APS physics

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Energy Efficiency Crucial to Achieving Energy Security and Reducing Global Warming, States Leading Physicists Report

American Physical Society Report Says Recovery of Lost Energy From Inefficiencies Is America's Hidden Energy Reserve for 21st Century

Tapping wasted energy from inefficient automobiles, homes and businesses is equivalent to discovering a hidden energy reserve that will help the United States improve its energy security and reduce global warming, an American Physical Society (APS) study panel concluded in a major report.

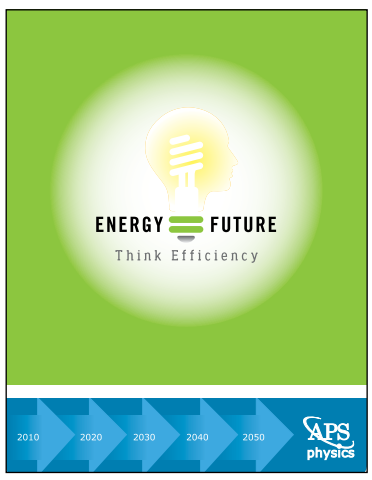
The report, *Energy Future: Think Efficiency*, states that the key to unlocking the efficiency potential is developing policies that will put technology into the marketplace and developing new technologies through applied and basic research in the public and private sectors.

The study panel concluded that increased energy efficiency, particularly in the transportation and building sectors, will help eliminate U.S. reliance on foreign oil and reduce greenhouse gas emissions that contribute to global warming.

Most recommendations addressing high fuel costs focus on either increasing the supply of oil or finding a substitute fuel, but the APS report offers a practical roadmap with short-term and longer-term solutions for reducing demand through cost-effective efficiencies that find public and political acceptance.

The report provides a path to 50 miles per gallon mileage for cars and other light-duty vehicles by 2030 and the elimination of energy from fossil fuels in new residential buildings by 2020.

It also states that the federal government should broaden its research, development and demonstration programs, particularly in the areas of batteries for conventional hybrid vehicles, plug-in hybrids and battery electric vehicles. The report credits automakers for devoting resources to the development of hydrogen fuel cell and plug-in hybrid vehicles, but concludes that they are not a solution to the nation's short-term energy needs because they require significant scientific and engineering breakthroughs in several critical areas.



The study also calls on Congress and the White House to increase spending on research and development of next-generation building technologies, training scientists who work on building technologies and supporting associated national laboratory, university and private-sector research programs. Additionally, it recommends that lawmakers develop policies that address a wide-array of market barriers that discourage consumers from adopting investment in energy-efficient efficient technologies, especially in the highly fragmented building sector.

"The American people need leadership from the Congress and the next president on this issue," said Nobel Laureate Burton Richter, chair of the study committee and director emeritus of the Stanford Linear Accelerator Center. "Both Sens. McCain and Obama have outlined plans for improving energy efficiency and the important role new technologies will play in our energy future. The next leader of the United States will have an opportunity to be the first in history to lay the necessary groundwork to reduce energy use among Americans."

Among its other key findings and recommendations based on the 12-month study are:

Transportation

•The federal government should adopt new standards for light-duty vehicles that average 50 miles per gallon or more by 2030.

•Vehicle weight can be significantly reduced through

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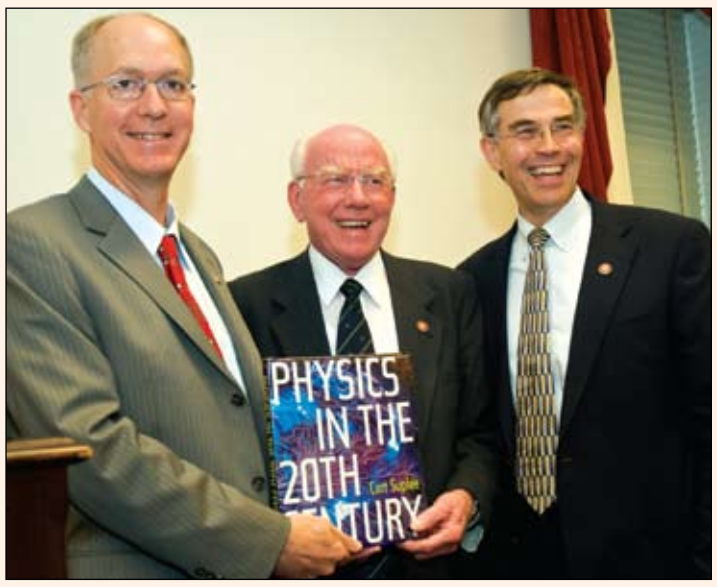
APS Honors Third Physicist in Congress



