

Career *currents*

Exploring Today's Energy Careers with the NEED Project

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NETL Researchers Develop New Material for CO₂ Adsorption

Researchers at the Department of Energy's National Energy Technology Laboratory (NETL) are looking for new ways to safely and economically capture greenhouse gases. NETL researcher Jeff Culp recently developed a new material that **adsorbs** carbon dioxide (CO₂).

The new adsorbent is a unique member of the latest class of materials called **metal organic frameworks (MOFs)** and is a flexible pillared-layered compound. The pillars are made of a specially chosen organic compound and the layers consist of sheets of nickel cyanide. Together they are inter-layered to create a series of open channels that can accommodate gas molecules. When CO₂ is not present, the pillars are tilted and the structure is partially collapsed; as CO₂ is adsorbed into the structure, however, the pillars "stand at attention", the channels open, and more gas molecules are captured.

The behavior of the MOF is very unusual in that it displays dramatic structural changes when exposed to varying degrees of pressure. Most adsorbents used to capture gases are rigid; they simply fill with increasing pressure and empty with decreasing pressure. When the MOF is filled with CO₂, a certain threshold pressure is required to force the structure open. Pressure can be released once the structure is full, yet it retains the CO₂ until pressure levels are minimal. Unlike rigid structures, the adsorbent then returns to its previous relaxed state.

This degree of control is a great advance in adsorption science and opens up new doors for novel materials that have the potential to improve the capture or separation of carbon dioxide.



Above, Jeff Culp with an MOF sample. Photo Credit: DOE Pulse.

Adsorption: the capability of all solid substances to attract to their surfaces molecules of gases or solutions with which they are in contact. *Encyclopædia Britannica*, 2008. *Encyclopædia Britannica Online*. www.britannica.com/eb/article-9003800.

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Career Currents provides educators and students with resources to introduce energy careers. Each issue focuses on a different sector of the energy industry. No single issue is meant to be all-inclusive to either the sector profiled or all careers in energy. This issue focuses on careers in the U.S. National Labs.

The NEED Project

National Energy Education Development
P.O. Box 10101
Manassas, VA 20108
TEL 1-800-875-5029
FAX 1-800-847-1820
EMAIL info@need.org
WEB ADDRESS www.need.org

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Zarin Sidiqi - *Office Administrator*



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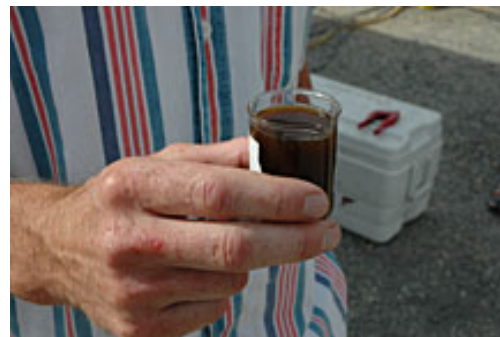
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Molasses as a Groundwater Cleaner

Enough molasses to make 88,000 batches of gingerbread cookies is helping researchers at Pacific Northwest National Laboratory (PNNL) conduct a safe and very inexpensive groundwater cleanup technique. PNNL scientists are injecting the sticky solution into the groundwater in Washington state. The mixture of 5,500 gallons of molasses and water is expected to alter subsurface contaminants through **biostimulation**, resulting in cleaner groundwater migrating toward the Columbia River.

Scientists expect bacteria in the soil to consume the molasses solution and produce a favorable subsurface environment that will promote the conversion of hexavalent chromium into a nontoxic substance. **Hexavalent chromium** is a toxic industrial pollutant known to cause cancer in humans. The solution should also invigorate an existing chemical barrier that uses naturally occurring iron in the **aquifer** to perform the chemical conversion.



Above, molasses is used as a key ingredient in groundwater cleanup. Photo credit: DOE Pulse.

Sunshine to Petrol Project

Using concentrated solar energy to reverse combustion, a research team from Sandia National Laboratories is building a prototype device intended to chemically **reenergize** carbon dioxide into carbon monoxide. The carbon monoxide would then be used to make hydrogen or serve as a building block to synthesize a liquid combustible fuel such as methanol or even gasoline, diesel or jet fuel.

The prototype device, called the Counter Rotating Ring Receiver Reactor Recuperator (CR5, for short), will break a carbon-oxygen bond in the carbon dioxide to form carbon monoxide and oxygen in two distinct steps. The Sandia research team calls this approach "Sunshine to Petrol" (S2P). "Liquid Solar Fuel" is the end product—methanol, gasoline, or other liquid fuel made from water and the carbon monoxide, produced using solar energy.

