

Nobel Laureate Richter to chair APS energy study

Former APS President and Nobel Laureate Burton Richter will chair a newly established APS study group that will produce a report on energy efficiency. The study will focus primarily on buildings and transportation, which together account for more than 70 percent of the total domestic carbon emissions.

Richter, who received the Nobel Prize in 1976, served as APS president in 1994 and has chaired the APS Physics Policy Committee. He is also the director emeritus of the Stanford Linear Accelerator Center.

According to the study group charge, "Improving

energy efficiency is the simplest and least costly means available to reduce U.S. oil consumption and carbon emissions, but the U.S. is not doing enough to capitalize on energy efficiency either at home or in the products it exports. Improving energy efficiency must be one part of a portfolio of approaches for treating the U.S. 'oil addiction' and reducing its output of greenhouse gases."

"First on everyone's list, whether you're concerned about global warming or energy supply security, should be conservation and efficiency," said Richter.

Richter said APS completed

its first study on efficiency in 1975.

"This new study will review where we are and define the most promising areas of development for the future," said Richter.

The study group will address many questions, including the following:

- What gains in energy efficiency are technically feasible and over what periods of time?

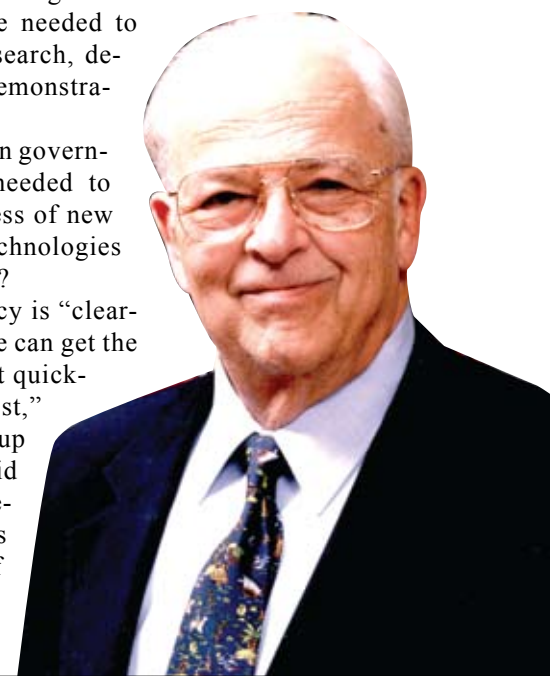
- What basic and applied research, development and demonstration need to be conducted and/or funded by government and industry to achieve the technically feasible gains in energy efficiency?

- What changes in government programs are needed to accomplish the research, development and demonstration?

- What changes in government policy are needed to facilitate the success of new energy-efficient technologies in the marketplace?

Energy-efficiency is "clearly an area where we can get the greatest gains most quickly for the least cost,"

said study group Vice Chair David Goldston, who previously served as staff director of the House Science Committee.



Physics training leads to 'Star Trek' and beyond

By Alaina G. Levine

Andre Bormanis is among the privileged few to have a biography listed on, of all things, the official Web site of Star Trek.

The physics-trained scriptwriter helped shape strange, new worlds when he served the "Enterprise"—initially as a science consultant for "Star Trek: The Next Generation," "Star Trek: Deep Space Nine" and "Star Trek: Voyager."

He later worked as a writer, story editor and producer for the last series, "Star Trek: Enterprise."

He says serving as the Star

in atoms, stars and globular clusters.

"Like physics, storytelling involves problem solving, formulating hypotheses, exploring unexpected connections between phenomena and seeking a solution," explains Bormanis, who has a bachelor's in physics from the University of Arizona and a master's in science, technology and public policy from George Washington University.

After graduating with his undergraduate degree, he completed a year of post-baccalaureate study in physics and music composition. But he didn't



Andre Bormanis on the set of Star Trek

Trek science consultant was simply a gig. But it soon developed into a successful one bolstered by his formal education

like studying physics in graduate school.

