AWIS

ASSOCIATION FOR WOMEN IN SCIENCE

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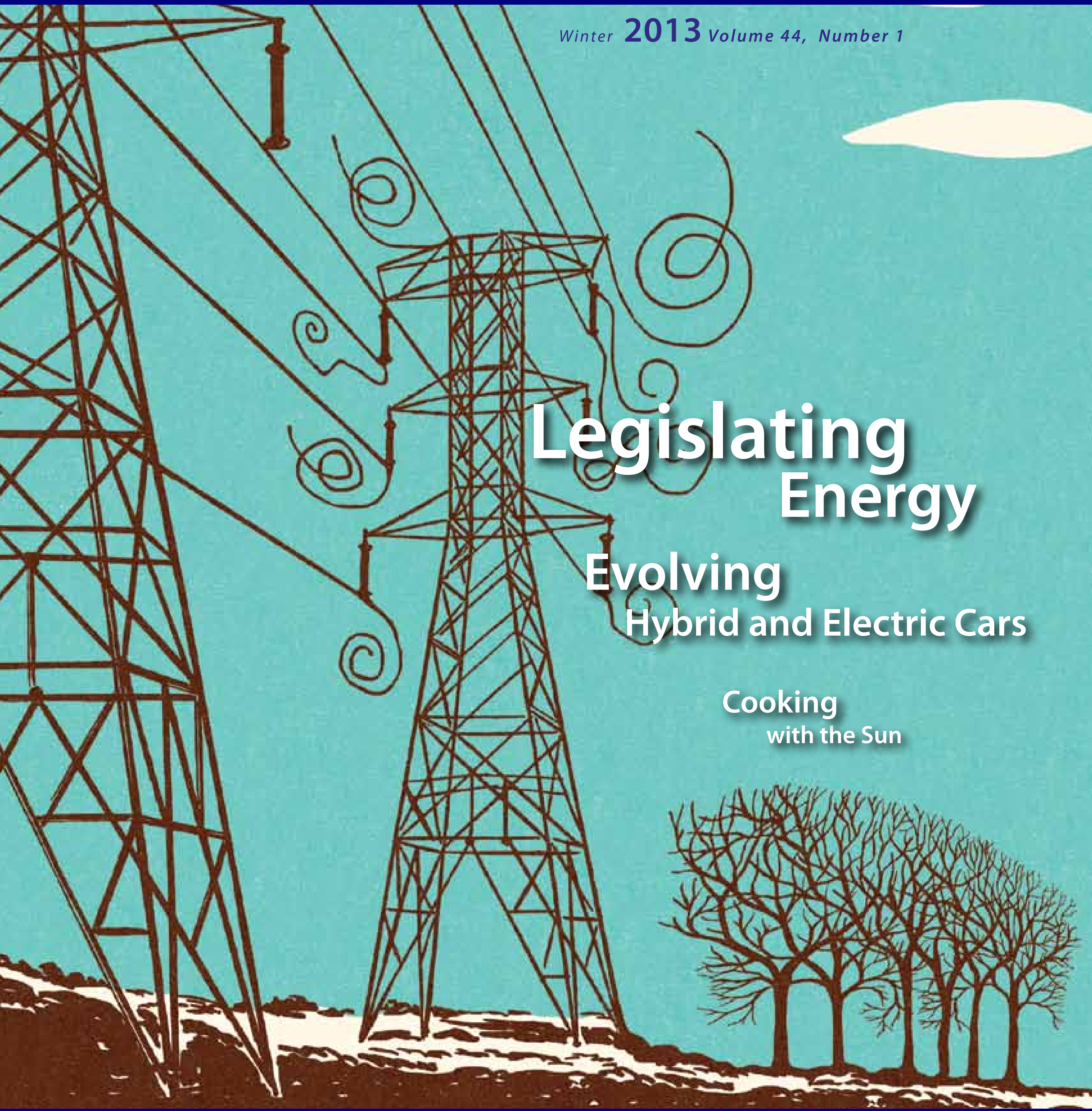

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Features

National AWIS

In Every Issue

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From Where I Sit:

Conserving Your Energy

What's Your Strategy?

By Susan M. Fitzpatrick

AWIS President Susan M. Fitzpatrick can be contacted at susan@jsmf.org

Energy looms large in the policy debates at the intersection of science, technology and society. Concerns about the environment and climate change bump up against job creation and economic worries. Decisions made in the near future have ramifications for generations to come. Women trained in the STEM disciplines are an essential component of the creative energy contributing to innovative solutions.

The global energy issue requires smart strategies, so does managing your own personal energy. Demanding jobs, family and community commitments, maintaining health and wellness – what is your plan for making sure you have enough fuel in the tank to make it through the day? And to be honest – is making it through the day the right goal? I know that I want more. I want to feel excited about my work. I want to look forward to my time with family and friends. I want to make sure I have regular opportunities to engage in physical activities – preferably outdoors!

Succeeding at these goals means I have my own energy conservation plan. What does that mean? One, I use networking opportunities (like AWIS events) to learn from my colleagues about strategies for how I can work smarter, using the hours I devote to my work as effectively as possible. The AWIS work-life satisfaction program is an excellent way to gain control over your time. I have gained the confidence, again from some terrific role models, not to apologize for making exercise and healthy eating part of my core activities. Since engagement with family and friends is essential for my well-being, I see the time I spend away from the office as contributing to rather than taking away from my professional success. A wise mentor advised me on how to decide when to say no when asked to do things that I might not necessarily be the only, or even the best, person for the task.

If we are among the fortunate, our personal and professional lives will last a long time. We have choices about the way we want to live. We can run ragged each day exhausted and stressed, feeling like we are robbing Peter's energy to pay Paul. Or we can have a way to apportion our energy in a way that allows us to engage fully in whatever it is we are doing at the moment – and for other activities awaiting us in the totality of our days. Will every day mesh? No. But AWIS can help you build a collection of tools that help you rally your reserves for everyday and for when work and life decide to pile it on. I am not Polly-Anna. I know that saying no is not easy for women. I know women are reluctant to make time for themselves. I know gender stereotypes require women to do 150% to appear to be doing 100%. AWIS is there to support you--working at the national policy level and on the personal strategies level. AWIS and you – creating an energy conservation policy we can all get behind. ■

AWIS STEMiNAR
Professional Growth Series
Friday, March 22, 2013 (12:00 PM – 1:00 PM ET)

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Leadership from the Inside Out"

Speaker:
Sherry Marts, PhD
President and CEO
S*Marts Consulting, LLC

Focus:
Leadership is a critical component of success at every stage in your career, and the most effective leadership is often the least visible. We'll explore how authenticity and integrity are key to effective leadership. Learn how to lead yourself and others and to grow your career to bring you ease and happiness while achieving the success you desire.

