THE UNIVERSITY OF NEW MEXICO SCHOOL OF ENGINEERING

FALL 2008

UNM engineering

Fueling the Future

1906-2006 100 YEARS OF EXCELLENCE

From the Dean

Energy and Sustainability

The last issue of *UNM Engineering* was devoted to the general topic of large-scale complex systems. In this issue, we focus on what is arguably the most important and challenging of those: energy. The scale sizeand complexity of energy can hardly be overstated, particularly in its tight coupling to other systems, like the global economy, geopolitics, and the planet's climate. It has evolved in ways that are clearly not sustainable against high and increasing world wide demand. At present, approximately 80% of the world's primary energy supply comes from fossil fuels, i.e., coal, oil, and gas. Not only are these exhaustible on relatively short time scales (approximately 50 years for oil and up to 150 years for coal), but collectively they are responsible for about 80% of the total anthropogenic global CO_2 emission, thus contributing significantly to global warming.

Clearly the past practice of relying on the most readily obtainable energy sources has not produced a sustained approach to supplying the world's energy needs. There is an urgent need to transform the present energy landscape from one that is so heavily reliant on unsustainable technologies to one that takes a systems perspective and embraces sustainability as a fundamental principle.

Given the magnitude of the problem, there is no single technology that will meet the rising demand for energy in a sustainable way. Instead, the challenge is to develop multiple solutions and then to integrate them on a large scale. Certainly renewable energy sources, such as wind, photovoltaics, solar thermal, hydropower, geothermal, and tidal power represent technologies that also mitigate climate change. Adding carbon capture and sequestration to coal and gas electric generating facilities also moves in the right direction, as does nuclear power, which is clean and carbon free. Biofuels and hydrogen production by carbon free sources represent additional possible solutions. Perhaps the simplest and most fundamental approach is conservation and increased efficiencies.

In this issue, you will read about increasing the efficiency of solar thermal energy for heating and cooling, and how a "smart grid" can produce energy conservation. Other articles in this issue highlight new research collaborations in the areas of biofuels, nuclear energy, photovoltaics, and hydrogen production. You'll also read about how our students are designing and implementing innovative energy solutions. We hope you find this an informative issue.

Joe

Joseph L. Cecchi
Dean of Engineering

Centennial Engineering Center Opens for Fall '08 Semester

The largest building on the University of New Mexico main campus, the new 147,500 square feet, $42 million **Centennial Engineering Center** opened for fall semester classes on August 28, 2008. The official dedication and ribbon-cutting ceremony took place on Sunday, September 14.

"The Centennial Engineering Center will enable us to serve students in engineering and computer science by giving them hands-on experiences that are critical for the 21st century," says School of Engineering Dean Joseph L. Cecchi. "The Center will increase the School's capacity for innovation, multidisciplinary research, developing patents, creating new businesses, and economic growth."

The Center is the new home of the Civil Engineering Department, the Center for Biomedical Engineering, some labs for the Chemical and Nuclear Engineering Department, Engineering Student Services, and the Dean's Office. Modern labs, classrooms, and collaboration areas are designed to facilitate teaching and research in the School's areas of expertise, including biomedical engineering, water resources, sustainability, and transportation.

The building was designed by Van H. Gilbert, Architect PC of Albuquerque in collaboration with Shepley, Bulfinch, Richardson & Abbott of Boston.

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Intelligent Energy

Researchers help solve the energy challenge with smart buildings and a smarter grid

The numbers at the gas pump keep rising, demand for oil is skyrocketing, and political unrest around the world is destabilizing oil supplies. While America relies on fossil fuels to satisfy 85 percent of its primary energy demand, there is mounting concern about global warming. Looking through that lens and considering the impact of fossil fuels on the economy, the environment, and national security, our nation's energy situation looks dire.

Even with solar power fields and wind farms sprouting around the country, there is no single resource — no "silver bullet"— that can replace the volume of energy produced by fossil fuels. And when you consider that demand for electricity is expected to increase by 40 percent in the next 20 years, the picture becomes even more challenging.

So what's the solution? One UNM researcher says a big part of the answer is simple: Get smart. Through his research, Andrea Mammoli, associate professor of mechanical engineering, is discovering smart new conservation techniques, more efficient ways to utilize renewable energy sources, and wise approaches for using every energy source.

Old System, New Potential

Mammoli's original focus was optimizing the energy production and conservation potential of one of UNM's most unique buildings. When the Mechanical Engineering building opened in

The ME solar team installs one of 640 state-of-the-art vacuum tube collectors on the roof of the Mechanical Engineering building.

Professor Andrea Mammoli programs the digital controller, which automatically adjusts system parameters such as flow rates, fan operation, and building temperature as demand for power changes throughout the day.

1980, it was a model for energy conservation and solar power technology. Its unique internal heating and cooling system and rooftop solar panels reduced the building's energy use to just one-third of that used by other buildings. But, as energy prices dropped in the '80s and '90s, the system fell into disrepair.

With prices skyrocketing again and concern about global warming on the rise, Mammoli and Peter Vorobieff, associate professor of mechanical engineering, decided to refurbish the system, with the help of Physical Plant Department engineers Hans Barsun and Robert Notary and students Mario Ortiz, Will Brenneman, Anthony Menicucci, and Dan Fisher. "We're trying to study performance as well as economics," explains Mammoli. "We want to save energy and see how economical it is to produce these energy savings."

The new solar array is a hybrid of 124 square meters of unused 30-year old solar panels and 108 square meters of state-of-the-art vacuum tube collectors. The team also renovated and simplified the building's internal system to include an absorption chiller, thermal storage tanks, and supplementary heat exchangers that help the solar system to heat and cool the building. (See sidebar titled "ME Solar/Thermal System," next page.)