Although this invention is 15 to 20 years away from reaching the market, researchers believe it will reduce carbon dioxide emissions while preserving options to keep using some of the conventional fuels. Recycling carbon dioxide into fuels provides an alternative to other mitigation strategies.



Above, Sandia researcher Rich Diver assembles a prototype device intended to chemically reenergize carbon dioxide into carbon monoxide, which could ultimately become the building block to synthesize liquid combustible fuels. Photo Credit: Randy Montoya.

Career Chat

with a Section Supervisor

In this Career Chat, meet Paul Torcellini, a Mechanical Engineer who works at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. Paul has a BS degree in Mechanical Engineering from Worcester Polytechnic Institute, and both a Master of Science and a Ph.D. in Mechanical Engineering from Purdue University.

Career Currents (CC): Thanks for chatting with us, Paul. Tell us about your job.

Paul: At NREL, I'm a **Section Supervisor**. I manage a staff of researchers. Together, we look for ways to design and build commercial buildings such as stores, office buildings, hospitals and schools, using substantially less energy than typical buildings do today.

CC: How did you decide to work in the field of energy?

Paul: I have always been interested in energy efficiency and finding ways to save energy in buildings. I went to college with this focus and have been involved in the building industry my entire career.

CC: Did studying any particular subjects help you gain your current position?

Paul: In high school, my interest in energy intersected with a new organization called NEED. I attended the first NEED Leadership Workshop in 1981 and was heavily involved in NEED programs for many years. I took a lot of math and science classes. In college, my classes focused on the science of energy--heat transfer, thermodynamics, and electrical distribution systems, for example.

CC: Would you follow the same career path again?

Paul: I would. It is very challenging. There are new problems to solve every day. Energy use is the underlying foundation of most of our environmental concerns, economics, and national security.

CC: What opportunities have you had in your career?

Paul: I've traveled around the world teaching others how to build energy efficient buildings. I have been instrumental in designing and evaluating some cutting edge buildings. And, I've met many passionate people along the way who care about making a difference.

CC: What challenges do you face in your career?

Paul: Convincing people that energy efficiency is easy and that you can make substantial changes to how energy is used with relatively simple ideas. There is great satisfaction knowing you can make a difference, both in reducing the impact of buildings and in peoples' lives.

CC: What is a typical day of work like for you?

Paul: I work primarily in an office mentoring staff to think creatively about the future generation of energy solutions. Many days, that involves writing proposals, sending e-mails, meeting with staff and doing engineering analyses. Some days, I travel and speak at conferences or attend meetings.

CC: How does your job affect the public?

Paul: People are inside commercial buildings every day. I create buildings that consume less energy. This benefits everyone.

CC: What do you expect to be doing in 5-10 years?

Paul: As we do more research, the possibility that buildings will generate more energy than they consume is a reality. I look forward to helping design these buildings and transforming how we use energy.

CC: What is the most exciting technological tool you have helped develop?

Paul: We have developed computer tools that design buildings. These tools are very complex and require supercomputers to get the best energy solutions. It is amazing what we can predict and engineer without building a single building—but seeing this theory applied to real buildings is very exciting.

CC: What advice can you give to a young person considering a career in the building industry?

Paul: Take as much math and science as you can. These courses provide a great foundation for problem solving. I think the best jobs are about solving problems, not just doing repetitive operations. Also, learn how to communicate your ideas. As an engineer, I spend a lot of time writing and communicating my ideas to others. If I cannot communicate effectively, I cannot do a good job.

CC: Anything else you would like to share with us?

Paul: The next time you are in a commercial building, consider that buildings consume 40 percent of the energy in the United States, yet have the potential to use half the energy they currently consume. Imagine a world where buildings generate more energy than they consume, and you are looking at our future.

Paul helped design the Visitor Center at Zion National Park, built with energy efficient features such as a photovoltaic system, trombe walls, daylighting and natural ventilation.

Photo Credit: Robb Williamson.



Career Chat

with a Project and Group Leader



This career chat is with Catherine Grégoire Padró (left), a **Project Leader** for Hydrogen and Biomass Systems, and **Acting Group Leader** for the Sensors & Electrochemical Devices Group for Los Alamos National Laboratory, in Los Alamos, New Mexico. Catherine received her BS and MS degrees in Chemical Engineering from the State University of New York at Buffalo, New York.

Photo Credit: Efrain M. Padró

Career Currents (CC): Tell us about your job.

Catherine: As Project Leader, I provide technical and management leadership to researchers who are investigating safety-related technologies for hydrogen applications, and who are developing new catalysts for biomass conversion processes. As the Group Leader, I am in charge of a diverse group of 35 engineers, scientists, and technicians who are working in alternative energy, where they are developing advanced sensors and innovative fuel cells.