Information: https://m360.awis.org/calendar

Getting Women Tapped Into Technology Transfer Activities

By Erin Cadwalader,
Phoebe S. Leboy Public Policy Fellow

Innovation and job creation are important topics in society and government at present. Capitalizing on all of our nation's intellectual potential is crucial for global competitiveness and for remaining an attractive destination for future innovators and entrepreneurs to obtain an education. Part of that development puzzle requires identifying barriers to participation. Women make up 50 percent of the workforce, more than 25 percent of STEM employees, but hold less than 10 percent of the patents. At AWIS, we identify the problems that cause women to leave the STEM pipeline and propose solutions to increase retention. In a new study to be released in Spring 2013, we sought to identify reasons why women patent at a lower rate than would be expected and develop realistic solutions.

Technology transfer is the process by which an individual, at a university or federal agency, transmits knowledge and information by way of technology disclosures and patents. The intention of sharing this material is to make it more broadly available to the public. These ideas may then be licensed to other businesses to develop into a product, or they may be used to start-up a separate company. Through this process, over 70 drugs have been brought to market over the years; hundreds of companies, some very successful like Google and Genentech, have been created; and countless other products used to improve the quality of life have been taken to market.

While the number of women applying for patents is generally on the rise, a gender gap persists with regard to technology transfer and entrepreneurial activity. Several recent studies indirectly bring attention to this problem. A study coming out in the Journal of Management looked at hypothetical initial public offerings (IPO) and found that second year MBA students undervalued the company and offered the CEO less compensation if they believed the company was being run by a woman (Bigelow, 2012). Another study recently published in the Proceeding of the National Academy of Sciences (PNAS) found that an applicant for a lab manager's position was seen as less competent, a less desirable hire, less worthy of mentoring, and offered a lower salary if the identical application had a woman's name on it rather than a man's, regardless of if the evaluator was a man or a woman (Moss-Racusin, 2012). A current study is looking at the likelihood of technology licensing managers to encourage an entrepreneur to disclose his or her technology. Using identical disclosures but changing the name of the inventor, the preliminary results suggest that the officers are more likely to encourage the entrepreneur if an XY is involved in the chromosomal arrangement.

This implicit bias, or unconscious bias, is the idea that while consciously many people outwardly condemn racism, sexism, and other forms of discrimination, we hold opinions informed by the culture, both domestically and broadly, in which we were raised, and as a consequence subconsciously associate different values based on this (Fazio, 1986; Nosek, 2002). Many interesting and compelling studies have been done in this field, including the Implicit Association Test out of Harvard, which show that subconsciously most people associate science with masculine traits (Nosek, 2007). The aforementioned PNAS study was one of the most important in this field in recent years because it demonstrated that both academic women and men in physics, chemistry, and biology hold these same biases, despite claims of immunity to prejudice by scientists who are inclined to think they only evaluate people and ideas on merit. Of course, most of those people would honestly say that they do not think women are less competent or deserve less pay for the same work, but the data suggests otherwise.

Following our public policy symposium with experts in the technology transfer space and interviews with dozens of technology transfer managers and officers, patent attorneys, policy-makers, federal agents, and academic experts, we produced several recommendations for universities and technology transfer offices to increase the number of women disclosing ideas, getting patents, licensing technologies, and starting up companies. These recommendations can be found in our final report available at www.awis.org/associations/9417/files/Tech_Transfer_White_Paper_2013.pdf ■

AWIS Magazine
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A Word from Your Editor

By Laura Mackey Lorentzen

Welcome to the first issue of the *AWIS Magazine* for the New Year 2013! This issue has energy as its theme. Our next magazine issue will focus on wellness, followed by an issue themed education and teaching. We will close the year with professional development.

Herein we feature articles and columns exploring a variety of perspectives on energy, from personal, to national, to global. Both energy policy and technological innovations in how we derive and use energy sources are featured.

In late 2012, I had the opportunity to join a meeting of the AWIS Governing Board in Houston, Texas. Both the formal and informal discussions held over the multiday meetings reaffirmed for me why I continue to find inspiration in our organization. Indeed, I was "re-energized" by the board members' deep-seated belief in the collective mission and cause of our organization. For forty years, AWIS has fought for equity and career advancement for women in the STEM disciplines. You don't have to look far to see that the need continues for such advocacy. For example, it was after a five year court case that ended in December 2012, whereby female professors at a prominent university in the northeast settled a multi-million dollar sex-discrimination lawsuit in which they demonstrated that they were paid less than their male counterparts (K. Heyboer, The Star-Ledger, 7 Dec. 7, 2012, www.nj.com).

Write to us to comment on what struck you as you read this issue, or share with us your thoughts on what topics you wish us to focus on in the future. Letters to the Editor can be submitted to the AWIS National Office at 1321 Duke Street Suite 210, Alexandria VA 22314 or via email awis@awis.org. ■

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Editorial Correspondence can be submitted to the AWIS National Office at the above address. Articles considered for publication will be subject to editing. Editorial rights are reserved. Statements and opinions presented by the contributors are not necessarily those of AWIS.

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Rachel Britt earned her Ph.D. in Biochemistry from the University of Wisconsin-Madison. She is currently a postdoctoral fellow conducting cancer research at the University of Southern California (USC), where she also serves as President of the USC Postdoctoral Association. Rachel is passionate about improving the training experiences of aspiring scientists through networking, career development and education. Rachel joined the AWIS Los Angeles/Ventura County Chapter in 2011.

Vania Cao is a Ph.D. candidate in Neuroscience in the Graduate Partnerships Program at the National Institutes of Health with Brown University. She is investigating how animal behavior affects brain activity over experience and is using in vivo imaging and recording techniques to probe neural circuit dynamics in awake behaving mice. She recently joined AWIS as a student member and enjoys communicating about scientific topics through writing and the arts.

Ana DePina is currently a Research Fellow at The Food and Drug Administration Center for Food Safety and Applied Nutrition (FDA-CFSAN) in Laurel, MD. She joined AWIS in 2010, is an advocate of girls and women in STEM fields, and therefore very supportive of AWIS' mission.

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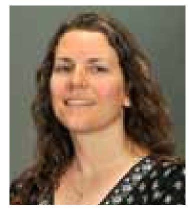

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Heather Luckarift is a Research Scientist for Universal Technology Corporation in Dayton, OH and has been based at the U.S. Air Force Research Laboratory since 2002. Her current research focuses on the development of biological fuel cells that generate electrical power directly from the environment. She holds a B.S. in Process Biotechnology from the University of Teesside (UK) and a Doctorate in Biological Sciences from the University of Warwick (UK). She has been a member of AWIS since 2008. Outside of the laboratory, she enjoys the 'Florida' life and competes in triathlons. Contact her at heather.luckarift.ctr.gb@us.af.mil

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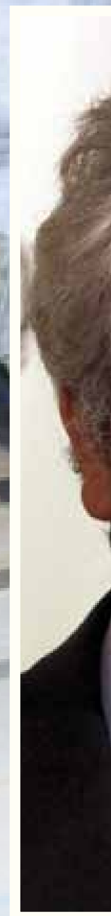
Image 2.