By Ken Cole/APS

APS held a reception July 16 on Capitol Hill, honoring the newest physicist to enter Congress, Representative Bill Foster (D-IL 14th). Representative Foster, a physicist formerly with Fermilab and an APS Fellow, won a special election in March to fill the seat vacated by former Speaker Dennis Hastert.

Foster (left) joins two other congressional physicists, Representative Vernon J. Ehlers (R-MI 3rd) (middle) and Representative Rush Holt (D-NJ 12th) (right), in the House of Representatives. The reception was attended by over 100 scientists and invited guests.

Basic Research Funding in the FY '09 Continuing Resolution Critical to Solving Energy Crisis

News Analysis

Americans are digging deeper into their pockets to fill up at the pump, fretting about paying for home heating oil and worrying about the devastating effects of global warming. With a Continuing Resolution Bill for Fiscal Year 2009 looming this fall, Congress must not allow energy research funding to languish at Fiscal Year 2008 levels. To do so will set our nation further back on a course toward energy independence.

Last year, the U.S. Department of Energy's (DOE) Basic Energy Sciences (BES) program responded to the U.S. energy crisis that has gripped the nation with proposals focused on solar, hydrogen and nuclear research. But funding that had been promised for the proposals did not materialize in the Fiscal Year 2008 Omnibus bill, leaving the plans on a shelf to collect dust.

Additionally, scientists lost their jobs; grants and fellowships were cut; and facilities operations were scaled back at national laboratories. The nation's $160 million contribution to the construction of the International Thermonuclear Experimental Reactor (ITER), was also cut from the budget, damaging America's reputation as a reliable partner for the international fusion energy project.

"I was very excited about doing something to contribute to research that had the possibility of helping with the energy problem, and now I won't work on that problem," said Jim Freericks, a physics professor at Georgetown University, who submitted a proposal to BES to research converting solar energy into electricity using thermoelectric materials.

Sustainable solutions to our nation's energy woes are within our reach, but policymakers must be willing to make the

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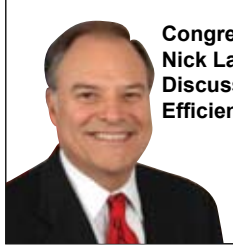

Congressman Nick Lampson Discusses Energy Efficiency.

PhysTEC Prepares Future Physics Teachers

Eight years ago, three national physics organizations jointly launched the Physics Teacher Education Coalition (PhysTEC) to help U.S. universities prepare more highly qualified physics teachers and alleviate the nation's critical physics teacher shortages.

PhysTEC is a partnership among the American Physical Society (APS), the American Association of Physics Teachers (AAPT), and the American Institute of Physics (AIP). Institutions participating in PhysTEC improve their teacher preparation programs by recruiting future teachers, hiring full-time master teachers from local schools to work with pre-service teachers, developing high-quality courses and early teaching experiences, and mentoring program graduates. The National Science Foundation (NSF) and APS fund the project.

Faculty members at PhysTEC institutions said the project has been instrumental in helping them jump-start their teacher preparation programs.

"PhysTEC has helped us place 20 teachers in Arkansas classrooms over the past six years," said Gay Stewart, a physics professor at the University of Arkansas. "Before the project began, we had graduated one physics teachers in a decade, and now we're graduating five or more teachers every year."

PhysTEC began with six universities and has expanded to a total of 14 sites, which are chosen through a peer-reviewed solicitation that considers the applicant's potential to increase the number of teachers who graduate and develop programs that serve as national models. Evidence of collaboration between physics and education faculty is another important criterion. In 2006, the project received 45 proposals for four available slots.