The team added a digital controller that automatically adjusts system parameters such as flow rates, fan operation, and building temperature as demand for power changes throughout the day. That flexibility conserves energy and makes the building an excellent teaching tool. Eventually students will use the system for real life demonstrations of computer-generated energy consumption models and programs.

The New Mexico Energy, Minerals and Natural Resources Department provided a grant of approximately $200,000 to fund the building's solar system renovation. Mary Vosevich, director of UNM's Physical Plant Department, helped coordinate an additional $490,000 in funding from the UNM Building Renewal and Replacement funds to renovate the building's air handling system and to assist with extensive reconfiguration of the original thermal storage system. The U.S. Department of Energy's Office of Electricity provided a further $42,000 to install instrumentation and control equipment. Dave Menicucci and his group at Sandia National Laboratories provided design input based on their 30 years experience in solar thermal systems.

The new system is expected to reduce the peak electric power demand by approximately 50 percent by shifting the cooling load to the solar chiller and to night-time charging of the thermal storage tanks. It will also reduce carbon dioxide emissions by about 100 tons annually. Mammoli says that while the system shows what can be achieved with existing technology, a single building won't impact the grid substantially.

Multiplying the Power

What will make a big difference is linking large groups of buildings like the ME building and enabling them to communicate with the power grid. Such a "smart grid" is a system that combines technology and intelligent distribution sources to enhance the entire system's ability to use renewable resources like wind and solar power. "I believe a smart grid is a key enabling component in the solution to the energy problem," says Mammoli.

Here's just one example of how the system would work: With a smart grid in place and more electric cars on the road, owners could recharge their cars at special parking lot charging stations. The power company would signal the cars to charge only when inexpensive, clean renewable resources like wind power were available. "The cars would create this huge storage capacity for intermittent renewables that we didn't have before," explains Mammoli. That's just the start. Homes, buildings, and entire city blocks would also be part of the smart grid.

Associate Professor of Mechanical Engineering Peter Vorobieff and Anthony Menicucci inspect cooling tower parameters while Physical Plant Engineer Hans Barsun monitors absorption chiller performance.

UNM's campus will lead the way. In 2006 while Mammoli was concentrating on refurbishing the ME building, Jack McGowan was searching for a smart grid demonstration site. McGowan is president of Energy Control, Inc., an Albuquerque-based energy service company and system integrator that applies intelligent building systems for comfort and security. He is also chair of the U.S. Department of Energy GridWise Architecture Council (GWAC), a team of industry leaders shaping the development of an intelligent, interactive electric system.

ME Solar/Thermal System

Summer Daytime Operation

Solid lines indicate flow, dashed lines indicate flow that could occur in other modes of operation.

Open valves: V1, V2, V6, V7, V8, V11, V13
Closed valves: V3, V4, V9, V10, V12

Solar loop

Water is drawn from the bottom of the stratified hot water tank (HWT) by pump P4, and directed first to the flat plate collector array (FPA) then to the vacuum tube array (VTA). Water is heated to a set temperature as a function of the flow rate and the position of the three-way solar control valve (SCV), and returned to the top of the stratified tank.

Water-fired chiller hot water loop

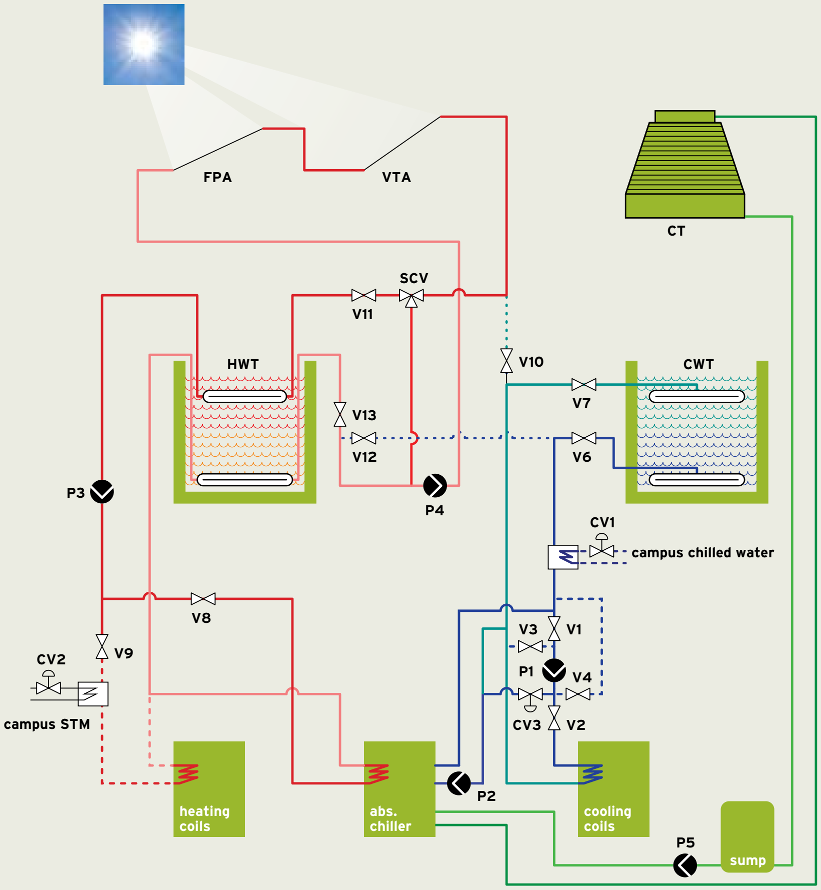
Hot water is drawn from the top of the stratified hot water tank by pump P3, and directed to the generator section of the "water-fired" absorption chiller, where it cools down by a set amount (controllable by varying the flow rate) and is subsequently returned to the bottom of the stratified hot water tank.

