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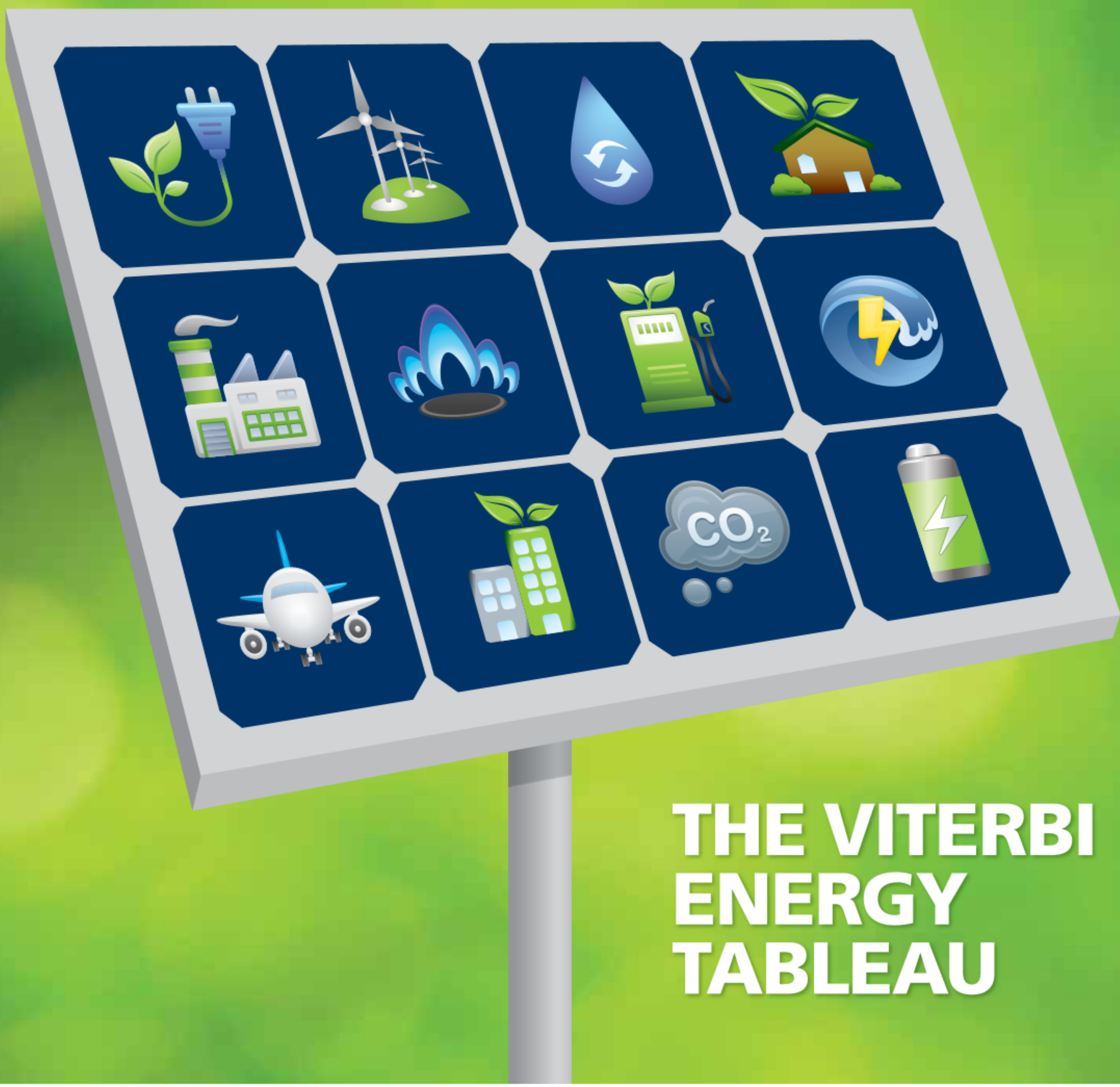
USC Viterbi // Engineer



THE VITERBI ENERGY TABLEAU

USC PRESIDENT STEVEN B. SAMPLE ON ENGINEERING AND LEADERSHIP
TACKLING HEART ATTACK PLAQUE // VIZIO CO-FOUNDER REMEMBERS HIS USC DAYS