"The physics community is clearly showing broad interest in teacher preparation," said Ted Hodapp, director of education and diversity for APS.

"If there were funding for 10 times as many institutions to replicate PhysTEC's efforts, major progress could be made toward putting highly qualified teachers in every one of our country's physics classrooms. With today's highly competitive technical workplace, the need for physics teachers has never been greater."

PhysTEC institutions now graduate about three times as many certified physics teachers per year as they did before the project's inception, which represents an average increase of about 30 percent per year. By comparison, data from 10 state certification offices show only about a 3 percent increase per year in physics teacher certifications, despite federal No Child Left Behind legislation requiring schools to hire certified teachers.

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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.

APS Members in the Media

"We've done the calculation. By midcentury, I think, we'll have a functioning majority."

***Rush Holt**, on the growing number of physicists in Congress,* The New York Times, **(NJ-12th)** *June 10, 2008*

"The future for students is bleak if their only vision is to become a professor. This year's budget cuts alone may not be enough to convince someone [to leave physics] but it will definitely influence people on the cusp of a decision."

***Gary White**, Society for Physics Students, on physics students leaving for other fields,* Boston Globe, **(VA-8th)** *March 10, 2008*

"Fortune 500 companies are cutting greenhouse gas emissions and increasing energy efficiency all over the world."

***Amory Lovins**, Rocky Mountain Inst Inc.,* Northwest Arkansas Times, **(CO-3rd)** *June 24, 2008*

"Every time you break an egg or spill a glass of water you're learning about the Big Bang,"

***Sean Carroll**, Caltech,* BBC News Online, **(CA-29th)** *June 6, 2008*

"Tremendous progress has been made, much higher technical performance, for much lower cost."

***John Deutch**, MIT, on solar power,* Boston Globe, **(MA-8th)** *July 11, 2008*

"The specific experience you get doing that stuff doesn't have applications outside that narrow world. It's not obvious that I will be able to be fully employed."

***Ken Sale**, a nuclear weapons expert who was recently laid off from Lawrence Livermore Lab,* The Associated Press, **(CA-10th)** *June 3, 2008*

"I understand clearly as a freshman in Congress you don't get to steer the bus."

***Bill Foster**, former Fermilab physicist recently elected to Congress,* Scientific American, **(IL-4th)** *April 1, 2008*

"The result is certainly funny, but the process seems reasonable. I don't know of any previous attempts to make diamonds from drinks."

***Rudolf Pfeiffer**, University of Vienna, on a process for making diamond thin films from tequila,* New Scientist, *June 20, 2008*

Snapshots from Physics History

Maria Goeppert Mayer and the Nuclear Shell Model

Maria Goeppert Mayer, who made important discoveries about nuclear structure, is one of only two women to have won the Nobel Prize in physics. But during her early career, she was forced to spend many years in unpaid positions before she was able to obtain a professorship in physics. Nonetheless, she persevered in her research. In August 1948, Goeppert Mayer published her first paper detailing the evidence for the nuclear shell model, which accounts for many properties of atomic nuclei.

Goeppert Mayer was born in 1906 in Kattowitz, which was part of Germany at the time. When she was 4 years old, her family moved to Gottingen, where her father was a professor of pediatrics. In fact, he was the sixth-generation university professor in the family, and Goeppert Mayer was later proud of being the seventh-generation academic. Her father always encouraged her to grow up to be more than a housewife. It was assumed that Maria would get an education, and she did, even though it was difficult for women at the time.

Maria Goeppert Mayer

After attending public school and a college preparatory academy for girls, in 1924, she entered the University of Gottingen, at first intending to study mathematics. But after attending Max Born's quantum mechanics seminar, she switched her focus to physics.