CC: How did you decide to work in the field of energy?

Catherine: My first job was with the Department of Energy in Morgantown, West Virginia, where I worked on a number of alternative fossil-based technologies, including gas hydrates and oil shale. I don't know that I consciously made a decision to continue to work in energy fields, but every job I have had since then has been in an energy-related field.

I have developed control systems for coal-fired power plants, designed natural gas plants, and worked in biomass and hydrogen research fields for the past 20+ years. In retrospect, the pathway I chose has been an interesting metamorphosis from fossil fuels to renewable technologies.

CC: What subjects, courses, internships, or special training were instrumental in helping you gain your current position?

Catherine: I have been fortunate to have had several mentors who have pushed me to try new avenues of energy technology development, especially in the management field. I have participated in developmental programs in many of my jobs, and have asked for additional responsibility on a number of occasions.

CC: What do you think of the industry now that you work in it? Would you follow the same career path again?

Catherine: My primary field of activity is hydrogen and fuel cells, which is a very exciting field. There is so much research and development that need to be done, and so many really interesting aspects of energy systems integration that I think I could work in this field for a long time and not get bored.

CC: What are the biggest challenges you face in the industry?

Catherine: Cost is always the biggest challenge—hydrogen and fuel cells offer clean, carbon-free, sustainable energy production and delivery, but those benefits, sometimes called **externalities**, are not considered in the costs paid by conventional “dirty” technologies.

It is really hard to convince the general population that they should pay these costs if they use the “dirty” technology, or to convince them that they should buy clean technologies at a higher price. Researchers continue to work to reduce the costs associated with hydrogen and fuel cell technologies, so that they can compete in the marketplace.

CC: What are some benefits of working in the energy industry?

Catherine: Energy impacts everything we do. Although most of us don't think too often about the challenges of providing reliable power, affordable fuel, and other energy services, when we do not have electricity, when gasoline becomes really expensive, or when our environment becomes damaged, we begin to realize how important this industry is to our continued well-being.



Above, Catherine demonstrates the FreedomCART, a hydrogen-powered fuel cell “mobility” scooter developed at LANL. Photo credit: Luis Sanchez Saturno.

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CC: What is a typical day of work like for you?

Catherine: I spend a significant part of my day providing the researchers the support needed to perform research in a safe and healthy environment. I spend some time reading various technical reports on recent advances in energy fields. I also work to develop new projects with our industrial partners and DOE sponsors.

CC: What is the most rewarding part of your job?

Catherine: I enjoy discussing energy technologies with scientists, as well as non-scientists. It is particularly satisfying to help others see energy in a new light, and to discuss alternative configurations that could be effective in delivery reliable, clean power to their homes and businesses.

CC: How does your job interact with or affect the public?

Catherine: With the increased attention to clean technologies, especially hydrogen and fuel cells, I regularly present technical seminars to diverse groups, including legislators, teachers, energy analysts, students and scientists. These groups are usually pretty small (maybe 25-50 people), so educating the public on these new technologies will take lots of time. Luckily, there are a number of groups who are focused on energy education, with more and more groups becoming educated and involved every day.

CC: What do you expect to be doing in 5-10 years?

Catherine: I hope to be driving a hydrogen-powered fuel cell vehicle!

CC: What advice can you give to a young person considering a career the field of energy?

Catherine: Take all the science and math classes that you can, and keep current with advances in energy, which are often reported in the popular press (*Wired*, *Popular Science*, etc). This will help you focus on a particular aspect of research and engineering that is important to the energy industry.

What are the National Labs?

The U.S. Department of Energy manages an extensive National Laboratory System that represents one of the most comprehensive research enterprises in the world. These laboratories perform research and development, also known as R&D, that is multidisciplinary in nature and for which there is a strong public and national purpose. More than 30,000 scientists and engineers perform cutting-edge research at these world-class facilities.

Ames Laboratory is a national center for the synthesis, analysis, and engineering of rare-earth metals and their compounds. Ames conducts fundamental research in the physical, chemical, and mathematical sciences associated with energy generation and storage. www.ameslab.gov

Argonne National Laboratory is one of the U.S. Department of Energy's largest research centers. It is also the nation's first national laboratory, chartered in 1946.

Argonne is a direct descendant of the University of Chicago's Metallurgical Laboratory, part of the World War II Manhattan Project. It was at the Met Lab where, on Dec. 2, 1942, Enrico Fermi created the world's first controlled nuclear chain reaction. After the war, Argonne was given the mission of developing nuclear reactors for peaceful purposes. Over the years, Argonne's research has expanded to include many other areas of science, engineering and technology.