THE VITERBI ENERGY TABLEAU

Our world today would be unimaginable without energy on demand—power at our fingertips to fuel everything from computers and appliances to motorcycles and jetliners. Modern civilization depends on it, yet the 21st century presents a myriad of challenges concerning energy. Where will the power we need come from? How much will it cost? Will there be enough to sustain a rapidly expanding world? And can it be harnessed with the least amount of harm to the environment? Indeed, energy issues have emerged as one of the key grand challenges facing our society. Policymakers and scientists alike consider meeting these challenges as nothing less than fundamental to a global economic recovery—the key to the sustainability question. Enter the engineering disciplines. They are fundamental to answering these questions and providing solutions to a sustainable future. There's nothing accidental about the connection between energy and engineering: Extracting useful amounts of energy requires vast technical and scientific know-how.

The concept of energy itself is simple. Energy is stored within matter in multiple ways: through mechanical motion (kinetic energy), relative altitude (gravitational potential energy), and its thermal, chemical and nuclear states (internal energy). The variety of forms enables a broad portfolio of energy options: wind and wave (kinetic), hydroelectric (potential), fossil or bio fuels (internal), and nuclear (internal).

What's complex is the process of extracting or transforming the matter's energy content. The engineered processes that enable this transformation and release energy that we can subsequently harness are varied and multifaceted, including combustion, nuclear reaction and photonic-electrical conversions. What also complicates the issue is that sources of energy that may be superior in terms of energy content—such as the fossil fuels coal, oil and gas—contribute to a carbon imbalance in the atmosphere if their carbon is not recaptured. Other byproducts, such as nuclear waste, must be safeguarded for thousands of years. Inefficiencies are another key concern involving the capture, conversion and utilization of energy; they alone account for as much as 30 to 40 percent of the global energy flow.

The good news? Humankind possesses the tools to create the innovations that will solve these problems. "The breathtaking advances in information technology in the recent decade, and the continuous unlocking of mysteries at the nano- and molecular scales, promise unprecedented discoveries that will lead to a much-needed overhaul of the energy field," says Viterbi Dean Yannis C. Yortsos. "Smart solutions in the information age demand the use of information-age tools. These tools are in our hands, and we need to use them."

One of these tools—nanotechnology—enhances the traditional engineering and scientific fields of physics and chemistry by enabling manipulation of substances at the atomic level to create new materials with new properties. In nanotechnology lies the promise of ingenious new materials and devices to help harness emerging sources of energy, such as solar.

Informatics, another tool, employs computing power to analyze patterns previously too complicated to understand. For example, informatics can monitor the second-by-second changes in a huge system, like a city's power grid to optimize efficiency and to provide instant feedback and control.

The stories in this article detail how researchers at the Viterbi School are now attacking a whole range of energy and energy-environmental issues, aided by these technologies and supported by research funds from both private and public sources. They will show how research is boosting supply, decreasing demand, addressing environmental burdens and increasing livability. Indeed, stewardship and cultivation of our energy resources, with the protection of the planet as a paramount objective, will require nothing less than the most creative scientific and technological breakthroughs.

The Promise of Nano: Big Benefits in Tiny Packages

Imagine a world where solar rooftop panels that can easily power a home, and flat three-watt panels that can illuminate a room, are not a novelty. Rather, they're affordable and readily available at Home Depot or Wal-Mart.

The science of nanotechnology is helping to make this vision a reality, and ongoing Viterbi School research is paving the way.

Nanotechnology focuses on scientific process at the level of atoms and molecules, and its application to energy issues has extraordinary potential. This year, the Viterbi School's efforts in the nanotechnology field received a major boost with an award of a five-year, $12.5 million Department of Energy (DOE) grant establishing an Energy Frontier Research Center (EFRC). P. Daniel Dapkus, of the Ming Hsieh Department of Electrical Engineering (EE) and the Mork Family Department of Chemical Engineering and Materials Science (ChE/MS), will direct the new EFRC, which has a dual focus: applying nanotechnology to address the challenges of solar energy conversion and efficient illumination.

"Light emission and light absorption are inverse processes," says Dapkus, "and many of the same materials useful for solar cells are also potential light-emitters, which can be useful in producing low-cost renewable energy, and conserving energy in lighting as well."