Chilled water loop

Chilled water stored during the night is drawn from the bottom of the stratified cold water tanks (CWT) by pump P1, and directed to various cooling coils that service the building. Warmer return water from the cooling coil is returned to the top of the stratified cold water tank. Part of the warm return water is mixed with part of the cold supply water and directed to the evaporator section of the water fired chiller by pump P2. The mixture temperature is controlled by modulating valve CV3. The cold water exiting the chiller is fed back into the cold water supply loop, upstream of pump P1.

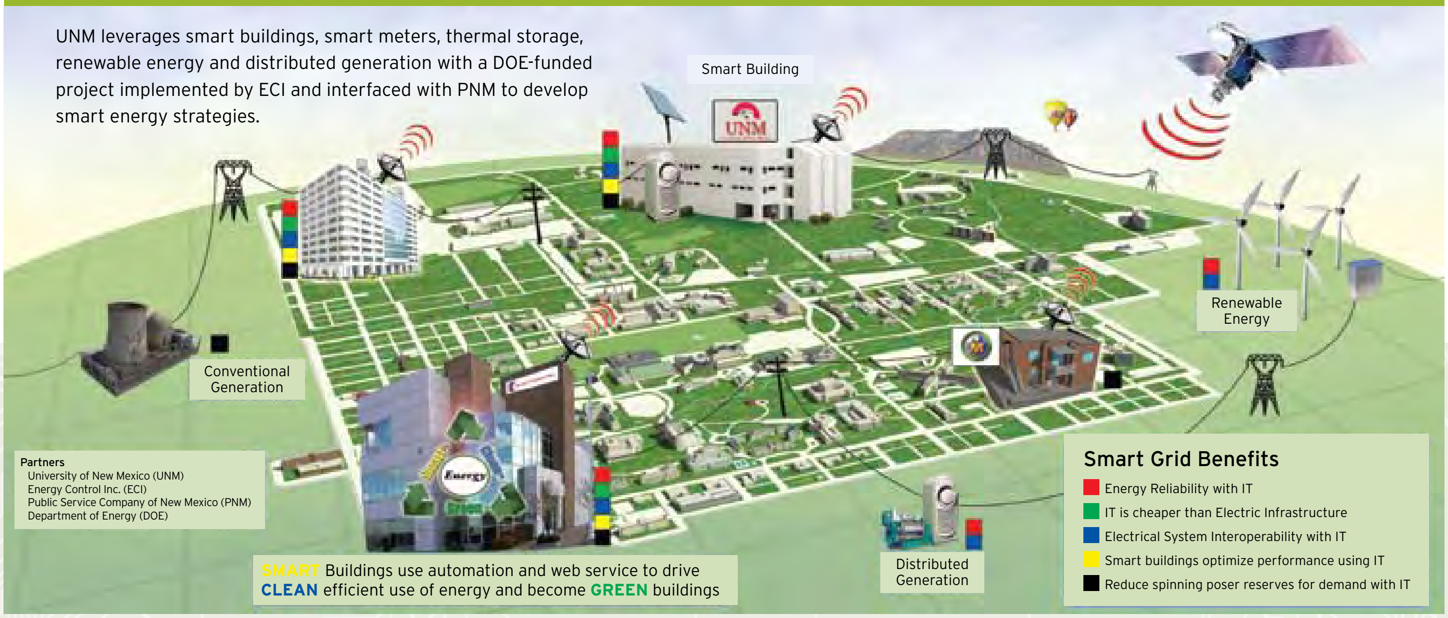
Cooling water loop

The sum of the heat supplied to the chiller by the solar hot water and the heat removed from the building is dissipated by the cooling tower. Cooling water is drawn from the sump by pump P5 and directed to the cooling tower via the condenser and the absorber circuits within the chiller. Water from the cooling tower flows back by gravity to the cooling tower sump.



Smart Buildings Meet the Smart Grid

Energy Intelligence = Today's Grid / Smart Buildings / Efficiency Technologies / Renewables + Information Technology (IT)



When McGowan heard about Mammoli and the ME building renovation, he knew it would be an ideal site. "Andrea has a passion for using this opportunity to position UNM as a national center of excellence for smart energy," says McGowan. Mammoli was equally inspired by the opportunity. "My thought process changed from saving energy as a standalone application to incorporating it with the rest of the buildings on campus and the grid. It's a much more valuable thing to do."

A Smarter Campus

Mammoli says campus buildings are currently "dumb entities" in relation to the grid. "They do their own thing based on what their controller says and the grid responds. We're trying to make them relatively intelligent entities that will take into account their own requirements and what's going on around them." He says the buildings will use occupancy rates, energy pricing information, and real time load on the grid to decide how to run their internal systems. The smart grid would include financial incentives for customers responding to requests from the power company.

Backed by a grant of over $500,000 from the U.S. Department of Energy, Office of Electricity, the team is busy developing UNM's smart grid. A key component is a portal used to share information between buildings, UNM physical plant, and Public Service Company of New Mexico, the local power company. If PNM needs UNM to shed load during peak demand times, the information will be exchanged on the portal and it will evaluate which campus facilities have the most capacity to reduce demand, then adjust the system accordingly.

Don Lincoln, a mechanical engineering doctorate student working with Mammoli, is working on the project. His research includes classifying campus buildings by their energy usage, helping to develop the portal, and assessing how PNM could compensate users for participating in demand-response programs.

The process is already yielding answers. "We're getting more accurate results in estimating energy savings than other researchers because we use fuzzy logic that adds information on building occupancy to determine how much energy is used," says Lincoln.

The team is also receiving accolades for the project. Recently, the DOE and GWAC gave the team a GridWise Applied Award recognizing the project for their activities and vision in smart grid implementation.