"I didn't have a good reason for being there," he says. "Graduate school was a fallback plan because I couldn't get a job. But starting a Ph.D. in physics as a fallback plan is a bad idea."

He eventually got a job in his hometown of Phoenix, but he couldn't shake "the writing bug."

Star Trek continued on page 3

Congress considers scaling back RRW following scientific report

Congress is weighing scaling back the Reliable Replacement Warhead program, following the recent release of a report on the role the RRW might play in the U.S. nuclear weapons program.

The American Association for the Advancement of Science's (AAAS) Nuclear Weapons Complex Assessment Committee developed the report, and APS served as an adviser to the AAAS committee while the report was being crafted. Many of the panel members are members of APS.

The report concluded that the RRW could have some benefits, but there is too much uncertainty about the program, including the lack of a long-term plan for the role of nuclear weapons and a determination of future stockpile needs.

"There needs to be a clear statement of U.S. nuclear policy and doctrine in the post-Cold War, post-9/11 world," said Benn Tannenbaum, project director for the Center for Science Technology and Security at AAAS. That concern was also echoed by House and Senate committees.

Since the report was released, the Senate Energy and Water Appropriations and Senate Armed Services committees have voted to reduce funding for the RRW and placed constraints on how those funds could be spent.

The House Energy and Water Development Appropriations Subcommittee eliminated fiscal year 2008 funding for the RRW, citing some of the points expressed in the AAAS report. The full House followed suit by

approving the subcommittee's bill by a vote of 395 to 13.

To follow up on the RRW issue, the House Armed Services Committee has asked APS and AAAS to examine the role of



Courtesy of the Department of Defense

nuclear weapons in a post-Cold War era more generally. The organizations' plans are still being formulated.

The nuclear weapons in the current stockpile were designed during the Cold War. For the past 15 years, the Stockpile Stewardship Program (SSP) has maintained those weapons without conducting any testing.

But the Department of Energy's National Nuclear Security Administration has (NNSA) expressed concerns about the SSP's ability to maintain the stockpile in the long term and proposed the RRW program in 2004.

Proponents claim that it will have larger performance margins, be easier to manufacture and maintain and have improved safety and security features.

In March, the DOE selected Lawrence Livermore as the lead laboratory in a design competition for the first RRW.

The AAAS study addressed the extent to which the RRW could mitigate some of the risks in the SSP.

In a recent article in the Bulletin of the Atomic Scientists,

Bruce Tarter, chair of the committee that developed the report and former head of Lawrence Livermore National Laboratory in Livermore, Calif., said, "During the conclusion session, the committee said it [the RRW program] could be a prudent hedge and might be a good opportunity. This is the best statement that we can make. I would, and I think

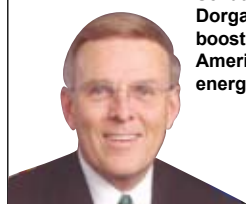
most of us would, go ahead and do the cost studies for the RRW. As far as the overall long-term RRW program, we don't have an opinion because we don't know what it is."

The report is online at <http://cstsp.aaas.org/content.html?contentid=899>. Bruce Tarter's quote reprinted with permission of the Bulletin of the Atomic Scientists.

Capitol Hill Quarterly is a publication of the American Physical Society, www.aps.org. APS is a non-partisan, professional society of physicists with more than 46,000 members.

On the Back Page

Senator Byron Dorgan discusses boosting America's energy security



APS Members in the Media

"It's important because we have a national problem with the level of science understanding in this country."

Joseph Bellina, *Saint Mary's College, on hands-on methods of teaching science, South Bend, IN, (IN-2nd)*, June 4, 2007

"I see in the British press and the BBC signs of a very strong anti-Israel bias—a kind of blind hostility that whatever Israel does, it is always in the wrong—so this is not an isolated action of a small group of anti-Semitic conspirators. This represents a widespread feeling among British journalists."