She completed her Ph.D. in 1930, with a thesis on double photon reactions. While at Gottingen, she met her husband, physical chemist Joseph Mayer. After she completed her Ph.D., the couple moved to the U.S., where he got a job at Johns Hopkins University in Baltimore. Nepotism rules prevented the university from hiring her as a professor, so she worked as a volunteer, continuing her own research, most of which involved applying quantum mechanics to chemical problems. She encountered a similar situation in 1939 when her husband got a job at Columbia University. Goeppert Mayer was given office space, but no salary. At first, she worked on calculations of properties of transuranic elements; later, she worked with Harold Urey on a photochemical method for isotope separation (the method was abandoned as impractical).

In 1946, Goeppert Mayer and her husband moved to Chicago, where she was employed half time at the University of Chicago's Institute for Nuclear Studies and half time at Argonne National Laboratory. At the lab, she began working with Edward Teller on a project to determine the origin of the elements.

The work involved creating a list of isotope abundances. While making this list, it became clear to Goeppert Mayer that nuclei with 2, 8, 20, 28, 50, 82, or 126 protons or neutrons were especially stable. (These numbers became known as "magic numbers," a term thought to have been coined by Eugene Wigner, who was somewhat skeptical about the shell model.) This observation led her to suggest a shell structure for nuclei, analogous to electron shell structure in atoms.

In the nuclear shell model, each nucleon moves in a central potential well created by other nucleons, just as the electrons orbit a potential well created by the nucleus in the atomic shell model. The orbits form a series of shells of increasing energy. Nuclei with completely filled outer shells are most stable.

The fact that nuclei with certain numbers of nucleons were especially stable had in fact been noticed before, but physicists were so certain that a shell model could not be correct, in part because an alternative model, the liquid drop model, which treats the nucleus as a homogeneous blob, had been quite successful in explaining fission. In addition, physicists assumed that the interactions between nucleons would be too strong for the nucleus to be accurately described by a shell model, which treats nucleons as independent particles. Goeppert Mayer, who had less formal training in nuclear physics, was less biased by evidence for the liquid drop model.

Goeppert Mayer then considered other nuclear properties, and found they all pointed to more support for magic numbers. In August 1948, her first paper summarizing the evidence for a shell model of the nucleus was published in *Physical Review*.

Although Goeppert Mayer had collected evidence for the nuclear shell model, at first she couldn't explain the specific sequence of magic numbers. Standard quantum mechanics and a simple central potential couldn't account for the magic numbers higher than 20.

The key insight came to Goeppert Mayer when Enrico Fermi happened to ask her if there were any evidence of spin-orbit coupling. She immediately realized this was the answer. Goeppert Mayer was now able to calculate energy levels and magic numbers.

As she was sending her paper off to the *Physical Review* for publication, she became aware of a paper by Hans Jensen and colleagues, who had independently come up with the same result. She asked that her paper be delayed to be published in the same issue as theirs, though hers ended up being published in the issue after theirs, in June 1949.

Goeppert Mayer had not met Jensen at the time, but later the two did meet. They became friends and collaborators and wrote a book together on the nuclear shell model. Jensen and Goeppert Mayer won the Nobel Prize in 1963 for their work on the shell model. They shared the prize with Eugene Wigner, for unrelated work.

Goeppert Mayer was appointed to a full professorship at the University of California, San Diego in 1960, but suffered a stroke soon after. She never fully recovered and died in 1972.

APS Physics Capitol Hill Quarterly

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Nuclear Forensics Bill Moves Through Congress

Legislation to bolster the nation's nuclear forensics capability recently passed in the House, enacting many recommendations in a report by the American Physical Society (APS) and the American Association for the Advancement of Science (AAAS).

The need for this [legislation] has gone up since the end of the Cold War," said Rep. Bill Foster, (IL-14th), explaining that the appearance of nuclear materials on the black market is a growing global concern.

Nuclear forensics is the technical analysis of materials to determine their nature and origin. The scientific process is used on nuclear materials that have been intercepted or following an explosion to deter or respond to nuclear terrorism.

Michael May, professor emeritus at Stanford University's School of Engineering and a senior fellow with the Freeman Spogli Institute for International Studies, chaired the panel that wrote the report, which was released in February. The study group concluded that the U.S. is in danger of losing some of the expertise needed to rapidly identify nuclear materials smuggled on the black market or used in a detonation.