An internationally recognized expert in the field, Dapkus says the goal of his project is not journal papers or theories—but more efficient and affordable solar cells and light-emitting diodes (LEDs).

The best existing solar cells convert about 40 percent of light energy that falls on them to electricity and are extremely expensive. "We've set as our goal solar cells that are as efficient as 50 percent but are much cheaper," says Dapkus. "These would produce power as cost-effective as that now generated from burning coal. That's a difficult challenge, but that's our goal."

"If it does not leave academe, we have not been a success," adds Mark Thompson, (ChE/MS), who was also instrumental in bringing the DOE grant to USC.

The scientists' goals for better LEDs are similarly ambitious. Standard incandescent bulbs waste most of the energy they use (and they use almost 20 percent of all the electricity produced in the United States). The now more widely used fluorescent bulbs are much more efficient, but also contain toxic mercury. LEDs can be twice as efficient as fluorescents, but cost 10 times as much at present. Dapkus and Thompson want to narrow or eliminate this differential.

The EFRC team Dapkus and Thompson have assembled brings a wide range of skills to the job, and include the following members:

- John O'Brien of Ming Hsieh (EE)
- Steve Cronin and Chongwu Zhou, who have joint appointments in Mork (ChE/MS) and Ming Hsieh (EE)
- Jia Grace Lu, with joint appointments in the USC College Department of Physics and Astronomy and Ming Hsieh (EE)
- Priya Vashishta, Rajiv Kalia, and Aiichiro Nakano, with appointments in Physics and Astronomy, and in the Viterbi School Department of Computer Science (CS)
- Richard Brutchey, Barry Thompson and Steve Bradforth, all of the USC College Department of Chemistry

The EFRC efforts are not the only Viterbi pursuits of innovative solar power technologies. Denis Phares and Hai Wang, of the Viterbi School's Department of Aerospace and Mechanical Engineering (AME), are working on developing a unitary panel that can be laid out in large thin films, able to cover large areas quickly, efficiently and cheaply.

The fabrication method involves burning titanium oxide—an inexpensive and nontoxic material used as a white paint pigment—and depositing the particles on a specially prepared surface, where chemical reactions make it into a solar-sensitive material. The results so far are "highly promising," says Wang, who directs the Viterbi Combustion Kinetic Laboratory.

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P. DANIEL DAPKUS, DIRECTOR, ENERGY FRONTIER RESEARCH CENTER

Burning Brighter: Engineering Flames

What about the process of combustion itself? Can it be better managed or streamlined to conserve energy?

On the surface, nothing seems more simple than a flame; striking a match produces an effect that all understand. Yet in combustion, there's much more than meets the eye, a "much more" that a large group of Viterbi researchers have long played a key role in researching. Indeed, the Viterbi School is examining every stage of the combustion process, from burning fuels more efficiently to better addressing the harmful byproducts of combustion, such as smoke, soot and greenhouse gases.

This effort is fundamental to solving the energy problem, because more than 80 percent of the world's energy production and use is based on combustion. "Combustion is ubiquitous in traditional energy conversion systems, such as automotive engines, stationary and aircraft gas turbines, rocket and space propulsion, electrical power generation, industrial furnaces, and home and institutional space heating," notes the AME Web page for combustion research.

A Viterbi collaboration with another EFRC—headquartered at Princeton University—is studying the way fuels burn in unprecedented detail, and will examine the combustion process from "fundamentals to multiscale predictive models," particularly for 21st century transportation fuels.

Because while flames are familiar, analysis of all the factors that affect their properties is dauntingly difficult. Its investigator is required to bring together at least three different physical realms—the flow behavior of gases, their chemical properties, and the effect of the radiant energy produced by the combustion on the process.

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To model these phenomena, scientists like Wang and Fokion Egolfopoulos (also of AME) must make some simplifying assumptions, rather than just plugging in set variables. Despite the obstacles, they recently recorded a big research win in combustion modeling: They showed a model of how jet fuel behaves when it is burned in turbines, like jet engines, opening a new area to computer modeling.