Steven Weinberg, *University of Texas, on his decision not to visit Britain after journalists' decision to boycott Israel, (TX-21st)*, May 25, 2007

"Thus, we have more and more convincing evidence that the dark matter is real material—probably elementary particles. Now we need to detect those particles directly with laboratory experiments."

Blas Cabrera, *Stanford University, on a recently discovered ring of dark matter around the remains of two galaxies that collided, (CA-14th)*, May 16, 2007

"They're thinking of a world without air...but air resistance is a big deal for little things. It slows down leaves, it slows down raindrops, and it slows down pennies."

Lou Bloomfield, *University of Virginia, on the myth that pennies thrown from the tops of buildings could kill pedestrians below, (VA-5th)*, May 3, 2007

"When I asked them to apply their knowledge in a situation they had not seen before, they failed. You have to be able to tackle the new and unfamiliar, not just the familiar, in everything. We have to give the students the skills to solve such problems. That's the goal of education."

Eric Mazur, *Harvard University, on why he switched from giving lectures to having students work in small groups in introductory physics classes, (MA-8th)*, May 10, 2007

"What drives me is seeing below the surface, seeing what is happening in there."

Daniel Rugar, *IBM, on a new technique combining magnetic resonance imaging and atomic force microscopy, (CA-16th)*, April 29, 2007

Snapshots from Physics History

July 1957: Bardeen, Cooper and Schrieffer submit their paper, 'Theory of Superconductivity'

Fifty years ago, John Bardeen, Leon Cooper and Robert Schrieffer presented their complete theory of superconductivity, finally explaining a phenomenon that had been a mystery to physicists since its discovery in the 20th century.

In 1911, Heike Kamerlingh Onnes, in his quest to study materials at ever lower temperatures, discovered that the electrical resistance of some metallic materials suddenly vanished at temperatures near absolute zero. He called the phenomenon superconductivity, and scientists soon found additional materials that exhibited this property.

But no one could completely explain how it worked.

For the next few decades, many prominent physicists worked to develop a theory of the mechanism underlying superconductivity, but no one had much success.

One physicist, Felix Bloch, proposed a new theorem: "Superconductivity is impossible." Richard Feynman added that he had "spent an awful lot of time in trying to understand it...and [eventually] developed an emotional block against the problem of superconductivity..."

Although physicists made little progress figuring out superconductivity following Onnes' discovery, experimentalists discovered some interesting features of superconductors. In 1933, Walther Meissner found that superconductors would expel a magnetic field, an effect that makes it possible to levitate a magnet. The discovery of the Meissner effect added a new wrinkle that any theory of superconductivity would have to explain. John Bardeen gave it try, but then went on to other work.

Explaining superconductivity

Some physicists experienced partial success explaining superconductivity. Brothers Fritz and Heinz London developed a theory that explained some of its features, but didn't provide a mechanism at the microscopic level. In 1950, Herbert Frohlich proposed that superconductivity might have to do with interactions between the electrons and the vibrations of the crystal lattice or phonons. Around that time, experimenters observed that the critical temperature at which a material becomes superconducting is related to the atomic mass of the superconductor. Frohlich's theory explained this isotope effect, but couldn't account for other properties of su-

perconductivity such as the Meissner effect.

At the time, Bardeen had been working on other research, but the discovery of the isotope effect renewed his interest in the problem of superconductivity. Bardeen and David Pines built on the explanation of the isotope effect. They took into account the electron-phonon interactions that Frohlich had considered, but they also determined how, at low energies in a crystal lattice, electrons could overcome the Coulomb repulsion and attract each other.

Another piece of the puzzle was contributed by Leon Cooper, who suggested that interactions with the lattice would allow electrons with opposite spins to combine to form strongly correlated pairs. The electrons in these Cooper pairs, as they are called, do not have to be close together, but they can

move in a coordinated manner. Cooper realized the motion of these pairs could explain how electrons could flow with no resistance in a superconductor. These pairs would form at low temperature; adding energy would break up the pairs, returning the material to a normal, non-superconducting state.