Fuel Barrels.

Image in the public domain. Credit: Trevor MacInnis.



The Global Energy Mix: An IEA Perspective

By Gaetan L. Kashala

The Council on Foreign Relations (CFR) recently hosted an important discussion concerning the global energy outlook where Dr. Fatih Birol, chief economist of the International Energy Agency (IEA), discussed the IEA's insights, trends, and term projections for the international energy markets. Notably, this is the seventh year in a row that Dr. Birol has functioned as the keynote speaker for this distinguished CFR lecture series. This article will provide AWIS readers with an overview of Dr. Birol's talk detailing the IEA's recent analysis of positions currently occupied by the principal actors in the global energy mix (oil, natural gas, coal, renewables, and nuclear).

The IEA is a Paris-based organization founded by the industrialized nations on November 8, 1974 in response to the 1973-74 Middle East Oil Crisis. It was originally created to allow for the coordination of western governmental petroleum policies providing much needed guidance to western companies engaged in upstream (exploration, identification, and extraction) and downstream (refinement, sale, and distribution) operations. At its inception, the IEA ostensibly served as a counterbalance to the increasingly powerful Organization of Petroleum Exporting Countries (OPEC) – an entity composed of oil producing nations in the Middle East North Africa (MENA) region such as Saudi Arabia, Libya, Iran, and Iraq. IEA membership consists primarily of industrialized nations from the Organization for Economic Cooperation and Development (OECD) such as the United States (US), Canada, United Kingdom (UK), The Netherlands, Germany and Japan.

Image 1.

Dr. Fatih Birol, Chief Economist of the International Energy Agency (IEA).

Image in the public domain.

The IEA expanded its mission to incorporate other constituents of the global energy mix such as gas, nuclear and renewable energy. It continues to serve an extremely important function by developing and maintaining systems that mitigate and respond to market disruptions. In addition to responding to international energy emergencies, the IEA offers dynamic capabilities crucial to the operations of global energy market participants: it prognosticates on short and medium term developments; publishes energy statistics (10 annual and 2 quarterly publications including the much lauded World Energy Outlook, WEO); and educates about the linkages between energy and the environment through the promotion of renewable energy, enhancing energy efficiency, expanding global access to electricity, and advocating for deployment of the most advanced energy technologies.

It is clear that effective transnational coordination, based upon a realistic understanding of the current state of the energy markets, will be critical to confronting the challenges and exploiting the tremendous opportunities that exist in the dynamic, but oft volatile international energy markets. Policymakers, multilateral organizations, business leaders, non-governmental organizations (NGOs) and consumers will have to be active participants in this dialogue. Each must demonstrate sufficient willingness to compromise in order to achieve mutually beneficial and sustainable global energy outcomes.

Petroleum

Dr. Birol speaks of an impending shift in the international oil security calculus owing to the evolving energy posture of many nations. The U.S. has historically been the principal guarantor of stability in the international oil markets, playing a variety of roles since the 1901 discovery of the Spindletop gusher in Beaumont, Texas that signaled the promise and drove the expansion of the American petroleum industry. The U.S. has at times been: (1) the primary global supplier of petroleum providing 50% of the world's petroleum in 1950, with 6 of the 7 billion barrels of oil consumed during World War II originated from the U.S.; (2) the primary consumer of petroleum; and (3) the implicit and explicit protector of the immense Middle Eastern oil reserves (for example, President Franklin Delano Roosevelt's security assurances to King Ibn Saud of Saudi Arabia in 1944).

The U.S., long the largest importer of oil, has traditionally assumed the responsibility for maintaining stability in the international oil markets as a means of keeping energy-hungry domestic industries satiated. Further, given the American experiences in World War I & II, in which the Allies access to petroleum proved outcome-determinative, policymakers understandably recognized petroleum to be a strategic commodity critical to American national security interests.

Dr. Birol cautions the global community to expect a modification in this American strategic viewpoint as a result of a reorientation on the U.S. demand side of the equation. Increased oil production and efficiency standards, development of new energy sources (e.g., natural gas, renewables), and the politics of energy independence, he posits, will translate into a significant reduction in American oil imports. In fact, the U.S. Energy Department estimates that American imports of crude oil decreased by approximately 11% in 2012. This projected trend has been accelerated by expanded commercialization of natural gas, which has further loosened America's dependence on oil and concomitant desire to secure strategic oil locales.

Importantly, the IEA projects that by 2017, the U.S. will become the largest producer of petroleum, although Saudi Arabia will retain its hold on the title of largest petroleum exporter. This is largely attributable to the American exploitation of shale crude, which is produced through the source rock from which traditional oil is extrapolated. Dr. Birol estimates that the US currently possesses 35 billion barrels of proven shale oil reserves and should reach 3 million barrels per day of shale crude production by 2025.

The IEA expects the scale of European Union (EU) oil imports to overtake that of the U.S. by 2015; by 2035, China is expected to import 12 million barrels of oil per day (bpd) representing 200 % of projected U.S. imports. This dramatic shift in petroleum allocation, Dr. Birol predicts, will lead to a major shift in the international oil security equation with the U.S. moving to a more peripheral stance requiring EU nations and China to assume a more direct role in securing and maintaining a stable global petroleum market. Dr. Birol's assessment is that, to date, the EU has failed to seriously consider this predicted shift in the global petroleum order and are, at best, ambivalent to the ramifications that this evolution of the international oil security paradigm will mean for their respective polities.

Dr. Birol is very optimistic about the potential for Iraq to assume a predominant position in the international oil hierarchy. The IEA projects that Iraq, which currently produces approximately 3

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million barrels of oil per day, would increase its production to 6 bpd by 2020. Incredibly, this number is 50% lower than Iraqi government projections, which are predicated upon contracts that the government has with oil companies. Dr. Birol explains his bullishness by referring to the Iraq's huge known reserves, industry projections of significant unknown reserves, and the cost effectiveness of producing oil in Iraq (13 times cheaper than producing from the oil sands in Canada, and 11 times cheaper than production in Russia). He did concede that the political problems (e.g., absence of a unified hydrocarbon law and historical grievances) between the central government in Baghdad and Kurdish administration in Erbil have the potential to result in suboptimal production. However, Dr. Birol is confident that the disunity will largely be resolved.