Other challenges to combustion research remain. Engineers have been working with diesel oil for many decades, says Egolfopoulos, and have discovered ways to optimize its performance. However, new fuels now coming into use—such as vegetable oil (biodiesel)—have different properties and call for different optimization paths. (Theodore Tsotsis (ChE/MS) is also involved in combustion research.)

As a part of yet another EFRC—headquartered at the University of Delaware—Wang is exploring ways to make good-quality gasoline fuels from vegetable oil by catalysis.

Emissions from combustion are another major concern. The burning of many liquid fuels produces soot, a byproduct that results partly from incomplete combustion and partly from unburnable components that come out in exhaust; Wang is carrying on major research initiatives in this area to study ways to minimize soot, as well as its effects on climate change.

At the same time, Constantinos Sioutas, of the Sonny Astani Department of Civil and Environmental Engineering (CEE), is leading the effort to measure the concentration of soot in the air and determine the health consequences of living in areas where large numbers of trucks pass in and out. Wildfires also produce soot, and Sioutas has found that they produce levels that are much higher and potentially more dangerous than previously thought.

As engines burn most of the fuel consumed worldwide, the Viterbi School is looking at ways to make them more efficient and less polluting. Paul Ronney (AME) has studied combustion in all kinds of environments, including space. (Ronney qualified to be an astronaut and sent several experimental kits on a shuttle launch to investigate zero-gravity combustion.)

Fifteen years ago, Ronney developed a new, more efficient thermal throttle for gasoline car engines. More recently, he has been working in three different directions regarding engines. One area is micro-engines, tiny devices that burn fuel and can replace batteries in handheld and smaller applications. This is significant, Ronney says, because hydrocarbon fuels store 50 times as much energy as the same weight of the best available batteries. "So we could potentially have laptops that last more than a week on battery power, or cell phones that last a month on one charge," says Ronney.

Another thrust is Ronney's work with Martin Gundersen (EE) on a new way to ignite fuels in engines using "pulsed power." These are very short bursts of high-energy radio waves; in experimental engines, pulsed power units replace spark plugs or other traditional ignition devices. Gundersen has studied pulsed power for more than a decade, and his latest research initiative involves working with Egolfopoulos to reduce the emissions from marine diesel engines.

Gundersen will focus on developing lab-scale prototype transient plasma ignition (TPI) equipment to achieve more complete combustion, while Egolfopoulos will analyze and compare the efficiency of and pollutants resulting from both compression ignition and TPI. The work will be housed at USC's new TCC Institute for Emissions Reduction from Marine Diesel Engines.

Ronney's final area of research involves a type of combustion that has nothing to do with flame. Working with geobiologist Ken Nealson of the College, Ronney is studying how a bacterium Nealson discovered might become a new, more efficient basis for microbial fuel cells. These bacteria "burn" metals, such as iron and manganese, to produce energy; and microbial fuel cells could leverage this metal consumption to generate electrical potential. Florian Mansfeld (AME) is also collaborating on this effort.

More Energy-Efficient Buildings and Cities: USC as a Smart Grid Test Bed

Part of the solution to the energy conundrum involves making its use more efficient—using less energy to begin with. A much-touted means to this end is the Smart Grid, which deploys digital technology to help reduce cost, conserve energy and increase transparency in the energy system.

But many questions remain, such as whether consumers are able to take full advantage of a world where appliances "talk back," and information about energy usage is king. And more importantly, how best should such a world be scaled up for deployment on a commercial level?

"The Smart Grid is a blending of IT infrastructure with the power infrastructure, while at CiSoft we combined IT with an oil and gas infrastructure. We are employing digital feedback and control to the system, ultimately, to be able to manage a more efficient (and more secure) system. These demonstrations are not really traditional academic research programs, but demonstrations of new applications, complex systems integration, and customer behavioral response."

DONALD PAUL, EXECUTIVE DIRECTOR OF THE USC ENERGY INSTITUTE

The Viterbi School has been tapped to find out. The USC campus will be outfitted as a laboratory of sorts—a microcosm of an entire city–for part of a $120 million Smart Grid demonstration project conducted by the Los Angeles Department of Water and Power (LADWP) and supported by the Department of Energy.