After the report was released, Foster, a former Fermilab physicist, introduced a bill (H.R. 5929) that included some of the study's recommendations. The legislation was rewritten as an amendment to the Fiscal Year 2009 Defense Authorization Bill, which the House passed on May 23.

The legislation:

- Supports the research and development of nuclear forensics capability;
- Creates a fellowship for Ph.D. candidates in nuclear chemistry;
- Calls for the creation of an international database of nuclear materials;
- Establishes an independent Nuclear Forensics Advisory Panel; and
- Requires the President to report to Congress on cabinet-level participation in nuclear terrorism preparedness exercises that include nuclear forensics analysis.

An international database to track the source of nuclear materials could play a critical role in deterring a terrorist attack, said Foster.

"If they know that we can trace it back to them, that's one of the few very strong deterrents that we have," he said.

Foster's amendment to move the bill along the legislative process was easily agreed to in the House.

"We proposed it at a propitious time," he said.

Reps. Ellen Tauscher (CA-10th) and Adam Smith, (WA-9th), provided Foster with assistance on the issue.

"Foster's ability to understand the science behind the legislation also played a key role in its success, said Francis Slakey," senior adviser to the study group and associate director of public affairs for APS.

"Rep. Foster comprehends that the solutions to issues confronting our nation often involve tapping our scientific expertise," said Slakey.

Nuclear forensics was first developed during the Cold War, but since then, the nation's capability has declined as scientists have neared retirement. According to the report, between 35 to 50 scientists are working on nuclear forensics in national laboratories, and many of them are ready to leave the field.

Benn Tannenbaum, associate program director of the Center for Science, Technology and Security Policy at AAAS, said, "While the number of scientists and engineers working in the field has gone down, the response to the report will hopefully lead to an increase in the size and scope of an appropriately skilled workforce."

Foster echoed Tannenbaum's comments.

"A very important part of this is to encourage a next generation of nuclear forensics experts," he said.

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long-term commitment to the transformational technologies needed to rid the U.S. of dependence on foreign oil and to reduce global warming. Advanced technologies will lead to greater energy efficiency and move the country toward a green economy that will generate new jobs and a better quality of life for all Americans.

Congress should not repeat the mistake of the Fiscal Year 2008 budget, which sent the wrong message to aspiring scientists who are considering entering the science field. Instead of doubling funding as outlined in the America COMPETES Act, the budget failed to even provide for inflation-adjusted costs.

Investing in basic research reflects America's pioneering heritage of pushing the frontiers of knowledge and has led to innovation, new jobs and unforeseen technological advances for our nation. If the country is to deal effectively with the ongoing energy crisis, it must not allow energy research funding to remain at the Fiscal Year 2008 level.

Instead, Congress and the Administration must work together to ensure that U.S. laboratories and universities have the necessary funding to develop advanced technologies and train the next generation of scientists to develop sustainable solutions to an energy crisis that is wrecking havoc in the lives of most Americans.