The IEA has previously noted the ramifications of geopolitical instability (especially in the MENA region) on the international oil markets. The year 2012 witnessed approximately $520 billion in fossil fuel subsidization with 50% originating from governments in the MENA region. Civil unrest has led to governments diverting significant financial resources, originally allocated for upstream investment, to social spending programs. This subsidization was a policy mechanism originated to mitigate the probability of civil chaos perceived to pose existential threats to various MENA regimes. The IEA estimates that 90% of global growth in oil production needs to come from the MENA region in order to satisfy increasing global energy demand and supplant exhausted petroleum reserves. The agency's analysis indicates that $100 billion dollars worth of investment in MENA capital infrastructure is necessary to identify new reserves and bring the petroleum to market. Paradoxically, it appears that this prioritization of social subsidies over upstream capital investment, and consequent failure to identify new reserves resulting in supply side limitations and an increase in oil price, will stimulate global investment in alternative energy solutions leading to a decline in revenue to the MENA treasuries. Dr. Birol believes this will ultimately culminate in reduced funds available for social spending. Unraveling this causality dilemma is sure to pose significant headaches for MENA policymakers charged with its resolution.

Natural Gas

The IEA has postulated that we are entering an era of unprecedented growth in the use of natural gas with the possibility of paying tremendous dividends for international consumers. Abundant natural gas supplies are coming to market from countries such as the U.S., China, and Australia. The IEA estimates that natural gas demand will increase by 50% over the next 20 years. Furthermore, the U.S. supply of natural gas to EU markets has been a tremendous "gift" to the European consumer providing EU policymakers with a desperately needed source of energy supply diversity. The U.S. liquefied natural gas (LNG) has provided traditional EU gas importers with much needed leverage to negotiate with countries such as Russia. Also, certain countries that were previously dependent on gas importation have themselves identified natural gas reserves and now are in the enviable position of being gas producers.

Dr. Birol asserts that market adjustments, particularly with respect to gas contracts, are necessary in order to instigate the commercial incentives necessary to significantly increase the volume of natural gas brought to market, thereby benefiting consumers worldwide. Primary among these adjustments is a need for market developments to be reflected in long-term gas contracts and a general move away from gas price indexation based upon petroleum. Opponents contend that oil-based indexation of gas contracts is overly rigid and represents a fundamental disincentive to the development of infrastructure necessary to take advantage of natural gas potential. This line of reasoning advances the notion that oil-based price indexation of natural gas distorts international energy market realities and leads to illogicality in pricing.

Dr. Birol affirms that the world has only witnessed the tip of the iceberg in terms of natural gas potential to revolutionize the global energy calculus; however, market axioms must be properly structured in order to realize this potential. Appropriate market and regulatory principles need to be adopted by all stakeholders and greater efforts must be made to mitigate the environmental damage that concern those living in proximity to natural gas exploration sites and environmentalists. Dr. Birol concedes that environmental damage resulting from the deployment of hydraulic fracturing (fracking – the use of pressurized fluid to cause fractures expediting the release of natural gas from rock formations), a primary method for the extraction of natural gas, has become a controversial issue in countries such as the U.S., Germany, Australia, and France (the procedure is currently banned by the French government). However, Dr. Birol states that the technological capacities for preventing much of the environmental damages caused by fracking are already in existence, and their usage would result in increased production costs of approximately 7% while still allowing for significant profit margins. Importantly, Dr. Birol surmises that increased regulation compelling natural gas explorers to use the appropriate technology and procedures is necessary to achieve the potential of natural gas. He notes that successfully entering the "Golden Age of Gas" requires us to adopt "Golden Rules" of production.

Coal

The current sustainable energy discussion with its focus on renewable energies and natural gas may lead one to incorrectly judge the use of antiquated coal as in its final descent toward extinction. Dr. Birol has often pointed out, quite accurately, the tremendous disconnect between the current state of the international energy debate and the practical realities of the international energy markets. The statistics irrefutably establish that King Coal is indeed alive and doing quite well. Over the past 10 years (2000-10), coal has comprised approximately 50% of the growth in global energy demand with the remaining 50% divided among oil, gas, renewables, and nuclear. Paradoxically, American enhanced capability in the production of LNG in 2012 resulted in an overcapacity of coal leading to massive exports of U.S. coal to the EU. Europeans, facing a sovereign debt crisis of historic proportions, were provided with the option of cheap coal versus more expensive natural gas. As a result, the EU, with 7.2% increase in coal usage, ranked second to China in coal utilization growth.

This situation has important public health, environmental, and water security implications. Policymakers and citizens around the world will need to take a realistic assessment of King Coal and his function in the global energy equation in order to effectively address the ramifications of His Majesty's preeminence. The divergent commercial interests and strategic optics by which industrialized versus developing nations perceive coal will no doubt complicate efforts to implement a coherent international strategy. The success of such an effort will be conditioned upon stakeholder capacity to empathize and willingness to compromise.

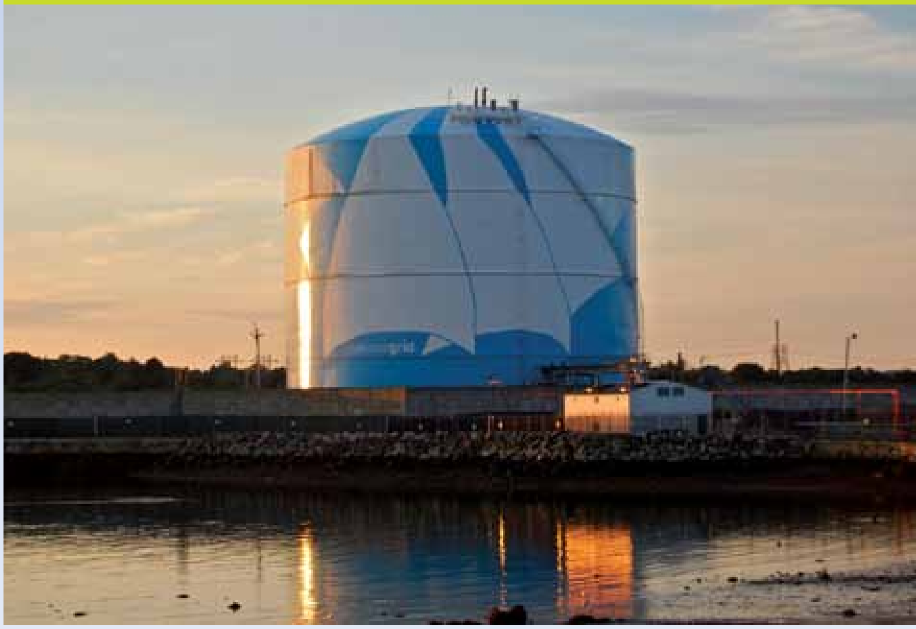

Image 3.

A liquefied natural gas storage facility in Massachusetts

Image in the public domain. Credit: Fletcher.

Climate Change and Electricity Accessibility

Finally, Dr. Birol offers a stark assessment of the international community's efforts to retard climate change. The IEA's WEO offers a surprisingly gloomy outlook for the probability of maintaining global warming below the 3.6°F (2°C) per year levels agreed to by world leaders at the 2009 Copenhagen Summit and later ratified at the 2010 conference of the UN Framework Convention on Climate Change (UNFCCC). Dr. Birol calls attention to the fact that the international energy market's existing capital infrastructure – power plants, factories, and supporting structures – consumes approximately 80% of the emissions allowance necessary to stay below the 3.6°F (2°C) per UNFCCC. Further, by 2015, IEA projects that this capital infrastructure – predicated upon the burning of fossil fuels resulting in massive emissions of the greenhouse gas carbon dioxide (CO2) – will consume 95% of allowable emissions. Dr. Birol states that the worsening efficiency despite the high price of energy is primarily the result of tremendous growth in energy demand from developing countries such as China, India, and the Middle East.