*Argonne occupies 1,500 wooded acres in DuPage County, IL.
Photo Credit: Argonne National Laboratory.*

Today, the laboratory has 2,900 employees, including 1,000 scientists and engineers, of whom about 750 hold doctorate degrees. Argonne's annual operating budget of \$475 million supports upwards of 200 research projects, ranging from studies of the atomic nucleus to global climate change research.

Since 1990, Argonne has worked with more than 600 companies and numerous federal agencies and other organizations. Argonne is managed by UChicago Argonne, LLC.

Argonne research falls into five broad categories: basic science research, scientific facilities, energy resources programs, environmental management and National security. To learn more about the research and educational opportunities at Argonne National Lab, visit their website at www.anl.gov.

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Brookhaven National Laboratory conducts research in physical, biomedical, and environmental sciences, as well as in energy technologies and national security, and builds and operates major scientific facilities available to university, industry and government researchers. For more information, go to www.bnl.gov/world.

Fermi National Accelerator Laboratory advances the understanding of the fundamental nature of matter and energy by providing leadership and resources for qualified researchers to conduct basic research at the frontiers of high energy physics and related disciplines. www.fnal.gov

Idaho National Laboratory is a science-based, applied engineering national laboratory dedicated to supporting the U.S. Department of Energy's missions in environment, energy, science and national defense. www.inl.gov

Lawrence Berkeley National Laboratory conducts unclassified research across a wide range of scientific disciplines with key efforts in fundamental studies of the universe, quantitative biology, nanoscience, new energy systems and environmental solutions, and the use of integrated computing as a tool for scientific discovery. www.lbl.gov

Lawrence Livermore National Laboratory is a U.S. Department of Energy national laboratory founded in 1952 as a second nuclear weapons design laboratory to promote innovation in the design of our nation's nuclear stockpile through creative science and engineering. www.llnl.gov

Los Alamos National Laboratory, as part of the National Nuclear Security Administration, contributes to meeting the nation's nuclear deterrence capability and other security needs. www.lanl.gov

National Energy Technology Laboratory conducts research and development to ensure that U.S. fossil energy resources can meet the country's increasing demand for affordable energy without compromising the quality of life for future generations. www.netl.doe.gov

National Renewable Energy Laboratory (NREL) is the nation's primary laboratory for renewable energy and energy efficiency research and development. NREL began operating in 1977 as the Solar Energy Research Institute. It was designated a national laboratory in September 1991 and its name was changed to NREL. NREL is currently managed for DOE by Midwest Research Institute and Battelle.

Most of NREL's research laboratories and offices are located in Golden, Colorado, where their researchers and scientists support critical market objectives to accelerate

research from scientific innovations to market-viable alternative energy solutions. NREL's research and technology development areas span from understanding renewable resources for energy, to the conversion of these resources to renewable electricity and fuels and, ultimately, to the use of renewable electricity and fuels in homes, commercial buildings, and vehicles.

The laboratory thereby directly contributes to our nation's goal for finding new renewable ways to power our homes, businesses, and cars. To learn more about the research and career opportunities available at NREL, visit their website at www.nrel.gov.

NREL has created an inclusive work environment that benefits from diversity throughout the lab, values individual differences, and encourages employees to develop and contribute to their full potential. Photo courtesy of DOE/NREL, Credit - Mike Linenberger.



New Brunswick Laboratory is the Federal government's Nuclear Materials Measurements and Reference Materials Laboratory and the National Certifying Authority for nuclear reference materials and measurement calibration standards. www.nbl.doe.gov

Oak Ridge Institute for Science and Education is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup efforts, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. www.orise.orau.gov

Oak Ridge National Laboratory is the Department of Energy's largest science and energy laboratory. Managed since April 2000 by a partnership of the University of Tennessee and Battelle, ORNL was established in 1943 as a part of the secret Manhattan Project to pioneer a method for producing and separating plutonium.

During the 1950s and 1960s, ORNL became an international center for the study of nuclear energy and related research in the physical and life sciences. With the creation of the Department of Energy in the 1970s, ORNL's mission broadened to include a variety of energy technologies and strategies.

Today the laboratory supports the nation with a peacetime science and technology mission that is just as important as, but very different from, its role during the Manhattan Project.

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ORNL has a staff of 4,200 and hosts 3,000 guest researchers annually who spend two weeks or longer in Oak Ridge. Annual funding exceeds \$1.2 billion.