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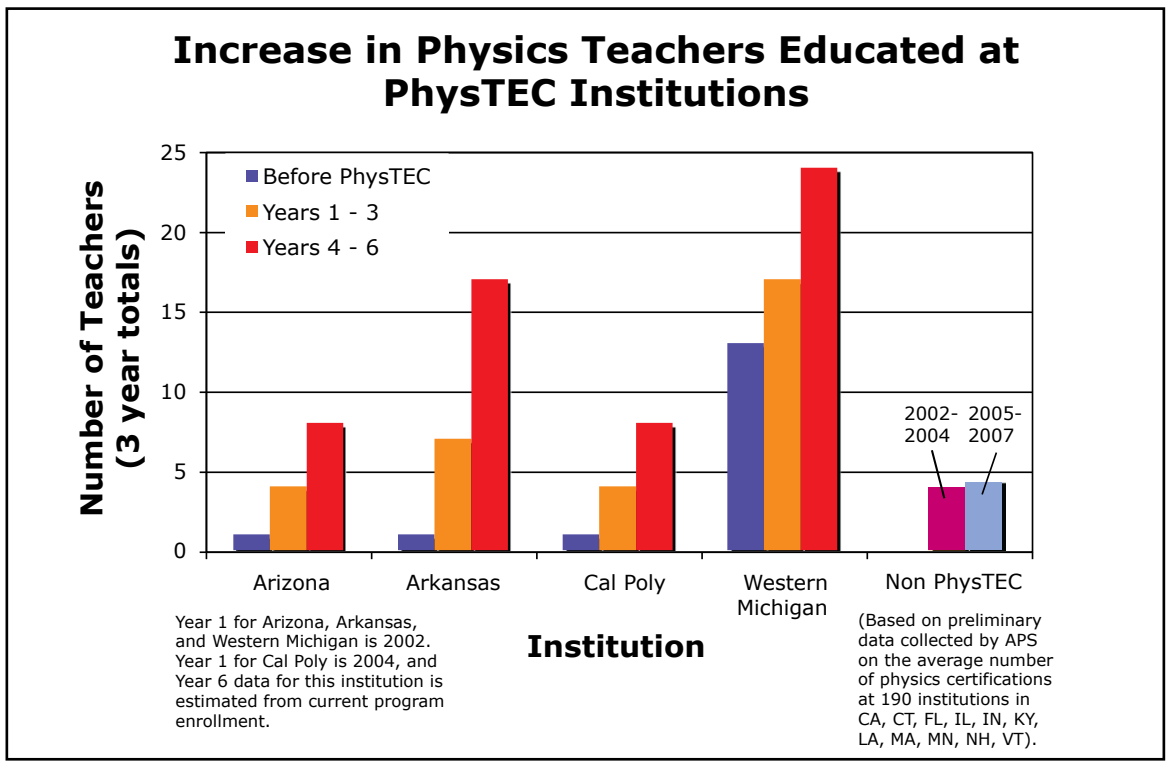
"The best thing we can do to help our children succeed in math and science is to invest more in the success of their teachers," said U.S. Rep. George Miller (CA-7th), chairman of the House Committee on Education and Labor, during a recent Capitol Hill hearing. "We cannot expect our teachers to teach what they themselves do not know."

School officials have confirmed that qualified physics teachers are the most difficult of any science or mathematics professional to hire, according to the American Association of Employment in Education, and AIP reports that the number of high-school students taking physics is increasing by about 1 percent per year, creating an even greater need for qualified teachers.

"PhysTEC is the largest effort in the country focusing on physics teacher education," said APS President Arthur Bienenstock.

"APS is very pleased to see evidence that these efforts are having a significant impact on this serious problem, which affects not only the physics community but also our nation's economic future."



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design and new materials without compromising safety. Vehicle weight reductions of 20 percent, for example, achieved by greater use of high-strength steel, aluminum and composite materials, would improve fuel economy by approximately 14 percent while reducing traffic injuries and fatalities.

•Plug-in hybrids require more efficient and more durable batteries, able to withstand deep discharges that are not yet in commercial large-scale production. Given the technical difficulties, plug-in hybrids will not replace the standard American family car in the near term.

•Improvements in the United States' electric grid must be made in order to handle charging of electric vehicles if daytime charging is to occur on a large scale or when the market penetration of electric vehicles becomes significant.

•Hydrogen fuel cell vehicles (FCVs) are not a short-term solution to our oil needs, but rather a long-term option requiring fundamental science and engineering breakthroughs in several areas.

Buildings

•To achieve the 2030 zero energy building goal for commercial buildings, the federal government should create a research, development and demonstration program that makes integrated design and operation of buildings standard practice.

•Green building rating systems should give energy efficiency the highest priority and require reporting of energy consumption data.

•The federal government should establish a comprehensive program of efficiency standards and labeling for appliances that are cost-effective and technologically feasible. A streamlined procedure is needed to avoid delays in releasing the standards.

•States should be encouraged to create demand-side, utility management programs.

•Energy standards for buildings should be implemented nationwide.

•Longer-term applied research opportunities include advanced ventilation, advanced windows, thermodynamic cycles and ultra-thin insulators.