"We will be using the entire USC campus as a living experiment—a test bed," says Donald Paul, executive director of the university-wide initiative, USC Energy Institute, which will coordinate the effort. Paul, a Viterbi research professor of engineering, is also the former chief technology officer of Chevron Corporation.

Using advanced information technology, the project will monitor energy consumption in campus residence halls, laboratories, office buildings, classrooms, gymnasiums, theaters, restaurants and other buildings. It will also test new cyber-security technologies and measure how plug-in electric vehicles impact energy flow, among other initiatives. All the while, the campus project needs to demonstrate real-world complexity and be sufficient in size, so that it will scale well for commercial use, according to Paul.

An added benefit to being selected as a test site is that as one of LADWP's largest customers, USC will be able to "get out in front" of the smart grid implementation that's in every energy consumer's future, says Paul.

Paul will bring the expertise gleaned from a five-year collaboration between the Viterbi School and Chevron research scientists, known as the Center for Interactive Smart Oilfield Technologies (CiSoft).

Indeed, CiSoft scientists have long studied how best to deploy the use of information technology to better solve a wide variety of oil and gas engineering and field management problems.

"The Smart Grid," Paul says, "is a blending of IT infrastructure with the power infrastructure, while at CiSoft we combined IT with an oil and gas infrastructure. We are employing digital feedback and control to the system, ultimately, to be able to manage a more efficient (and more secure) system. These demonstrations are not really traditional academic research programs, but demonstrations of new applications, complex systems integration and customer behavioral response."

The Viterbi School will play a prominent role in yet another Smart Grid project, this one sponsored by Southern California Edison. The SoCal Edison effort will incorporate the work of Viterbi researchers, such as Clifford Neuman of the Information Sciences Institute (ISI).

Neuman's grid security research explores how best to keep computers and databases safe from malicious intrusion, and is now expanding his research focus to include what he calls "cyber-physical" systems. Such systems are vulnerable not only to hacker electronic attacks, but also to electronic jolts and shoves, planned physical destruction or alteration of components that could cause severe systemwide disruptions.

"An attacker does not need to break into the computer," Neuman noted in a recent paper, "to affect such a system, but could cause a coordinated series of physical actions that are sensed and make the system respond in an unexpected manner. How one protects such systems from this kind of attack requires an understanding of the system and its responses, not the typical computer security defense mechanisms."

For both Smart Grid projects, USC and the Viterbi School will collaborate with a number of partners, including UCLA, Caltech/JPL and UC Irvine, to create prototype systems designed to reduce energy use and decrease the risk of power outages from technical and malicious causes. Viktor Prasanna (EE, CS), Gordon Roesler (ISI) and Julie Albright of the College Department of Sociology will play lead roles in the USC efforts. (Peter Will, of ISI, helped to form the project before his retirement in December 2009.)

> *"We want to compare these technologies and strategies with actual building performances and human comfort factors. We hope to get insight into correlations between energy consumption and comfort, building design and comfort, and building design and energy consumption."*
>
> BURCIN BECERIK-GERBER, USC VITERBI SCHOOL

Other Viterbi School specialists will be involved, as well as investigators from the College, the Keck School of Medicine, the Marshall School of Business, the School of Policy, Planning, and Development, and the School of Architecture.

Smart Grids are extremely complex systems, and another step in the energy conservation crusade is how best to work in elements of uncertainty and address difficult-to-predict risks of internal failure. That's where Roger Ghanem (AME) steps in; his latest project aims to predict grid behavior and manage risk at the point of intersection between networks, such as Smart Grids and social and other infrastructure networks.

And, of course, creating and controlling such networks—which are often spread out geographically—has long been a Viterbi School strength. ISI's role in developing the Internet is one example; ISI Fellow Carl Kesselman's role in co-developing grid computing is another.

Other Viterbi scientists are looking at buildings, home construction, road-building and other urban structures and institutions, focusing on whether informatics can make them more energy-efficient. Massoud Pedram (CS) is tackling computing and data storage centers—which consume a tremendous amount of energy for computation and cooling needs.

Pedram has published a series of papers on "Green Data Centers," or data storage facilities that are efficient and minimize environmental impact. He has focused on finding ways to predict and distribute computing load in ways that reduce energy cost and minimize the carbon footprint of information processing systems. He's also worked on minimizing the energy required to cool these giant data centers and power central servers.