Mammoli estimates it will take at least five years—and a lot more work—to make the UNM smart grid fully functional. It will be longer still until similar grids are in place across the country and the world. Our collective future depends on how engineers like Mammoli and his team use their knowledge and skills to create intelligent energy strategies that help us overcome those difficulties.

CATALYZING OPPORTUNITIES

International research collaboration creates new energy sources and educational experiences

Before a big race, many endurance athletes consume large amounts of carbohydrates that their bodies convert into energy to fuel them across the finish line. Now an international team of engineers is studying how "carb-loading" could help win the race to find new sources of energy for the world.

Abhaya Datye, Director of the Center for Microengineered Materials (CMEM), leads an international team of researchers and students studying large-scale chemical catalysis of biomass-derived reactants into fuels, chemicals, and materials needed by society. Biomass materials, such as cornstarch and sugarcane, are basic carbohydrates that a bio-refinery can catalyze into clean-burning liquid fuels for the transportation industry and chemicals that lead to products we use everyday.

Better Biofuels

Biofuels made from biomass materials are rapidly gaining market share and represent a big part of the future of energy around the world. Biomass is a globally distributed, abundant, and renewable resource, which can provide energy sources as well as organic carbon for industrial applications. While biofuels are already used widely, the production and processing of biomass needs to be improved. More efficient conversion of raw materials into fuel is especially important as energy prices rise and more farmers dedicate their acreage to growing crops for biofuel rather than food.

Datye and a team of researchers and students are investigating the steps in biomass catalysis and studying how to enhance selective conversion of reactants into useful products more effectively and efficiently.

The scope of the problem demands a multi-disciplinary, multi-investigator, international team because the required computational and experimental tools and skills span a range that no single investigator or institution can provide.

PIRE Partnership

That collaborative research effort is part of a Partnership for International Research and Education (PIRE), a grant funded by NSF designed to foster new international research partnerships, expand research capabilities, and provide international education opportunities for students. Of the more than 500 pre-proposals submitted last year, the NSF awarded only 20 grants in September 2007.

UNM leads the $2.5 million, five-year PIRE grant, which includes seven other institutions around the world: University of Wisconsin; Iowa State University; University of Virginia; Technical University of Denmark; the Fritz Haber Institute and the Institute for Colloids and Surfaces of the Max Planck Society in Germany; and Haldor Topsoe A/S, Denmark, a large Danish catalyst company. Haldor Topsoe has been a pioneer vin developing new tools and methods for in-situ studies of catalysts and will provide facilities for students to
do research in their laboratories.

Such a large group working on very complex issues requires a visionary leader. Highly respected in the catalysis community for his pioneering research on heterogeneous catalysis and catalyst imaging, Datye is named by some colleagues as the "best microscopist in catalysis and the best in chemical engineering." He has many publications to his name and is looked to as a leader in the field. Through his seminal research on catalyst imaging, Datye provided critical information that forms the foundation of the field. He arrived at UNM in 1984 and since then has been leading research efforts and creating successful, long-standing international partnerships, some of which are part of the PIRE.

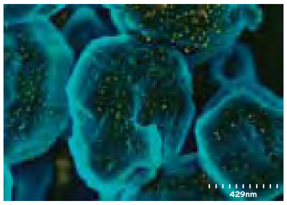
A Bottom Up Approach

The PIRE team is exploring, from the bottom up, how catalysts control the precise molecular transformations that will enable a biorefinery to generate products in an efficient manner. They are analyzing exactly how precious metals, like platinum and palladium, catalyze chemical reactions leading to processes that are highly selective. With that knowledge, they can work towards one of their ultimate goals: replacing the precious metals with less expensive, abundant resources like clay and iron oxide.

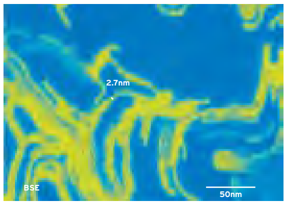
Datye says each institution will focus on different aspects of the project, then share results so the team can utilize each other's expertise. "We're addressing a global energy problem and the solutions are not going to come from just one place," says Datye. "That's why we are partnering with the leading institutions that have common interests and complementary expertise to both educate our students and work on these research challenges cooperatively."

The research program is still being developed, but three specific projects have already been defined. The focus of the first two is on hydroxymethylfurfural (HMF), a compound formed during the selective catalytic conversion of sugars. HMF has the potential to serve as a replacement for the petroleum-based building blocks

Abhaya Datye with undergraduate Chuan Zhang, summer student from the University of North Carolina at Chapel Hill (left) and UNM Ph.D. student Patrick Burton (right).



Gold nanoparticles in mesoporous silica (blue). These catalysts are being studied in the PIRE partnership for conversion of biomass derived reactants.



Nanowires of platinum in mesoporous silica. The unusual pore structure of the aerosol-derived silica developed at UNM allows the team to prepare novel catalysts with exceptional stability.

that are currently used in the production of plastics and fine chemicals. The team will study the downstream conversion of HMF to useful products. As an example, the team will explore the synthesis and stability of novel copper-based bimetallic catalysts for selective hydrogenolysis. Adding other metal components and manipulating solvents will allow them to enhance the catalytic process.

The second project is selective conversion of HMF and its derivatives under oxidizing conditions. Here the team will focus on gold catalysts for oxidation of HMF and its directivities to high-value organic acids. The third and final project is conversion of biomass into materials, which provides an opportunity to reverse the negative environmental effects of burning fossil fuels. This portion of the project builds on the work done by UNM's partners in Germany on conversion of biomass into carbon-based materials. The research projects will continue to evolve as the team develops novel pathways to convert biomass derived reactants into useful products.