Government Action

Legislative

•Congress should appropriate and the White House should approve for the U.S. Department of Energy's (DOE) Office of Science funds that are consistent with the spending profiles specified in the 2005 Energy Policy Act and the 2007 America COMPETES Act.

•Congressional oversight committees should ensure that DOE fulfills its obligation. Historically, coordination among basic and applied research programs within the Department of Energy has been far from ideal. Congress should periodically review the Energy Frontiers Research Centers program to ensure that basic research related to energy efficiency receives adequate attention.

•Estimating the long-term effects of transportation infrastructure on transportation demand should become a required component of the transportation planning process, and to that end, a better understanding of social science is needed.

Executive

•DOE should fully comply with the 2005 Energy Policy Act mandate to improve the coordination between its basic and applied research activities.

•Long-term applied research, whether it is general or strategic in nature, often is the orphan child of science and technology programming. DOE must take steps now to fold long-term applied research into its scientific programming in a more serious way than it currently does.

•Smart growth policies in planning urban and transportation infrastructure can contribute to energy efficiency by reducing vehicle miles traveled (VMT) by 10 to 30 percent by 2030 compared to business as usual.

For a full copy of the APS report *Energy Future: Think Efficiency* and related materials, including video and photographs, go to http://www.aps.org/energy-efficiencyreport/.

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Understanding New Frontiers in Energy Efficiency Research: APS Study as a Roadmap to Energy Solutions

By Congressman Nick Lampson

It is no coincidence that the U.S. ranks at the top of the major economies in both per capita GDP and per capita energy use. A couple of centuries of innovative, if not judicious, exploitation of our natural resources have allowed us the quality of life we enjoy today and brought along an assortment of unfortunate side effects of which we are all aware. We now have the opportunity and responsibility to leverage that same capacity for innovation to decouple our prosperity from our energy use. This change could not have come at a more opportune time with rapidly developing countries such as China following in our footsteps and looking to create a feasible model of large-scale economic growth with responsible energy use. Economic transformation on this scale will not be quick or easy, and for the time being all options are on the table. Luckily, the most powerful approach happens to be the simplest and the least expensive-conservation and efficiency.

Reducing the nation's energy intensity requires both a change in consumer behavior and a constant flow of new, more efficient technologies into the marketplace.

"Reducing the nation's energy intensity requires both a change in consumer behavior and a constant flow of new, more efficient technologies into the marketplace."

When it comes to behavior, we know surprisingly little about what drives individuals, communities and the industry in making energy-related decisions. For instance, we have seen how a slowing economy and high fuel prices have reduced driver mileage in the U.S. by almost 5 percent from last year, but there is more to consumer behavior than money. Americans are developing a new system of values for energy. However, there is still too little correlation between what we believe and what we do. The application of social sciences to the energy problem will give us critical new insights into these complex dynamics, and will in turn, give us new tools to guide public policy and help consumers make better choices.

In order to make wise energy decisions, consumers must first have reasonable options to choose from. That may sound obvious enough, but I believe there is a false impression about the availability and efficacy of many new energy technologies. If there is anything that traditional energy resources have provided it is low-cost, reliable, and accessible end-use technologies–and consumers will only expect it to get easier. The next generation of vehicles must be as affordable and have a driving range and ease-of-use similar to conventional vehicles. The same can be said for buildings and industrial processes in terms of life-cycle costs, comfort, productivity, etc. Whether we are talking about hybrid cars, Energy Star appliances, or even coal gasification, there is a wide range of more efficient and cleaner technologies available today. But, in the absence of aggressive and binding policies mandating their use, the market simply will not bear a significant cost premium or energy penalty just for the sake of doing the right thing. Furthermore, I believe the current "advanced" technologies are just the frontrunners of an energy future that we can scarcely conceive of today. That is where this study and the membership of APS come in.