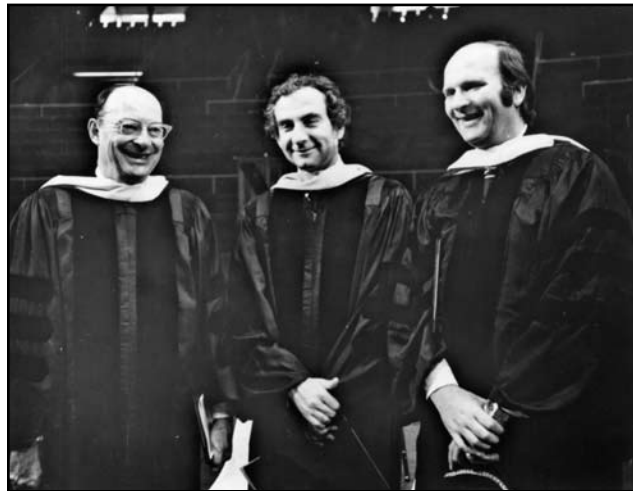
The next insight came from Robert Schrieffer, a student of Bardeen's at the University of Illinois. In 1957, Schrieffer figured out how to mathematically describe the enormous collection of Cooper pairs in a superconductor with one single wave function.

Superconductivity solved

Together, Bardeen, Cooper and Schrieffer formed a complete theory: Electrons, through interaction with lattice vibrations, form Cooper pairs, which move in a coordinated manner, rather than randomly as in a normal conductor, allowing electricity to flow with no resistance.

They submitted their report, titled "Theory of Superconductivity," to the *Physical Review* in July 1957, and it was published in December.

Bardeen, Cooper and Schrieffer were awarded the Nobel Prize in 1972 for their theory of superconductivity. This was Bardeen's second Nobel Prize in physics. He received the other for the discovery of the transistor. The theory works for conventional superconductors, but does not explain the high temperature superconductors first discovered 20 years ago.



Source: AIP Emilio Segrè Visual Archives

Bardeen, Cooper and Schrieffer (left to right)

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NASCAR fans find the physics

University of Nebraska physics professor Diandra Leslie-Pelecky recently went to the asphalt at the Daytona International Speedway to uncover the science behind the National Association for Stock Car Auto Racing (NASCAR).

She became interested in NASCAR physics while watching a race during which a car suddenly veered into the wall. She couldn't figure out what caused the crash and set out to solve the problem.

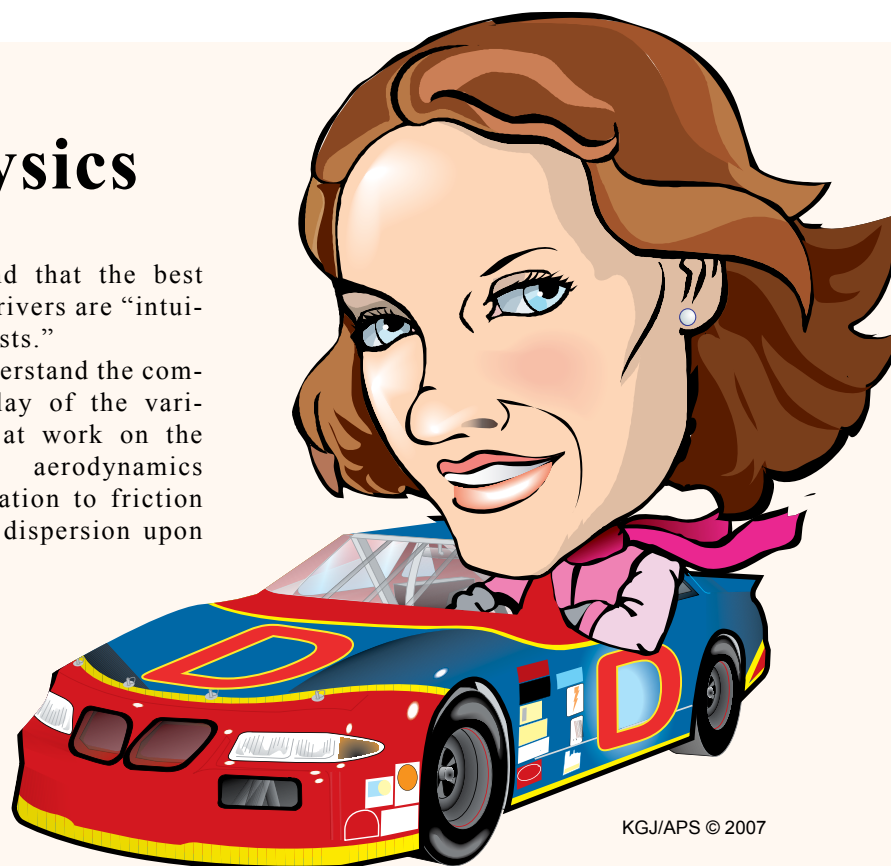
Leslie-Pelecky soon discovered that there was a lot