And in the green building arena, Burcin Becerik-Gerber (CEE) is focusing on streamlining management techniques in the construction process to maximize time, save costs and reduce energy use.

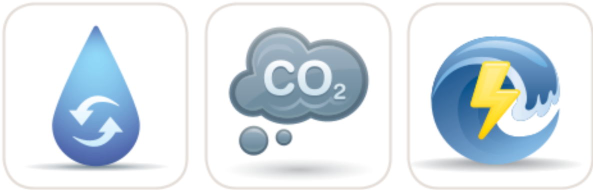
In a current study, Becerik-Gerber is trying to measure how accurately the energy models used by her Building Information Modeling (BIM) system reflect actual building performance. "We want to compare these technologies and strategies with actual building performances and human comfort factors," Becerik-Gerber says. "We hope to get insight into correlations between energy consumption and comfort, building design and comfort, and building design and energy consumption."

Other Viterbi research has wide-ranging energy implications. Take transmission, for example. Deploying a different type of cable for transmission lines may become a critical conservation strategy; the power grid has traditionally been comprised of plain, insulated steel-supported aluminum wires. Steve Nutt (ChE/MS) of the M.C. Gill Foundation Composites Center, in conjunction with the Composite Technology Corporation of Irvine, Calif., has developed a composite cable consisting of a lightweight core of carbon and glass fiber, surrounded by aluminum wires. Such cables are lighter, easier to handle, and can carry up to twice the amount of energy in the same diameter cable.

Finally, as automotive transport counts among society's most energy-intensive uses, Viterbi researchers are helping to find ways to move people and goods more efficiently. Part of this effort involves the METRANS project, created in 1998, in which the Viterbi School partners with the School of Policy, Planning, and Development.

Petros Iaonnou (EE) serves as METRANS' associate director of research, and a major focus of his work is traffic-flow modeling and developing concepts for an automated highway system, in which computer controls in vehicles might be able to use existing highway space more efficiently.

This work is particularly important in Southern California, one of the most congested metropolitan areas in the country.



Optimizing The Earth's Energy Resources

Finding energy sources, including fossil fuels, and improving methods of tapping into them, have long been a Viterbi School strength, particularly in the area of petroleum engineering. In recent years, the school has expanded on this strength, adding new informatics techniques to both broaden and deepen its expertise.

The school has not only greatly improved oil-recovery technology, but also has expanded into newer areas, such as gas and geothermal, explored how best to sequester carbon dioxide produced by combustion, and even looked at harvesting electrical energy from the waves breaking along the California coast.

A leading example in this area, again, is CiSoft. Chevron came to USC for this partnership because of the strengths of the school's petroleum engineering program and information technology prowess. The corporation was also attracted to the pioneering research of that department's director, Iraj Ershaghi (ChE/MS), its faculty, and the expertise of other researchers in the areas of information technology and integrated media systems.

At the time of CiSoft's founding, Ershaghi, who holds the Viterbi School's Omar B. Milligan Chair, was already a longtime specialist in using informatics to coax more petroleum out of the ground by combining detailed knowledge of the underground gas and oil deposits with improving physical production tools, such as pressure maintenance and fluid displacement processes.

CiSoft expanded Ershaghi's vision with a unique structure. Chevron engineers with real-world oil-extraction problems reached out to the Viterbi faculty to find expertise and create an exemplary model of interdisciplinary research.

Now, some 80 Viterbi professors, post-docs and graduate students are addressing or have addressed a huge range of oil and gas field management problems using advances in information technology. To call the effort interdisciplinary is an understatement: Only a small number of these researchers are from specialties dealing with petroleum engineering, or even chemical engineering and materials science. Many more are from computer science, electrical engineering and systems engineering.

The continuing flow of CiSoft papers—more than 50 in just the last two years—attests to the range of research. One example: Viktor Prasanna (EE), who will play a leading role in the SmartGrid projects, collaborated on "Semantic Web Technologies for Smart Oil Field Applications," "Workflow Instance Detection: Toward a Knowledge Capture Methodology for Smart Oilfields," "A Framework for Design Space Exploration in Oilfield Asset Development," and several more papers in 2008 alone.