International Opportunities

The PIRE team balances research advancements with unique educational opportunities. Students will benefit from international research and learn how education works in other countries. "That is valuable experience because our students will know how other countries do their work and who their competition is going to be," says Datye.

Each year 12 graduate students and four undergraduate students selected from the participating PIRE schools and elsewhere in the country will study abroad for up to a semester. Summer programs and workshops are also planned. The first summer school was held this year in Denmark and UNM hosted a research planning workshop in June.

Andrew Delariva, a chemical engineering graduate student researching noble metal catalysis, was one of the first UNM students to participate in the PIRE. He is also a trainer and administrator for an important PIRE research tool, the field emission scanning electron microscope (FESEM) funded by the New Mexico Experimental Program to Stimulate Competitive Research (EPSCoR). Team members from Haldor Topsoe and the Fritz Haber Institute have already used the FESEM at UNM to analyze alumina catalysts and molybdenum-based oxidation catalysts.

Last fall, Delariva studied at the Danish Technical University and worked at Haldor Topsoe. He returned to DTU this summer to attend the PIRE summer school. "The PIRE gave me a chance to experience life outside of my research group, not only working for a company, but also exposing me to a foreign university and its methods of research," says Delariva. "Without attending UNM and working with Abhaya Datye, I wouldn't have had the opportunity to study abroad."

The PIRE's educational opportunities aren't limited to college students. The grant also includes plans for a sustainable energy outreach program for K-12 teachers who will inspire the next generation of engineers to catalyze even greater change in the world.

CENTERS OF COLLABORATION

SOE adds two new research centers

How do you train people to solve future nuclear non-proliferation issues? What new materials can be used to make better power generation devices? What's the best way to bridge biofuels and fuel cell technology?

Finding answers to these engineering challenges requires collaborative thinking, unique partnerships, and a focused effort. When the questions are large enough and focus on an area of SOE expertise, the challenge calls for more than a research program, it requires a larger initiative—a center. The SOE currently has eight centers that bring together engineers and scientists from different disciplines and various organizations to catalyze research and collaboration with the public and private sectors.

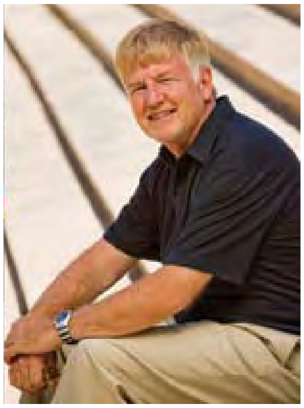
Recently, the SOE created two new research centers to address important issues in the areas of nuclear non-proliferation and emerging materials.

Science and Technology

As global pressures increase to find additional sources of emissions-free energy, nuclear power is re-emerging as part of the solution. Nuclear power presently produces 19 percent of the nation's electricity. It is efficient, clean, and carbon free, but presents challenges in cost and waste. But perhaps the biggest issue is the production and theft of nuclear materials that can be used by terrorist organizations or as weapons of mass destruction.

With those challenges in mind, the University of New Mexico launched the Center for Nuclear Nonproliferation Science and Technology (CN^{2}ST) in 2007. The CN^{2}ST is one of five national academic centers of excellence funded by Idaho National Laboratory (INL) and the Battelle Energy Alliance, which operates INL.

The CN^{2}ST will be a facilitating entity, fostering funded collaborations between UNM faculty and DOE national laboratory scientists at INL, Los Alamos National Laboratory, Sandia



IF YOU'RE TRYING TO DO A BETTER JOB OF NUCLEAR SAFEGUARDING, THE CHALLENGE IS HOW TO INTERPRET LOTS OF DIFFERENT TYPES OF DATA, AND HOW TO LOOK FOR ANOMALIES THAT DON'T JUST JUMP OUT. DATA VISUALIZATION CAN HELP YOU SPOT THOSE THINGS.

Edward Arthur

AND CREATIVITY

National Laboratories, and faculty at Texas A&M University. CN^{2}ST efforts will support UNM faculty initiatives to develop new technologies to address nuclear nonproliferation and to train the next generation of scientists and engineers to manage future nuclear proliferation challenges.

Edward Arthur, director of the CN^{2}ST and UNM research professor, is leading the Center through its early stages of development. He says the UNM SOE is the ideal place for the Center because of the school's expertise in many disciplines, including computational modeling and simulation, robotics, nuclear criticality safety, detector development, fuzzy logic, and more.

Arthur says CN^{2}ST will collaborate with UNM departments and research centers to focus on advanced visualization, advanced radiation detectors, and training new scientists and engineers to fulfill national needs in nuclear safeguards and related areas. Advanced visualization techniques can be used to identify anomalies in detector and other data that indicate potential material theft or misuse of a peaceful nuclear facility. "If you're trying to do a better job of nuclear safeguarding, the challenge is

WE'RE LOOKING FORWARD TO EXTENDING INTERNAL AND EXTERNAL COLLABORATIONS IN THE AREAS OF PHOTOVOLTAICS, BIOFUELS, AND OTHER AREAS OF RENEWABLE ENERGY WHERE UNM HAS SOME REAL STRENGTH.

Plamen Atanassov

how to interpret lots of different types of data, and how to look for anomalies that don't just jump out. Data visualization can help you spot those things," explains Arthur.

In the detection arena, the focus is on new approaches that better model how radiation interacts with materials so that nuclear emissions of interest can be separated from random backgrounds. The effort includes developing new instruments and methods for detecting clandestine nuclear materials that are often hidden in well-shielded environments.

CN^{2}ST also plans to help address the critical national issue of educating more engineers and scientists to enter nuclear safeguards and homeland security fields. The Center and the Chemical and Nuclear Engineering Department intend to develop a graduate level curriculum that would lead to a nuclear nonproliferation science and technology certificate associated with a master's degree. Other goals include adding new faculty in the Chemical and Nuclear Engineering Department and collaborating with public and scientific technology policy experts through alliances with the UNM Center for Science and Technology Policy.