To know where we are going in energy efficiency, we have to first recognize the major technological hurdles to be addressed through research and development. The problem is that, unlike other energy technology areas such as renewables, "energy efficiency" does not describe one particular subset of technologies. It is more an approach to optimizing a highly fragmented assortment of energy-consuming devices that range from the ubiquitous and mundane to truly revolutionary technologies and a framework to reevaluating our relationship with energy. The APS study should provide the first real roadmap for developing a long-term energy efficiency research agenda.

We all know there will not be one silver bullet energy technology, but countless solutions that have been accurately described as "silver buckshot." This is a multi-generational problem that we have to approach from all possible angles and never let up. In a perfect world, the laws of thermodynamics would be the only limiting factor. But it is not perfect, and there are a myriad of complex factors that hamper progress in energy. From my perspective in Congress, the biggest challenge is finding the financial resources to help fund the full range of research that will result in both incremental improvements to existing systems and fundamental game-changing breakthroughs for entirely new energy systems. We can't get there with the status quo. Funding energy R&D at a level commensurate with the scale and complexity of the challenge will require innovation at a number of levels.

"The APS study should provide the first real roadmap for developing a long-term energy efficiency research agenda."

First, we must be innovative about where we find the money. For instance, I have put forth various proposals that include exchanging crude oil in the Strategic Petroleum Reserve and using the marginal proceeds to fund energy R&D. We could also see a significant influx of R&D funds from auction revenues under a carbon cap-and-trade regime. These are just two examples of alternative funding models, and there will be many more. But they illustrate the growing recognition that it is getting more difficult to rely on the annual appropriations process alone to put our federal energy R&D enterprise on the trajectory the problem requires.

We must also be innovative about how we approach energy R&D. We should devise new models for translating fundamental scientific breakthroughs into technological advances, and then shepherd these advances into the marketplace. In regards to the existing Department of Energy bureaucracy, again, we just can't get there from here. DOE currently does a lot of good work, but it is not enough. Bridging the so-called "valleys of death" between government-sponsored basic research, applied research and the marketplace will require more than just money. We have to rethink the structure of our national research enterprise, go beyond organizational stovepipes and institutional inertia, take greater risks, and leverage the talent and resources in the academic and private sector on a level that has not been attempted before. DARPA has done this for defense technologies, many of which have ended up in the broader marketplace. We now have authorized in law an ARPA for Energy, or ARPA-E, which will utilize many of the organizational and cultural elements that made DARPA a success. As the report points out, it has to be done right or not done at all.

ARPA-E will have no in-house research capability. Instead, projects are carried out through teams of public and private sector researchers, technology developers, and market experts, led by talented and determined Program Managers hired for three-year terms and on a pay structure similar to that of the private sector. ARPA-E staff should have the flexibility and autonomy to take technological leaps of faith and explore areas that are too multi-disciplinary or risky for any one sector alone to tackle. Because industry and universities are involved at the outset, chances are much greater that the results of ARPA-E sponsored research will end up in the marketplace, and not on the laboratory shelf. The ultimate products of a properly functioning ARPA-E will be more research areas explored, more money for energy research being spent in more places, and the feeding of more talent into the energy innovation pipeline.

"Funding energy R&D at a level commensurate with the scale and complexity of the challenge will require innovation at a number of levels."

A new ethos is taking shape in America akin to the resourcefulness that settled the American West, gave us victory in World War II, and landed on the moon. These historical feats were not achieved through indiscriminate wastefulness, and there is no reason we cannot reverse the current trends in our energy consumption. I believe Americans as a whole understand the value of energy efficiency and that technological progress does not have to come at the cost of economic hardship. We have the opportunity and obligation to capitalize on our vast innovative capacity to transform our energy economy. But it will take the concerted efforts of organizations like APS to lay the groundwork and provide the technical baselines and projections for addressing the energy challenge. Therefore, I support its efforts in that regard, and I look forward to working with APS to translate the results of this and other studies into sound energy policies for the nation.

Congressman Lampson (D-TX 22nd) serves as Chairman of the Subcommittee on Energy and Environment, U.S. House of Representatives Committee on Science & Technology. As a representative of Southeast Texas, Lampson has been a staunch advocate for the development of new energy technologies and NASA's Johnson Space Center during his 5 terms in Congress.