Carefully calibrated incentives must be developed to encourage these countries to use energy-efficient technologies. These incentives need to be designed in a manner that does not significantly injure the domestic industrial growth that has accelerated socioeconomic development in emerging markets. Successfully navigating toward a solution to this complex problem will be extremely difficult. The most viable response mandates international collaboration and a willingness to negotiate in good faith by governments, industry, and consumers. As with King Coal, the current rhetoric of the climate change debate and public statements of action do not necessarily reflect the reality of the situation.

Dr. Birol believes that fossil fuel subsidies represent the single greatest impediment to retarding climate change because they incentivize consumer use leading to increased emissions. Dr. Birol mentions that 2012 saw approximately $520 billion dollar in such subsidies, primarily in the MENA region. Whereas existing EU structured carbon taxes represent a $10-20 per ton of CO2 disincentive to use carbon tax, fossil fuel subsidization equates to a $110 per ton of CO2 incentive to use fossil fuel.

Dr. Birol reminds us that 2010 saw the highest CO2 emissions ever recorded. Additionally, in a stark reversal of the historically positive trajectory of global energy efficiency (approximately +1% per annum), 2009-2011 represented an actual worsening of the international community's efficiency performance. China and the U.S. represent approximately 50% of global CO2 emissions. Dr. Birol notes that if the U.S. does not take serious steps toward addressing this challenge, then China will not take action resulting in inaction by the EU. Policymakers, business leaders, thought leaders, multilateral institutions, and the public at large will have to reconcile the rhetoric of preventing global warming and the fact that the situation is not improving. The alternative would be to endure the calamity of severe environmental degradation featuring frequent extreme weather events and public health consequences. Maintaining the status quo when faced with this threat is a morally indefensible and unacceptable proposition.

Dr. Birol makes a forceful argument for the expansion of electricity access to the approximately 1.3 billion people, approximately 20% of the world population, who subsist without it. The United Nations (UN) recognized this problem, leading them to designate 2012 as the International Year of Sustainable Energy for All. Tragically, the IEA estimates that in 2035, there will still be 1 billion people without access to electricity and its associated quality of life improvements. ■

Reference

Birol, F. and Ross G. (November 29, 2012) *World Energy Outlook* 2012. Council on Foreign Relations, New York, NY. Transcript available at http://www.cfr.org/energyenvironment/world-energy-outlook-2012/p29609.

U.S. Energy Policy: The Impact of Recent

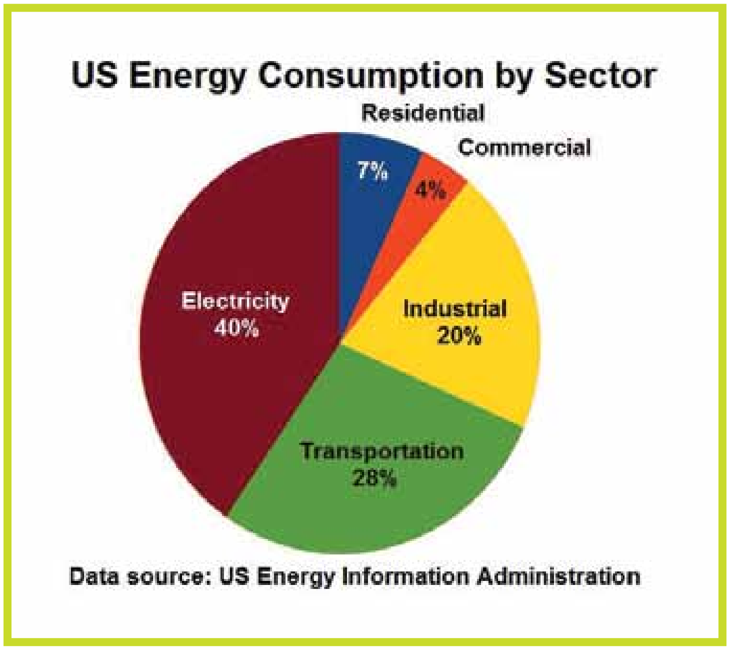

Image 1: Image is in the public domain.

As the U.S. legislature attempts to create a balanced energy plan, it is faced with the nation's increasing demand for energy production, energy transport, and energy efficiency. To date, no comprehensive long-term energy policy has been proposed, but in the past two decades, three Energy Policy Acts (EPActs) have been passed that include provisions for conservation and development of renewable energy technologies. The goals are to produce cleaner, more efficient energy to meet our needs and reduce harmful effects on a global scale.

Our largest energy consumption is in the form of electricity (Fig. 1). The generation and consumption of electrical energy accounts for a significant amount of greenhouse gas emissions and adversely affects climate change. To address this issue, the 1992 Energy Policy Act (102nd Congress H.R.776.ENR, abbreviated as EPACT2) established several energy management goals for clean and renewable energy, as well as overall improved energy efficiency. The Federal Energy Efficiency Fund provided grants to agencies for water conservation measures and energy efficiency improvements in federal buildings. Federal agencies were encouraged to participate in utility incentive programs that provided both cost-effective and increased energy efficiency services for electric, water, and gas utilities. In addition, increased use of alternative fuel vehicles by government fleets was also mandated as a measure to decrease our dependence on foreign oil.[1]

In spite of the ambitious effort of the aforementioned act, another bill had to be passed by Congress the following decade, named the 2005 Energy Policy Act (EPAct 2005), in order to cope with the problem of our growing energy needs. This act authorized tax incentives and loan assurances for various types of energy production, especially the use of alternative fuel sources and support of energy conservation.