Energy Technologies

Another new center at the SOE, the Center for Emerging Energy Technologies (CEET), will support research on new materials for energy conversion and power generation.

Plamen Atanassov, associate professor of chemical and nuclear engineering, is the director of CEET. "We're looking forward to extending internal and external collaborations in the areas of photovoltaics, biofuels, and other areas of renewable energy where UNM has some real strength," he says. CEET will help UNM capitalize on its investment in materials science by focusing on forward integration and moving from materials as commodities to materials used in devices that bring true value to society. To do that, CEET would provide grants to faculty researching energy technologies and materials that can be applied to devices.

With help from STC.UNM, which supports UNM's inventive culture and licenses innovative technology developed at the university, Atanassov is gathering funding for CEET and fostering collaborations with industry and organizations including the National Science Foundation, the Department of Energy, and the Department of Defense.

CEET is meeting with early success, having recently received a $1.8 million Department of Energy EPSCoR Implementation award. The DOE EPSCoR award can be viewed as a continuation of the New Mexico Experimental Program to Stimulate Competitive Research, an NSF initiative to develop engineering and scientific enterprise at the state level. CEET will host the three-year initiative, which includes an option of another three-year renewal, and provide for integration of biofuels and fuel cells research by developing a materials set for ethanol-based fuel cell technology.

The award was given to support a research collaboration that will develop enabling materials for bridging mass-produced biofuels, such as ethanol, with fuel cell technology as a way to generate electrical power. The research project will explore two different pathways to achieving this goal. The first approach is to reform ethanol to produce hydrogen. The other is direct electrochemical oxidation of ethanol in a new type of alkaline membrane fuel cell. This program is an important pioneering effort to bridge, through materials, an approach to two major DOE initiatives: a hydrogen economy and bio-derived fuels.

The EPSCoR award will create partnerships between scientists and engineers from around New Mexico who will share knowledge and resources to engineer new and better materials for energy conversion. Participants in the program include faculty and researchers from the University of New Mexico, New Mexico State University, New Mexico Institute of Mining and Technology, and Eastern New Mexico University. This program is also supported by Los Alamos National Laboratory, Sandia National Laboratories, and the DOE Office of Science Center for Integrated Nanotechnologies.

Atanassov says he hopes that CEET will have a wide impact. "I would like to see local industry fostered and new companies formed. We are engaged in supporting small business in New Mexico and in start-up companies. We would like to see companies coming to Albuquerque and working with us." He adds, "Our key partner in this is STC.UNM, which provides both organizational and logistics support in addition to being the very effective patenting and licensing arm of UNM."

Students' enthusiasm will be central to the success of the new centers like CEET, says Atanassov. "I see students in all of the engineering disciplines interested in new technology and they are committed to conserving energy and finding new means of generating energy. It's a manifestation of the social demands and awareness that we see in our world now."

Engineering students participate in solar house design competition

Energizing Education

Solar house design award winners and two of their mentors: Dr. Marlene Brown, President of NMSEA, Drew Johnson, Engineering 1st place prize winner, photovoltaics class instructor Dr. Olga Lavrova, and Julie Welch, Engineering 2nd place prize winner.

A solar powered house that's stylish and so energy efficient that a power bill never arrives in the mailbox? You don't need a subscription to *Modern Architecture* or *Green Builder Magazine* to find a design for one. Plans are available right here at UNM, thanks to a group of hardworking architecture and engineering students.

Last spring Olga Lavrova, assistant adjunct professor in electrical and computer engineering, was looking for an alternative to a traditional midterm exam for students in her Special Topics: Photovoltaics class. When she heard about a unique solar house design competition sponsored by the New Mexico Solar Energy Association (NMSEA), Lavrova knew it was a perfect fit. NMSEA, a non-profit that promotes renewable energy and sustainability, sponsors the competition for architecture students. This year, engineers decided to step up to the challenge and participate in the contest to help strengthen the entries.

Each of Lavrova's engineering students collaborated with one or more students from the UNM School of Architecture and Planning for the contest. More than 30 student teams submitted entries. Their challenge: design and develop architectural and engineering plans for a 1,500 sq. ft. New Mexico home. Solid architectural design and efficient use of passive and active solar energy were key criteria. Students also had to take into account cost effectiveness, quality of life, and options for future expansion.

Those were just the *contest* goals. Lavrova and the professors from the architecture school wanted the students to gain other experience too. "We thought it would be a good project for students from both schools because they can learn from each other," says Lavrova. "Projects like this are a great way to prepare our students for real life teamwork because they will be working in multidisciplinary settings and they must know how to work together and communicate."

A Pioneering Approach

Drew Johnson (ECE, 08) took Lavrova's photovoltaics course to complement his study of power systems. He chose to work with three different architecture students for the contest. His responsibilities for each entry included calculating how much energy the home would need, choosing the correct orientation for the house, designing the solar system, integrating it with architectural design, and calculating the cost of the system, taking into account any available energy credits.

"We acted like outside contractors," says Johnson. "We talked about what the architecture students wanted and how to accomplish their goals." It was no small task, especially when multiplied by three. Johnson took a comprehensive approach that didn't change dramatically among the three home designs he worked on.

However, one of the architecture students *did* challenge Johnson to think unconventionally. She wanted a solar-powered home that was so energy efficient that she'd never receive a power bill, and she didn't want to pay a dime to fuel her hybrid car either. It took some higher-level calculations, but Johnson's design did just that; using the sun to power both the home and the car. It was that kind of creative and comprehensive thinking that earned him the first place prize among the engineering students in the contest.