As an international leader in a variety of scientific areas that support the Department of Energy's mission, ORNL has six major mission roles: neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. ORNL's leadership role in the nation's energy future includes hosting the U.S. project office for the ITER international fusion experiment and the Office of Science-sponsored Bioenergy Science Center. Visit the Oak Ridge National Laboratory website at www.ornl.gov.



Above, the ORNL facility located in Oak Ridge, TN.

Pacific Northwest National Laboratory delivers science-based solutions to the Department of Energy's major challenges of expanding energy, ensuring national security, and advancing mission-driven science through outstanding staff and R&D capabilities, excellent operations, and high-value partnerships. www.pnl.gov

Princeton Plasma Physics Laboratory is a national center dedicated to plasma and fusion science with a leading international role in developing the theoretical, experimental, and technology innovations needed to make fusion a practical and affordable energy technology for the future. www.pppl.gov

DOE's **Radiological and Environmental Sciences Laboratory** is a reference laboratory that conducts key measurement quality assurance programs. It provides technical support and quality assurance metrology that is directly traceable to the National Institute of Standards and Technology. www.inel.gov/resl

Sandia National Laboratories develop technologies to sustain, modernize, and protect the United States' nuclear arsenal, prevent the spread of weapons of mass destruction, defend against terrorism, protect national infrastructures, ensure stable energy and water supplies, and provide new capabilities to the armed forces. www.sandia.gov

Savannah River Ecology Laboratory provides an independent evaluation of the ecological effects of the Department of Energy's Savannah River Site operations through a program of ecological research, education, and outreach. www.uga.edu/~srel

Savannah River National Laboratory is recognized as a world-class center of excellence for the development and application of unique and innovative science and technology solutions. www.srs.gov/general/srs-home

Stanford Linear Accelerator Center is a laboratory dedicated to the design, construction and operation of state-of-the-art electron accelerators and related experimental facilities for use in high-energy physics and synchrotron radiation research. www.slac.stanford.edu

Thomas Jefferson National Accelerator Facility is a national user facility for nuclear science using continuous beams of high-energy electrons to discover the underlying quark and gluon structure of nucleons and nuclei. www.jlab.org

Plant Defense Study May Improve Biofuel Production

Plant Scientists at DOE's Brookhaven Lab have uncovered clues that may help them better engineer pest-resistant crops and feedstocks that are more easily convertible to biofuels. The scientists followed the uptake of a radioactive form of nitrogen (^{13}N) into plant amino acids before and after exposure to jasmonate—a **plant defense hormone** produced, for example, when insects start chewing on a leaf.

Jasmonate resulted in increased production of certain amino acids linked to changes that render the plant more difficult to digest. Understanding these changes may assist scientists who are trying to design hardier crops or varieties with fibers that break down easily for more cost-effective biofuel production.

Ammonia gas labeled with radioactive nitrogen-13 is pulsed into a tobacco plant leaf using this apparatus.

The setup allows scientists to monitor nitrogen uptake into plant amino acids and monitor their distribution within the plant. Photo credit: DOE Pulse.



Sponsors – Plan Now to Participate in NEED’s Passport to Energy Careers Fair

From June 20-23, 2008, students from across the United States will be honored in Washington, DC, at NEED’s 28th Youth Awards for Energy Achievement. These students have proven themselves to be leaders in energy through award winning energy activities. We invite you to participate in their experience.



On Friday, June 20, we are hosting the Passport to Energy Careers Fair for attendees. We invite your company or organization to be a part of this event. We will have three to four hundred students in attendance.

This fair is an excellent opportunity to expose outstanding students, teachers, and parents to the advantages of considering careers in energy. It also provides participating companies and organizations with the opportunity to attract outstanding future employees.

The fair will be located on the ballroom level of the Hyatt Regency Hotel in Crystal City, Virginia. The \$200 fee for exhibit space will support the NEED Youth Leadership Award—an annual \$1,500 award for outstanding commitment to NEED and the intent to pursue a career in education, science or energy.

To assure maximum attendance at the fair, each attending student will receive a Passport to Energy Careers. The passport will be stamped at each exhibit. Upon receiving a predetermined number of stamps, the passport can be entered into a drawing for prizes to be awarded at the opening banquet.

It is recommended that participating companies make the exhibits and career information as student-friendly as possible, and include hands-on items relating to their fields. The ages of the attendees range from primary to high school seniors, with the majority in the 11 to 16 year old range. The focus should be on the career field and the education needed to be a part of that field, including any grants, internship opportunities, or scholarships available to students.

Please contact Rebecca Lamb at 800-875-5029 or email rlamb@need.org for further information. The registration form is available online at www.need.org/needpdf/2008CareerFair.pdf.