Among the directives, was the installation of advanced meters and other metering devices in all federal buildings to monitor use of electricity and assess energy efficiency. Federal agencies were also expected to incorporate improved standards of electrical products and lighting by using ENERGY-STAR and Federal Energy Management Program (FEMP)-designated product guidelines to achieve energy efficiency. The act also set precedence for use of renewable energy, defined as electric energy generated from natural sources such as solar, wind, biomass, landfill gas, ocean, geothermal, solid waste, or hydroelectric energy. The act required that renewable energy consumption by federal agencies increase by 3% in 2007-2009, to 5% in 2010-12 and to 7.5% in 2013.[2]

Two years later, the 2007 Energy Independence and Security Act (originally named the Clean Energy Act of 2007) took additional measures toward greater energy security and independence by promoting research on greenhouse gas capture and creating further mandates to increase production of biofuels and improve fuel economy. Its overall perspective was enhancing the efficiency of buildings, vehicles and products. Energy reduction in federal buildings through improved design and construction of facilities, which was expanded to include industrial and laboratory buildings, was again addressed. Successful implementation of these measures is expected to result in 30% decrease in energy consumption by 2015. Major renovations to federal facilities or construction of new federal buildings require that energy-efficient lighting fixtures be used, that fossil fuel –generated energy be reduced, and that renewable energy systems be promoted. Once again, the precedence for procuring ENERGY-STAR and FEMP-designed products to maximize energy efficiency was reinforced. The goal of establishing these green practices and standards is to create new and existing federal buildings that are high-performance green facilities. As incentives for meeting energy efficiency goals, federal agencies are able to more easily start or terminate energy savings performance contracts (ESPCs), and all energy cost savings can be retained in the agency's discretionary budget.[3]

Energy Policy Acts

By Ana DePina

The act also contained provisions for improved vehicle fuel economy standards, incentives for the development of hybrid vehicles, production of electric transportation technology, and creation of biomass-based diesel fuel. In this context, sections of EPAct 1992 pertaining to government vehicles were amended, mandating that agencies adopt cost-effective policies to reduce petroleum consumption and prohibit federal agencies from acquiring vehicles that are not "low greenhouse emitting." The projected outcome is that federal agencies will achieve a 20% reduction in annual petroleum consumption in conjunction with a 10% increase in annual alternative fuel consumption by 2015.[3]

During President Obama's first term, there was growing concern about global warming and energy shortages, which led to the introduction of legislation that would cap greenhouse gas emissions and support green-energy companies. However, the legislation did not make it past Congress, thus it remains a challenge for green-energy companies to compete with established energy companies.[4] However, the Obama administration had made investments specifically in clean energy and energy efficiency research, development, and outreach projects, as part of the American Recovery and Reinvestment Act of 2009.[5]

In the President's second term, no significant climate change or green–energy legislation is expected to pass. On a positive note, there has been a surge in oil production due to a boom in shale oil, and the United States is predicted to surpass Saudi Arabia as the world's largest oil producer by 2020, lessening our dependence on foreign oil (Fig. 2). The International Energy Agency also predicts that natural gas, which is inexpensive and largely produced from a drilling technique called hydraulic fracturing, or fracking (which uses pressurized water and chemicals to extract more oil and gas from rock formations) will become the largest single fuel in the United States, helping to reduce carbon-dioxide emissions.[4] The Obama Administration's energy security strategy emphasizes 'green' initiatives such as raising fuel efficiency standards, doubling the number of hybrid vehicles in the federal government's fleet, and expanding domestic offshore oil and gas exploration in Alaska and off the southwest coast of the United States.[6] Such shifts will bring down energy costs for both manufacturers and consumers. The economics of energy are complex and operate by their own rules of supply and demand. Rising oil prices largely contributed to the current increase in production, and we could see a trend reversal if the global economy were to change. In the future, U.S. Energy Policy will have to shift focus from addressing scarcity, which has been the main goal for almost half a century, to dealing with adequacy. Dealing with energy abundance will no doubt bring about a different set of challenges. In order for the United States to boost energy production, diversify its energy portfolio, and promote clean energy innovation, the government's energy policies should remain competitive in meeting and balancing our domestic energy needs, provide continued support for production of natural gas and energy from alternative renewable sources, as well as encourage implementation of practices that curb global warming. ■

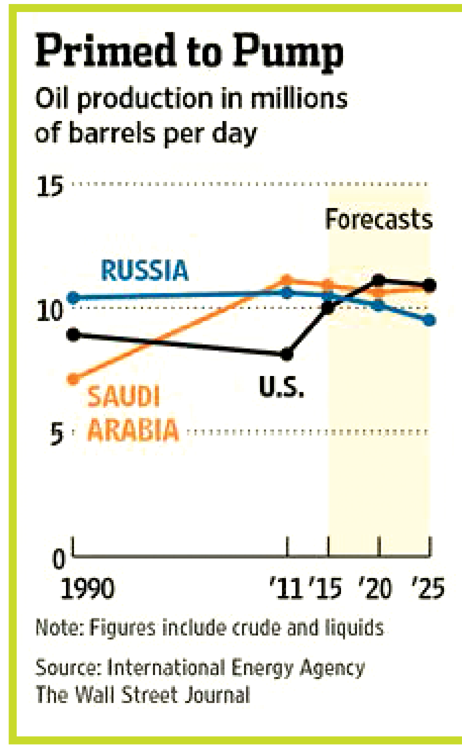

Image 2.
Source: Faucon, B. and Johnson K. (2012, November 13) U.S. Redraws World Oil Map. The Wall Street Journal, p A1. http://online.wsj.com/article/SB10001424127887324073504578115152144093088.html. Reprinted with permission.

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How Our Quest For Energy Leaves Us With More Than We Bargained For