"Drew was really pioneering with his ability to charge the electric vehicle," says Lavrova. "His work was the most detailed and it had real life applications. He also took into account incentives from the utility company for homeowners," she adds.

Johnson says he gained much more than the $150 in prize money from the NMSEA contest. "This was a great experience," says Johnson. "We talked about solar power in class. But to design the system from scratch, calculate load requirements, and put it all into a practical design was excellent hands-on experience." ◆

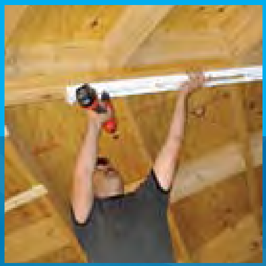
CDs with solar house designs are available at www.nmsea.org

a world of

Engineers Without Borders gives students hands-on experience close to home and around the world.

Advisor Barbara Kimbell and EWB-UNM students Shaun Maruna, Kelly Isaacson and Josh Goldman

experience



UNM engineering students learn how to design bridges, improve energy sources, and create new computer programs. Now, by participating in Engineers Without Borders (EWB-USA), they're also learning how to make immediate improvements to the quality of life for people here in New Mexico and on the other side of the globe.

Started in 2000, EWB-USA is a non-profit humanitarian organization that improves the quality of life in developing communities around the world through environmentally and economically sustainable engineering projects. Most projects focus on sustainable enterprise development, clean water, and renewable energy. Recent EWB-USA efforts include rebuilding Indonesian shrimp hatcheries destroyed by the 2004 tsunami, installing a solar-powered laptop computer for a painting school in Nepal, and bringing potable water to a war-ravaged community in Rwanda.

EWB-USA has 230 professional and student chapters in the U.S., including one at UNM. The EWB-UNM chapter started two years ago and has 25 active members. Participation is voluntary but the return is invaluable; students get hands-on experience planning and implementing engineering projects as well as the chance to travel internationally. "EWB-UNM students are partnering with developing communities to design, build, and maintain environmentally and economically sustainable solutions," says Barbara Kimbell, EWB-UNM advisor. "They are sincerely committed to applying their considerable talent, passion, and compassion to build safer, healthier communities in New Mexico and abroad."

The chapter is actively recruiting new members from across campus with varied skill sets. "Having students from public health, community planning, and anthropology is advantageous as they provide a different perspective and may be able to identify potential impacts engineers may not consider," explains Kelly Isaacson (CE, '08), president of the chapter.

Helping Close to Home

EWB-UNM students can just drive to the western edge of New Mexico to help people in need. There UNM students are collaborating on the design and installation of a solar-powered heating system for a hogan in Ramah, a remote town on the Navajo Nation. The community uses the hogan to hold classes and as a meeting place for a local weaving co-op.

You Can Help

EWB-UNM relies on financial contributions, expertise, grants, and in-kind donations to support its work. To learn more about the organization, please contact EWB-UNM advisor Barbara Kimbell, 505-277-5539, bkimbell@unm.edu or ewb@unm.edu. The UNM Foundation carries a 501(c)(3) for Engineers Without Borders-UNM. To donate, please make checks to UNM/EWB, c/o Development Office, School of Engineering, MSC01 1140, 1 University of New Mexico, Albuquerque, NM 87131-0001.

The team has designed a system that uses two solar panels to heat a working fluid, a combination of water and a chemical. The fluid will flow through a series of pipes and into an efficient radiator installed inside the hogan. The radiator will heat the hogan, and the working fluid will be pumped back to the panels where the process will be repeated.

The team is finalizing the system's design, researching radiators and pumps, and raising funds to buy equipment. Ten students are working on the project, but more will be on hand to install the system. "EWB students are helping a community in need while enhancing their engineering ability," says Elena Berliba-Vera, a junior in mechanical engineering, who is in charge of the Ramah effort. Funding, designing, and installing the system is just the start. Like all EWB projects, the chapter must commit to sustaining it for five years after implementation.

Making a Difference Around the World

Half a world away from Ramah, in the lowland savannas and forests of northwestern Bolivia, an indigenous group of forager-farmers called the Tsimane lives in 60 small villages along the Maniqui River. Development upriver is steadily polluting the Tsimane'swater sources.

Helen Davis, a research assistant in the UNM Anthropology Department, presented the Tsimane's need for clean water and communications systems to the EWB-UNM chapter in 2007. Davis is working on her graduate studies with Hillard Kaplan, professor of anthropology at UNM. Kaplan and his students have worked in the villages for years studying the Tsimane's health, longevity, and social interactions. That connection provides great synergy for the engineering students who will need information about the Tsimane as well as help with logistics and translation services.

EWB-UNM will receive extra support on the Bolivia project from the EWB Albuquerque Professionals Chapter. Jeannette Moore, an employee at Sandia National Laboratories and one of the founders of the student chapter at UNM, acts as a liaison between the professional and student chapters. She says participating in EWB benefits everyone. "The students learn from the professionals, and the professionals learn from the students on many different levels. They find a deeper meaning for the word 'teamwork' through collaboration toward a common goal."

Professor James Matthews, EWB-UNM faculty advisor, concurs. "Observing the positive attitude and spirit of these young engineering students as they plan and interface with engineers in the professional community definitely gives one the feeling that the future of our society is in good hands."

EWB-UNM's first challenge on the Tsimane project is to raise $50,000 to fund research, project development, and travel. Then they'll plan an assessment trip for a small team of students who will travel to Bolivia, talk with villagers about their requirements, and take the measurements needed to develop water, sanitation, and communication systems. A much larger group of students will engineer solutions in Albuquerque, then return to Bolivia to implement the systems. The process is expected to take about a year.