Another component of CiSoft research involves the work of John Heidemann and Wei Yu, both of ISI, who have been working in recent years to model a new way to keep track of underwater oilfields, using low-power sensors. Such sensors will take advantage of the excellent sound-carrying capabilities of water to communicate with each other using sound, rather than radio. Resolving the communication issues of such sensors helps with the remote managing of deepwater resources, especially under rough weather conditions. They can also aid environmental monitoring of underwater structures in oceans, lakes and rivers.

Applying signal processing techniques to underground mapping is another significant CiSoft effort in energy recovery. Antonio Ortega (EE) and Jerry Mendel (EE) published two papers proposing different ways to map underground fracture patterns in oil-bearing geological structures, using advanced signal processing techniques. Craig Knoblock and Cyrus Shahabi (both CS) are developing innovative subsurface mapping and data management algorithms.

> *"Energy and sustainability are the critical issues of our future, and indeed, we at Viterbi are attacking the problem on all possible fronts."*
>
> DEAN YANNIS C. YORTSOS, USC VITERBI SCHOOL OF ENGINEERING

Some of the innovations developed at CiSoft have already found their path to prototyping. These include the "Concurrent Water Collection" developed by Behrokh Khoshnevis, of the Daniel J. Epstein Department of Industrial and Systems Engineering, for dewatering gas wells, and visualization schemes by Ulrich Neumann (CS) that help oil producers better understand underground structures.

Besides Chevron, The Energy Corporation of America also has stepped up to fund ongoing research at the Viterbi School. The Energy Corporation—which owns and operates more than 5,000 gas and oil wells in the United States (and whose chief executive, John Mork, is the namesake of the Mork Family Department of Chemical Engineering and Materials Science)—is funding basic research led by Kristian Jessen (ChE/MS) and his colleagues on optimizing gas production from "tight" shale deposits.

Jessen is concentrating on improving techniques to extract gas from these shales, techniques which have vastly boosted the estimated size of recoverable U.S. gas energy reserves. Jessen's mission is to push the edge further, carry out advanced work leading to improved imaging and modeling of the gas resources, and increase the productivity and recovery from such reservoirs by better understanding underground structures.

The use of these new subsurface imaging techniques is not limited to fossil fuels like gas and oil, however. Fred Aminzadeh (ChE/MS), who teaches one of the Smart Oilfield Technology courses and carries on research on soft computing, recently received $1.5 million in stimulus funding from the Department of Energy to carry out 3-D imaging and mapping of the Geysers Geothermal Field in Northern California. The work will be accomplished in collaboration with the Lawrence Berkeley National Laboratory and the Geysers Power Company, LLC, a subsidiary of Calpine and the operator of existing geothermal power plants in the area.

Aminzadeh's objective is to develop new methodologies to characterize the northwestern part of the Geysers reservoir; to gain better knowledge of its porosity, permeability, fracture size, fracture spacing, reservoir discontinuities (leaky barriers), and impermeable boundaries in order to prolong the life of the field; and to explore more effective heat recovery by water injection.

The most exciting news? New technologies may soon allow capture of yet-untapped potential sources of energy. The newest ISI project leader is Gordon Roesler, a former Navy submarine officer who is creating a new Center for Energy Informatics and Systems at ISI, while leading the Smart Grid efforts.

Additionally, Roesler has his eye on energy capture from waves, a technology which has the potential, "if applied to the Pacific Coast alone, to provide the equivalent of five nuclear power plants' worth of completely clean energy, at a far higher reliability level than wind and solar energy," according to a Center announcement. Roesler's earlier work with waves included developing a new system for steering small boats that took wave forces into account to make them more maneuverable.

And the Center will have a much broader focus than just ocean waves; besides the Smart Grid efforts, Venkata Pingali of ISI is now developing a "carbon intelligence tool" to help businesses get more detailed information about their energy use.

Finally, substantial attention is being devoted to another major energy technology—carbon sequestration, or the long-term storage of CO_2 and other forms of carbon to lessen the impact of global warming. Fossil fuel combustion releases enormous quantities of carbon dioxide, to a first approximation, of nearly four pounds of CO_2 for every pound of coal burned.