more to car racing than driving around in circles. She shared her information with APS members and local residents during a recent APS meeting in Jacksonville.

Any good NASCAR driver can recite this basic mantra: Go fast, always turn left and don't crash. Leslie-Pelecky said that the drivers are working at a point of constant unstable equilibrium. The key to keeping that precarious balance is maintaining, as much as possible, the same amount of force on all four tires.

She found that the best NASCAR drivers are "intuitive physicists."

They understand the complex interplay of the various forces at work on the track—from aerodynamics and acceleration to friction and energy dispersion upon impact.



Nobel Laureates discuss science fund to tackle Middle East problems

More than 30 Nobel Laureates, including nine physicists, recently discussed the possibility of funding scientific projects to improve education in the Middle East.

Earlier this year, scientists gathered in the ancient city of Petra, Jordan to discuss ways to improve education, the environment, economy and health in the war-torn region.

A scientific fund could initially support projects in Israel, the Palestinian territory and Jordan, eventually expanding to include more of the Middle East, said the attendees.

The Elie Wiesel Foundation for Humanity and the King Abdullah II Fund for Development organized the meeting. It was the third annual Petra Conference of Nobel Laureates. Political leaders and youths from the region also attended the conference.

David Gross, a 2004 Nobel Laureate in physics and director of the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara, attended the conference and said he is pushing for more opportunities for scientists in the region to collaborate.

Although Israel and the Pales-

tinian authority both make it difficult for scientists to work together, Gross said, "a lot of people in these countries are interested in peaceful collaboration."

Another conference attendee, Val Fitch, a 1980 Nobel Laureate, joined a working group to promote environmental efforts in the region. He said he was inspired by youths from the region who attended the conference and discussed their experiences.

"The situation in the Middle East is so miserable. I think any attempt to span the gulf [between Arabs and Israelis] is a good thing," said Fitch.

Gross, who also attended the first Petra conference in 2005, has been involved with promoting scientific collaboration in the Middle East for years. For example, he promotes SESAME, (Synchrotron-light for Experimental Science and Applications in the Middle East), a synchrotron under construction in Jordan that could be used for innovative physics, biology and chemistry research by scientists from the Middle East.

Study yields insights into public attitudes toward science

Scientists promoting the teaching of evolution in public schools received good news from a recent survey.

The results of the survey, commissioned by a consortium of scientific societies and conducted last summer, revealed that 53 percent of the 1,000 respondents favored teaching evolution in public school science classes—a much higher percentage than those who favored either creationism (36 percent) or intelligent design (27 percent).

"The debate is not nearly as polarizing as previous polling would lead us to believe," according to the survey report. "In fact, there is more uncertainty than polarization. With this uncertainty [comes] opportunity; scientists can play a key educational role for the public."

APS joined other scientific societies, including the National Academy of Sciences, the American Chemical Society, the American Institute of Physics and several biological societies, in supporting

the study, which was conducted by two research firms, Greenberg-Quinlan-Rosner and Mercury Public Affairs.

The study was conducted to help the scientific community develop effective messages and establish public policy on science education.