Josh Goldman, a graduate student in civil engineering who is managing the Tsimane program, recognizes the great challenge. "At this point, our main goal is to raise the money to fund the assessment trip. The data we collect during that trip will inform our goals forward," he says.

Beyond the challenge, Goldman sees great potential for the Tsimane—and for EWB participants like himself. "EWB gives me the opportunity to use my engineering skills to assist people in need. At the same time, I have the chance to connect with people that I would be unlikely to ever meet in other circumstances. And hopefully I'll grow as an individual and an engineer." ✦

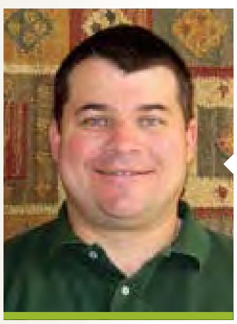
ENGINEERS WITHOUT BORDERS USA

Ten New Faculty Join the UNM School of Engineering

Chemical and Nuclear Engineering

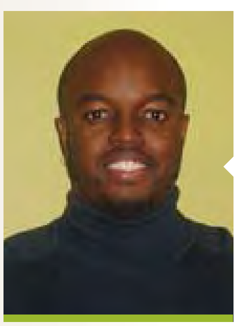
Eva Chi, *Assistant Professor*
Chi's mission is to understand how proteins aggregate and result in toxicity, which will contribute toward the development of a successful therapy to treat a wide range of diseases. Her research interests include biomolecular engineering, protein interfacial dynamics, and protein misfolding and aggregation in human diseases. Chi obtained her Ph.D. in Chemical Engineering from the University of Colorado.

Adam Hecht, *Assistant Professor*
Hecht comes to UNM following a post-doc in Medical Physics at the University of Wisconsin, with work on neutron production from proton beam radiotherapy. Previous experimental work includes stellar nucleosynthesis studies at Argonne National Laboratory. He has a patent pending on a novel accelerator mass spectrometry system based on a flexibly phased dynamic accelerator. Hecht earned his Ph.D. at Yale University.

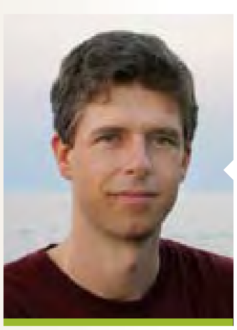


Steven W. Graves
Associate Professor and *Associate Director of the Center for Biomedical Engineering*
Graves' research interests include flow cytometry, affordable medical diagnostics, pre-symptomatic detection disease, and the study of protease mechanisms. He will also assist with the Center for Biomedical Engineering's efforts to develop a graduate program in Biomedical Engineering. He received his Ph.D. from The Pennsylvania State University.

Computer Science



Dorian Arnold, *Assistant Professor*
Arnold's research interests are in high-performance computing, fault-tolerance, and parallel programming tools. His research focuses on scalable, robust, autonomic infrastructures for effective utilization of extremely large scale distributed systems. In 2008, he received his Ph.D from the University of Wisconsin, where he studied reliable tree-based overlay networks. Arnold will join the UNM CS Department in January 2009.

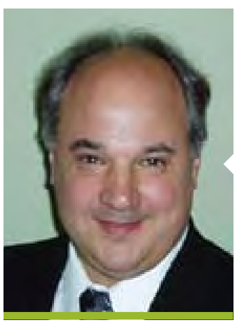


Thomas P. Hayes, *Assistant Professor*
Hayes' research interests include Markov chain Monte Carlo algorithms, online optimization, algorithms and complexity theory, machine learning, probability theory, statistical group theory, distributed and network algorithms. He received his Ph.D. at the University of Chicago and most recently was a Research Assistant Professor at the Toyota Technological Institute in Chicago.

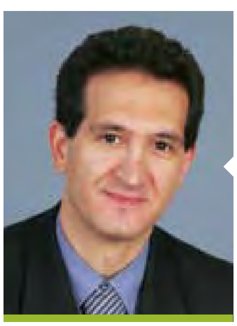
Wenbo He, *Assistant Professor*
He's research focuses on network embedded systems, pervasive and ubiquitous computing, cyber trust and security, privacy-preserving techniques, control of adaptive computing systems, and energy-aware management for server clusters. She received her Ph.D. from the University of Illinois at Urbana-Champaign. Her industry experience includes five years at Cisco Systems, where she was a software engineer.

Electrical and Computer Engineering

Ganesh Balakrishnan, *Assistant Professor*
Balakrishnan was formerly the Technical Director at the Integrated NanoMaterials Core Facility at the California NanoSystems Institute, UCLA. He received his Ph.D. from UNM and did post-doctoral research at the UNM Center for High Technology Materials. His research interests include compound semiconductor based optoelectronics and novel epitaxial processes.



James Plusquellic, *Associate Professor*
One of Plusquellic's areas of expertise is defect-based testing for integrated circuits. He is currently working on a NSF-funded grant to research the detection and isolation of hardware Trojan circuits in secure hardware. Plusquellic was formerly an Associate Professor at the University of Maryland. He received his Ph.D. from the University of Pittsburgh.



Mani Hossein-Zadeh, *Assistant Professor*
Hossein-Zadeh's main research area is photonics. His interests include RF/microwave-photonics devices and systems, optomechanical oscillators, ultra high-Q optical microresonators and bio/chemical photonic sensors. He was a postdoctoral scholar in the Department of Applied Physics at the California Institute of Technology and received his Ph.D. from the University of Southern California.

Mechanical Engineering

Claudia C. Luhrs, *Assistant Professor*
Luhrs has 10 years of teaching and research experience in academic and industry environments. Her research interests focus on nanostructured materials; novel synthetic pathways for their preparation, characterization of their crystal structures, properties and reactivity. Luhrs received her Ph.D. from the Autonomous University of Barcelona.

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