Energy theorists have discussed a wide range of possibilities, including injecting the CO_2 produced by burning coal back into the earth and locking it up. The Viterbi School's Don Zhang (CE, ChE/MS), who holds the Gordon S. Marshall Professorship in Engineering Technology, has been looking into the issue; indeed, known geological formations (underground saline aquifers) could potentially store 150 years' worth of CO_2 emissions at the planet's current production level. But the practical problems are formidable. The capture must be tight: leakage of even 1 percent per year would be unacceptable, Zhang says.

Zhang's research agenda got a big boost this year, with $2 million awarded to him and Jessen from Stanford University's Global Climate and Energy Project, to work on these issues with Peking University and China University of Geosciences at Wuhan. The effort will focus on applications in China, the world's largest producer and consumer of coal. Zhang will direct a group that includes 39 researchers in the United States and China, including Jessen.

This collaboration is important, as the world needs to come together to tackle the problem of carbon dioxide emissions and global warming, says Yortsos.

"Energy and sustainability are the critical issues of our future," says Yortsos, "and we are attacking the problem on all possible fronts." //

From the CEO's Office: Talking Energy with Alan Fohrer

Alan Fohrer

This Trojan believes that puzzling out the solution to the world's energy problems begins in Southern California.

Southern California Edison chairman and CEO Alan Fohrer (BSCE '73, MSCE '76) hopes to advance the national energy conversation by facilitating a collaboration between academia and industry.

"It's an exciting time to be an engineer," says Fohrer during an in-depth conversation from Edison's corporate offices in Rosemead, Calif. "I think the energy industry is going to change more in the next 10 years than it has in the last 30 or 40."

In 2009, Edison and USC sponsored two meetings of the inaugural Southern California Smart Grid Research Symposium. Nearly 200 experts from industry and academia gathered to discuss how to meet challenges by using the smart grid concept, which aims to reduce dependence on fossil fuels and increase efficiency.

Edison has pushed ahead by distributing 5 million smart meters to its customers that will "literally communicate with their appliances," says Fohrer. The goal? To reduce peak power consumption by an estimated 1,000 megawatts—about the output of one major power plant.

Renewable energy credits and electric vehicles also figure prominently among Fohrer's priorities, as does building a sufficient network of transmission lines to connect renewable power sources with customers—who often live miles away.

The father of four chuckles that he has "no idea" how he ascended to the helm of one of the country's most prominent utilities, but says USC helped pave the way.

Among the first in his family to go to college, Fohrer grew up in the small town of Hobart, Ind., in the "shadow of the Golden Dome" at the University of Notre Dame. "Notre Dame was originally my first choice," he says, "but then USC gave me scholarships, and I decided I liked being a Trojan."

Fohrer started in aerospace engineering, but gravitated toward the civil/structural classes. "I liked understanding how bridges and planes worked, but I was never good at building things," he jokes. "My wife likes to say that I'm the least mechanical engineer she's ever met."

Originally, Fohrer planned to stay "no more than three years" when he started at Edison. He planned on a Ph.D. and an academic career. But Edison made it very hard to leave, providing tuition for his M.S., and also an M.B.A. from Cal State Los Angeles. After an executive training program and a year in finance, he learned that he not only enjoyed working on big projects, but also liked the "people" aspect of management. "That led me on a different career path," Fohrer says.

Today, he enjoys donning a hard hat and heading out of the executive suite to Edison plants. Precious free time is spent with his family or on the golf course with two of his three sons. He also goes to Catalina Island for a week each summer to camp, hike and canoe with his youngest son's Eagle Scout troop.

Fohrer is a member of the Viterbi School's Board of Councilors. Through the Edison Challenge, the company also sponsors science contests at high schools throughout Southern California.

His Trojan roots run deep; Fohrer's wife attended the USC Marshall School of Business, as did his two eldest sons. He jokes that he "lost" his daughter to Georgetown University, but is working on imbuing his youngest son—currently in high school—with some Trojan pride.

"He seems to really like engineering, and USC would be at the top of his list, I'd hope," says Fohrer.

He's happy that USC supplies Edison with some of the company's most promising employees.

"Although we occasionally hire students from the 'other' school," he jokes, "it pains us to do so." //

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> ALAN FOHRER, SOUTHERN CALIFORNIA EDISON CHAIRMAN AND CEO