By Rachel Britt

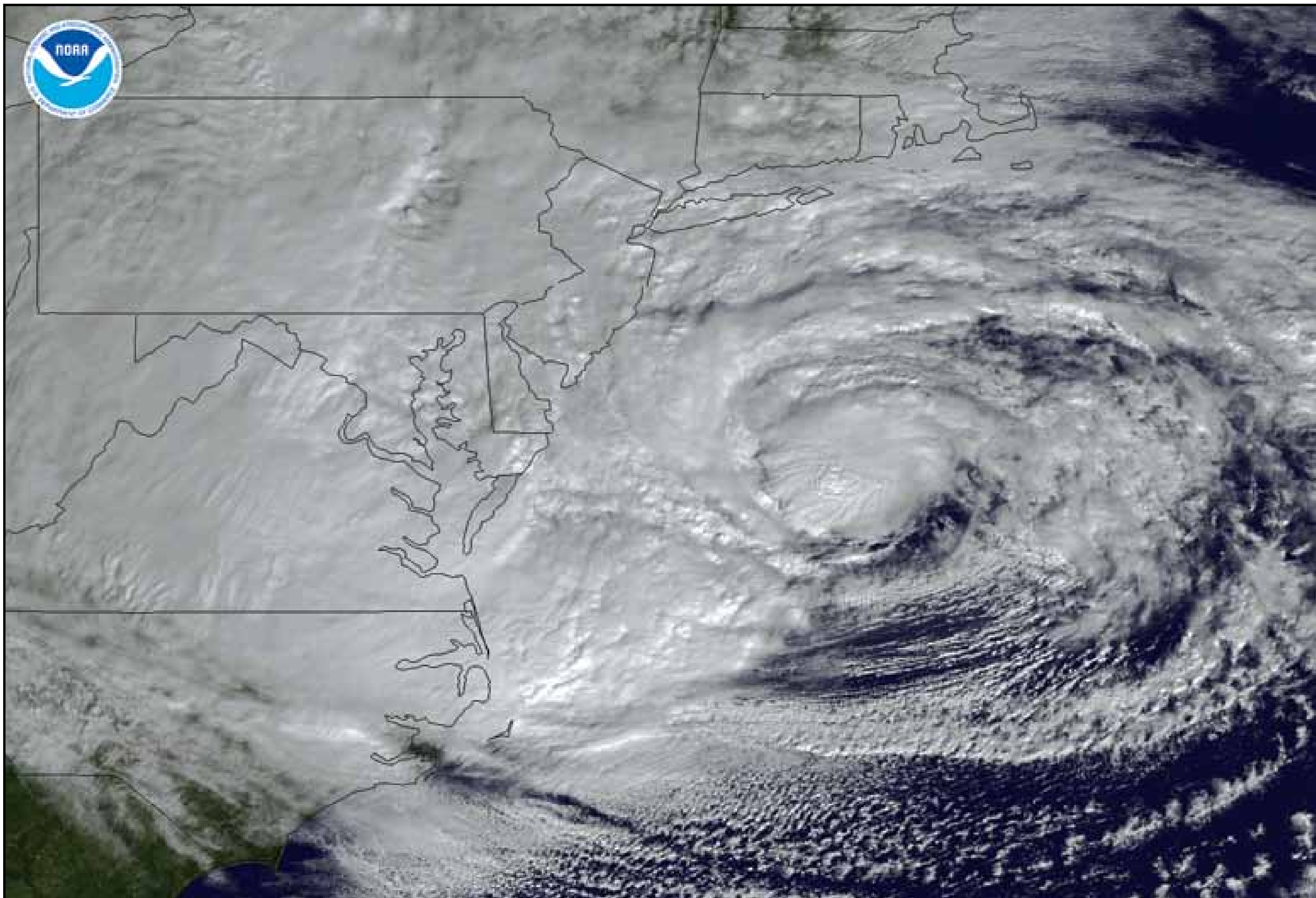
As we explore the topic of energy, it is important to consider how energy consumption and production impact our world and particularly how these activities impact our climate. The issue of climate change was barely discussed in the lead-up to the 2012 U.S. presidential election[1], but the aftermath of Hurricane Sandy brought it painfully back into focus. While no individual hurricane can be completely attributed to climate change, the contribution of rising sea levels to the destruction wrought by the storm is indisputable.

Politically, the time is ripe for a renewed discussion of climate change, but what is climate change exactly? With so much contradictory information and terminology present in the media, it is easy even for science, technology, engineering, and math (STEM)-trained individuals to be confused. For example, global warming is a large facet of climate change, but it is not the whole story. Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as "a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period, typically decades or longer." This means that the term encompasses any sustained alteration in the climate, not just warming.

The IPCC is a scientific body established by the United Nations to assemble current knowledge on the nature and impact of climate change. The IPCC presents this information in periodic assessment reports. In its most recent assessment report, "Climate Change 2007"[2], the IPCC identifies greenhouse gas emissions as the largest man-made or "anthropogenic" contributor to climate change. Human activities, such as driving a car or using a refrigerator, produce long-lived greenhouse gases like carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and halocarbons. These gases trap some of the radiant energy the earth receives from the sun, preventing it from being re-radiated out into space. The extent to which a gas or other factor affects the balance of energy entering and leaving the earth's atmosphere is called radiative forcing. Greenhouse gases have positive radiative forcing values, meaning that they keep energy trapped on earth, generally resulting in a warming effect. Each greenhouse gas differs in its radiative forcing due to its inherent ability to redirect energy radiated from the earth and its lifetime in the atmosphere. You may have heard of CO2-equivalents in the news. To simplify discussions of the combined effects of greenhouse gases on climate change, the concentration or emission of greenhouse gases are often standardized as CO2-equivalents based on a comparison of radiative forcing.

Two significant sources of CO2-equivalent anthropogenic emissions are agriculture and changes in land use that involve clearing and possibly burning vegetation. Agricultural pursuits release CH4 and NO2, in addition to CO2. Plants that are burned or left to rot release the carbon stored in their biomass as CO2. The emissions from these activities are not directly linked to energy consumption, but they do play an important role in trapping the sun's energy on earth. Entities on earth that remove CO2 from the atmosphere are called "carbon sinks." The largest carbon sink is the ocean, which can dissolve gaseous CO2. Vegetation is another carbon sink, the loss of which reduces the amount of plant life able to take up and convert CO2 into biomass[3].

The most significant source of CO2-equivalent anthropogenic emissions is the burning of fossil fuels. The term "fossil fuels" probably conjures images of crowded freeways and massive semi-trucks. Greenhouse gas emissions from transportation make up a considerable portion of total anthropogenic emissions (13.1 % in 20042). Despite efforts in developed countries to cut emissions, there was an increase in greenhouse gases released due to transportation during the period between 1990 and 2010[4]. Increasing the energy efficiency of motor vehicles plays an important role in decreasing these emissions. This, however, is not sufficient, as the largest contributor to anthropogenic greenhouse gas emissions is burning fossil fuels like coal for energy production. This means that even if we make cars that run on electricity, fossil fuels could still be used to generate that electricity.v Producing energy to power our daily lives inadvertently traps thermal energy from the sun that has dangerous consequences for the environment and for our well-being.



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According to Dr. Jacquelyn Gill, a Voss Postdoctoral Research Associate for the Environmental Change Initiative at Brown University, the deleterious effects of climate change are not always appreciated by the general public. A warmer climate may sound nice, with longer growing seasons and less severe winters, but as Dr. Gill points out, agricultural crops that depend on cold weather, like sugar maples, are particularly vulnerable to warmer temperatures. Agriculture at lower latitudes, where it is already warm, is also expected to suffer due to climate change. Increased temperatures are projected to alter ecosystems, shifting species' geographical ranges and likely increasing the risk of extinction for many plants and animals. The impact of climate change on our health is complex and will vary from region to region, but it is also expected to be negative. Water availability will change. Some regions will receive less runoff from snow pack and glaciers while other regions will experience heavier rainfalls and flooding[2]. Changes in the frequency and severity of extreme weather events will have a negative impact on our lives as we recently experienced with Hurricane Sandy. Climate change could even affect our security. Melting sea ice could make new routes navigable, creating a need to patrol coastlines that were previously inaccessible.

Even if sectors of the public believe that climate change is happening and that it has a negative impact on our lives, some of them are skeptical that human activities are driving climate change. Dr. Gill studies paleoclimatology. According to the National Oceanic and Atmospheric Administration (NOAA), paleoclimatologists investigate past climate conditions "before humans began collecting instrumental measurements of weather." This means that Dr. Gill and her colleagues rely on natural environmental records (such as the information stored in tree rings, fossils, glaciers and sediment) as proxy climate data to infer climate conditions present before direct measurements were possible[5]. Dr. Gill says that explaining the magnitude of the impact human activities have on the environment can be a challenge. She is commonly asked: if natural changes in climate have happened in the past, why should human activities be blamed for the changes we observe today? She explains that from ice core data we know greenhouse gas concentrations are higher now than they have been in the last 10,000 years and that their increase in concentration coincides with industrialization[2].

