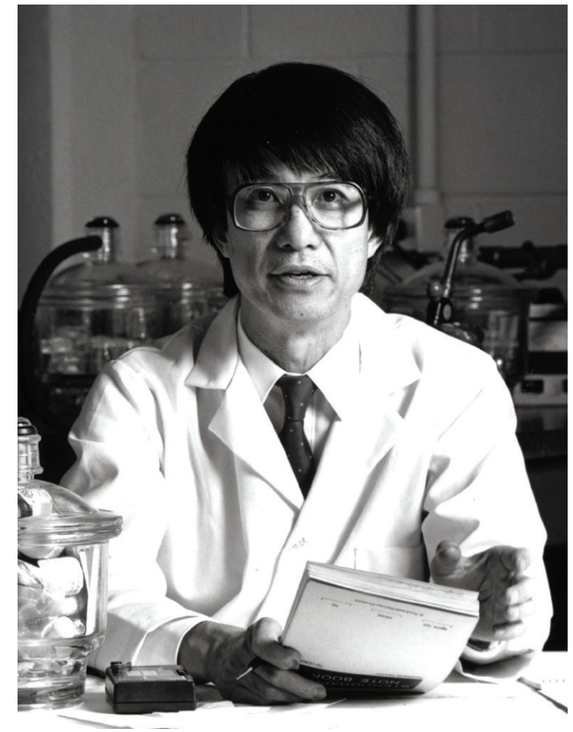
TOP-PAID MAJORS (STARTING SALARIES) FOR THE CLASS OF 2014



Source: April 2014 Salary Survey, National Association of Colleges and Employers. All data are for bachelor's degree graduates.

Engineering majors, especially petroleum engineering, continue to rule when it comes to top salaries for graduates. Engineering majors command eight of the top 10 spots for average starting salaries for graduates with bachelor's degrees, according to the 2014 Salary Survey by the National Association of Colleges and Employers. Those with a degree in petroleum engineering earned $28,000 more than the next highest average starting salary.

Can anyone say energy boom?



AS SEEN IN THIS CIRCA 1980S PHOTO, PAUL CHU CAPTURED THE SCIENTIFIC SPOTLIGHT WITH HIS EARLY BREAKTHROUGHS IN SUPERCONDUCTIVITY.

SUPERCONDUCTIVITY FUELED NEW ERA OF ENERGY RESEARCH

by Jeannie Kever

A discovery nearly 30 years ago at the University of Houston set off a frenzy, with scientists around the world joining in after physicist Paul Chu and his colleagues created the material that brought high-temperature superconductivity into the modern era.

Huge strides in energy, medicine, transportation – anything that involved electricity – seemed possible, now that a material able to carry energy without any loss due to resistance was within practical reach.

The work was fueled by his passion for science and research. "But in the back of my mind, it was for application," Chu said. "People knew this had promise."

Zhifeng Ren, now a physicist at UH, was a graduate student in China when he read about the discovery. "There was so much hope it would change the world overnight," he said. "Of course, it didn't happen. Science takes time."

That moment in January 1987, when Chu and members of his team created a material based on a compound of yttrium, barium and copper oxide, known as Yttrium 123, has had a lasting impact on both UH and Chu. He was elected to the National Academy of Sciences in 1989 and remains in demand as a speaker and scientific collaborator. In August, the Institute of Electrical and Electronic Engineers presented him with the Max Swerdlow Award for sustained service to the applied superconductivity community, the latest in a string of honors.

"He's a worldwide figure," said Allan Jacobson, Robert A. Welch Chair of Science and director of the Texas Center for Superconductivity at UH (TcSUH), founded just months after Chu's discovery. "As a result, the center is internationally known."

Chu brought in scientists working in related fields from the beginning. Jacobson was part of the Corporate Research Laboratories at Exxon Research and Engineering Company and an expert on superconductivity and energy materials when he joined UH in 1991. Ren was recruited from Boston College in 2012. Ren is now M.D. Anderson Chair professor of physics and principal investigator at the Center for Superconductivity.

Superconductivity was discovered in 1911, but until 1987, high–temperature superconductivity meant 420 degrees below zero Fahrenheit, far too cold for most applications. Chu's work, building on research at IBM Zurich, brought it into real life.

With their discovery in 1987, first of superconductivity at above 77 degrees Kelvin, and later that month at 90 degrees Kelvin (about 300 degrees below zero Fahrenheit) Chu's team created a material that could be cooled with liquid nitrogen, dramatically reducing the cost.

Superconducting materials now are used for energy generation, storage and transmission, as well as for ultra-fast and ultra-sensitive signal detection, levitated trains and magnets for magnetic resonance imaging, or MRI.

Much of the innovation has taken place at TcSUH, where Chu is founding director and chief scientist, TLL Temple Chair of Science and professor of physics. (He spent eight years as president of Hong Kong University of Science and Technology while maintaining his research here, returning to UH in 2009.)

Today, Yttrium 123 remains a popular material, and Chu still holds the record for high-temperature superconductivity – now at 164 degrees K (under pressure). He and members of his lab also continue to develop new materials, as competition once again intensifies.

"There are high-paying jobs at stake for the eventual winner," said Alan Lauder, executive director of the Coalition for the Commercial Application of Superconductors and a member of TcSUH's advisory board. "And that needs to be the United States, and Texas and Houston."

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UH ENERGY

124 E. Cullen Building, Room 124A
Houston, TX 77204-2040
713-743-6100
uhenergy@uh.edu
uh.edu/energy

uh.edu/magazine

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