More information is available at <http://www.aps.org/publications/apsnews/200707/acs.cfm>.

STAR TREK continued from page 1

Bormanis soon reconnected with friends who were comedy writers in Hollywood and was inspired to develop a script for Star Trek.

In 1993, like a scene from a movie, he got an agent on the phone and a job opportunity—the position of science consultant to the Star Trek series.

Bormanis' mission at Star Trek was simple: Use his knowledge of science to make

scripts believable within the realm of the Star Trek universe. His physics background was clearly an advantage in his science consulting job. Not only did he understand the technical "subjects" of time travel, phase shifting and tricorders, but he was also able to comprehend and apply terminology from other scientific specialties such as medicine, oceanography and geology.

Bormanis is currently pitching, writing and researching new television and film projects.

He easily rattles off the benefits of studying physics.

"It teaches you [how] to think logically, how to work through a problem and [how to] stick with it until you finish," he says.

Alaina G. Levine, © 2007

APS and Yale University honor J. Willard Gibbs



Photo by Michael Marsland/Yale University Office of Public Affairs

The APS Historic Sites Committee recently celebrated the work of the late J. Willard Gibbs (pictured on easel), who served as professor of mathematical physics at Yale University from 1871 until his death in 1903.

During his tenure at Yale, Gibbs made fundamental contributions to thermodynamics and statistical mechanics, two areas of classical physics. To mark the occasion, members of the Yale Physics Department and guests gathered in Sloane Physics Laboratory

to celebrate. Two years ago, the committee chose Yale as a historic physics site and noted Gibbs' contribution to the physics field during its selection process.

Standing left to right: Yale Physics Chair R. Shankar; APS Editor-in-Chief Gene Sprouse; and Yale Provost Andrew D. Hamilton, who is explaining the impact that Gibbs had on Yale and on science. Listening intently is the Chair of the APS Historic Sites Committee, John Rigden (seated at left).

The Back PAGE

Boosting America's energy security requires multi-front effort, new thinking

by U.S. Sen. Byron Dorgan (D-ND)

For the past three decades, we Americans have debated the growing threat to our nation's energy security and what to do about it. Each year we hear the warnings. Each year we hear the same solutions suggested. Each year we hear the same objections. It's as if the debate has been on an endless loop.

In all that time, only one thing changed. Our energy vulnerability grew much worse.

The threat we face is not new. The OPEC oil embargos in the 1970s were a major wake-up call to action. While the OPEC oil embargos spurred some changes, they have not been enough.

Now the threat to our energy security is much more dramatic.

Today the threat is terrorism and a war raging in the Middle East, one of the most volatile regions of the world, and the source for much of America's petroleum.

Unlike in the Cold War, our increasing dependence on imported oil and the need for access to secure energy resources play a central role in this new struggle. Yet, we still argue the same old policies.

One side says the answer is conservation. The other says just as forcefully that the answer is to produce more energy here at home.

Both are wrong. And both are right.

They are wrong because there is no single answer. They are right because more conservation and energy efficiency and greater production of energy here at home are very important parts of the solution. We need both.

As Chairman of the Senate's Subcommittee on Energy, and the Appropriations Subcommittee on Energy and Water, that's the path I'm working to pursue. It's also the philosophy at the heart of bipartisan legislation I have introduced with Sen. Larry Craig (R-ID), the SAFE Energy Act.

Our plan, the Security and Fuel Efficiency Energy Act—SAFE Energy Act—is a comprehensive approach that recognizes there is no magical "single bullet" that will solve America's dependence on foreign oil.

"We must realize that even as we develop alternative fuels and use our resources more efficiently, the development of our own resources is a safer and more sensible course than continuing our increasing and precarious dependence on other nations' oil."

Frankly, our plan advances policies neither Sen. Craig nor I would have supported as stand-alone proposals. Some we actively opposed in the past. But when they are part of a comprehensive package that asks no single effort to carry the whole load, they make sense.

1) Achievable, stepped increases in fuel efficiency of the transportation fleet;

2) Increased availability of alternative fuel sources and infrastructure;

3) Expanded production of domestic oil and

natural gas resources; and

4) Improved management of alliances to better secure global oil supplies.

Are some of the provisions of our legislation controversial? You bet. But our reliance on foreign oil is too dangerous for Congress to continue to avoid taking up controversial issues.



Since the introduction of the SAFE Energy Act, Sen. Craig and I have worked together to ensure that any bipartisan legislation moving through the Senate incorporates these principles.

In June, the Senate passed major energy legislation that included significant progress toward meeting three of these four principles. I am pleased with the progress we made with the Senate's recent passage of energy legislation. I remain committed to making further progress and to achieving all four goals of the SAFE Energy Act.

Here's what the Senate has done so far this year:

- Increased fuel efficiency standards—The most recent Senate Energy bill reforms the old corporate average fuel economy, or CAFÉ, system and raises fuel efficiency standards for our nation's passenger automobile fleet to 35 miles per gallon by 2020.

Raising the automobile fuel efficiency standard to a fleet average of 35 miles per gallon in the United States by 2020 will, alone, save 2 to 2.5 million barrels of oil per day.

- Expanded the availability of renewable fuels—The Senate Energy bill also expands the current renewable fuels standard (RFS) to 36 billion gallons by 2022. The original renewable fuels standard in the Energy Policy Act of 2005 called for 7.5 billion gallons of renewable fuels like ethanol and others to be used in our fuel mix by 2012. Increasing the RFS ensures that we will not only further use our expansive renewable resources from starch-based ethanol, but will also increasingly

look to cellulosic fuels in the future.

- Improved alliances on global energy supplies—The Senate Energy bill also strongly encourages strengthening our ties with other nations in order to increase cooperation and increase our energy security. Even as we seek to be more energy independent, it is clear we will also need to work through diplomatic alliances to reduce the risk of an international energy crisis.

One area where we also must do more is domestic energy production.

The SAFE Energy bill strongly encourages the production of more oil and natural gas at home. We specifically recommend that more production of both could be developed in the Eastern Gulf of Mexico and near Cuba. We also call for a further inventory of resources in the Southeastern U.S. waters.

We must realize that even as we develop alternative fuels and use our resources more efficiently, the development of our own resources is a safer and more sensible course than continuing our increasing and precarious dependence on other nations' oil.

Congress must also get to work helping to develop the next generation of energy technologies. Let's use America's innovative spirit! I am working to harness that innovation to increase our energy security through my work on the Senate Appropriations Committee. As the Chairman of the Energy and Water Appropriations Subcommittee, I've worked to provide funding to programs that seek to develop and demonstrate a wide array of new energy technologies.

I am proud to say that the Energy and Water Subcommittee, under my chairmanship, has funded the Department of Energy's energy programs—the programs seek to develop new energy technologies—with \$3.715 billion for the coming year. That funding is \$536 million above the President's request. While the President often speaks about the importance of energy, we are following through with increased funding for that effort.

Funding for these important initiatives lays the groundwork for the goals we seek to achieve in our SAFE Energy legislation. By adequately funding our research and development programs, we will be able to take these technologies and ideas into the marketplace. Automakers can use the advances we achieve to make more advanced, fuel-efficient vehicles. Companies will be able to produce the next generation of ethanol and biodiesel, especially cellulosic ethanol. We will be able to use new technologies and ideas for the development of unconventional oil and gas resources. All of these investments contribute to greater energy security for America.

Senator Byron Dorgan (D,ND) is Chair of the Indian Affairs Committee, Energy and Water Appropriations Subcommittee, Energy Subcommittee, and Interstate Commerce, Trade and Tourism Subcommittee.

"I am proud to say that the Energy and Water Subcommittee, under my chairmanship, has funded the Department of Energy's energy programs—the programs seek to develop new energy technologies..."

"By adequately funding our research and development programs, we will be able to take these technologies and ideas into the marketplace."