▶▶▶

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What if we go further back in time? Is there evidence that the earth's past climate experienced abrupt increases in temperature? Dr. Gill explains that approximately 55 million years ago, during the transition between the Paleocene and Eocene epochs, the earth experienced a rapid warming event with the average surface temperature increasing about 6 oC. This change had a profound effect on ecosystems: altering the geographical range of some species, while leading to the extinction of others. It was also accompanied by a release of greenhouse gases into the atmosphere, which reached a concentration similar to what will be reached as a result of anthropogenic greenhouse gas emissions projected over the coming century[2]. This was a natural occurrence that took place long before human intervention; however, it took place over the span of 10,000 to 20,000 years. If IPCC projections of climate change are correct, average surface temperatures could increase by as much as 6 oC by the end of the current century[2], a rate and magnitude of change unprecedented in history.

This all sounds pretty dramatic. A change in global temperatures and a release of greenhouse gases as described above would have dire consequences for life on Earth. How can we prevent it? Acting quickly is crucial because even if greenhouse gas emissions were stabilized, temperatures and sea levels are expected to rise for several centuries thereafter[2]. Societies can respond to climate change in ways that slow the rate and magnitude of the change, while preparing to cope with its inevitable negative outcomes. One key element to mitigating climate change is reevaluating our energy consumption and production. Reducing one's individual carbon footprint by limiting consumption and purchasing more carbon-neutral products is a possible first step. However, the largest source of anthropogenic greenhouse gas release is energy production, and solving this problem will require political intervention. Education and advocacy are essential to reducing greenhouse gas emissions. It is up to us to educate ourselves and others about the importance of climate change, and then to communicate what we have learned to lawmakers who could enact policies that curtail it. We have to act quickly and collectively to reduce the impact of the thermal energy that has been trapped on Earth during our quest to produce the energy that drives modern society. ■

A change in global temperatures and a release of greenhouse gases as described above would have dire consequences for life on Earth.

Resources

The resources listed below are excellent avenues for educating yourself and others about the causes and impact of climate change. Some of the sources include information aimed at multiple levels of familiarity with the subject matter. If you find yourself confronted with conflicting information about the origins or impacts of climate change, there is even a smart phone app ("Skeptical Science") that allows you to see what scientific evidence has to say on the subject6.

http://www.ipcc.ch/
The official website of the Intergovernmental Panel on Climate Change (IPCC) with links to its publications and data including Assessment Reports.

http://www.realclimate.org/
RealClimate is a moderated forum where working climate scientists provide commentary on climate science for journalists and the general public. Use the "start here" tab to view climate science information sorted according to the reader's previous knowledge of the subject material.

http://carboncycle.aos.wisc.edu
An educational website that explains the carbon cycle and discusses the various sources of CO2 emissions and carbon sinks.

http://www.ncdc.noaa.gov/cmb-faq/globalwarming.html
A report posted by the National Climatic Data Center of NOAA that answers frequently asked questions about global warming. Mostly, it is a brief synopsis of the IPCC 2007 Assessment Report.

http://www.skepticalscience.com/
A good resource for sifting through climate change science and its attendant misinformation.

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Cooking with the Sun

By Suzette Bienvenue

Image 1:
A solar Cook-It.

A photon released from the sun takes about eight minutes to reach the Earth. When the photon reaches Earth, it can be converted to stored energy or used to perform work. In the case of solar cooking, the focus is on the conversion of light energy to heat. The sunlight bounces off of a reflective material and is absorbed by a dark pot. The light energy is converted to heat that is trapped by a transparent covering. The simple physical principles applied in solar cooking can help bring desperately needed nourishment and clean drinking water to millions of impoverished people. Though not the first to use solar energy in this way, Barbara Kerr, in 1980, designed a cardboard box cooker kit that could be easily assembled at home. Her work inspired the creation of Solar Cookers International, which is one of the main non-profit organizations promoting solar cooking. This organization pioneered the introduction of a new type of cooking device, the panel cooker called the Cook-It. The simplicity and low cost of this invention made it a breakthrough. All one needed was cardboard, foil and heat resistant plastic. The Cook-It enabled solar cooking to spread through many poor countries where sunlight is plentiful, but natural resources are limited (Image 1).

More than half of the world's population relies on wood or coal to meet their most basic energy needs. Extensive wood gathering contributes to rapid deforestation of entire countries. The loss of forests causes flooding and soil erosion, resulting in further environmental degradation and thus increased poverty and hunger. In poor countries, the cost of cooking fuels can consume up to 30% of a families' daily budget. Solar cooking is a free alternative that allows families to spend money on food instead of fuel (Image 2).

Eliminating the need to gather wood for fuel is another valuable aspect of solar cooking. It is common for women to walk long distances searching for firewood and leaving them vulnerable. In the Iridimi Refugee Camp in Chad, solar cooking reduced firewood needs by 75% and kept women safer from the perils of the war-torn countryside (Images 3 and 4). To date, more than 90,000 refugees in this camp alone have benefited from solar cooking.

Solar cooking provides another set of health benefits for women. Without cooking fires, the dangers of burns, smoke inhalation and structural fires are minimized. And because it does not produce pollutants, solar cooking is an environmentally-friendly cooking method. In the third world, the most important use for solar cooking is water pasteurization. In places where preventable waterborne diseases like cholera and dysentery claim more than 3.4 million lives each year, this simple method of producing clean drinking water is a life-saver (Images 5 and 6).

Besides enjoying the health, safety and environmental benefits of solar cooking, women in developing countries have used it as an economic tool. Women have organized into cooperatives to teach the technique of solar cooking and have even used solar cooking as the cornerstone to build small businesses like bakeries (Images 7 and 8). It is only a matter of time until women worldwide recognize the benefit of solar cooking and advocacy for the spread of its use increases.

Even in a developed country like the United States, I have used solar cooking. First, it was a novelty, an interesting hobby for this food and cooking lover. Eventually, I began to use it as a teaching tool for young science students. As a classroom science teacher, I often sought practical examples of scientific principles I taught to engage my students. Knowing that all energy ultimately comes from the sun, I began to use solar cooking to help review physics. Solar cooking has proven to be a valuable hands-on activity that I use to demonstrate energy

Image 2: ***Groupings of food, each costing the same as the pile of charcoal in the middle.***

Image 3 (top): ***A refugee camp in Chad.***

Image 4 (bottom): ***Darfur.***

conversion, the greenhouse effect, conduction, convection and radiation to my sixth grade students. Each year, this project expands exponentially as students design and test their own cookers, vying for the bragging rights over creating the cooker design that achieves the highest temperature.

The inquiry and experimentation of the students leads to a marvelous learning experience about physics, engineering and materials. Capturing photons for heat transfer is the goal, but students unexpectedly find that they are also learning about other topics: geography, astronomy, nutrition, geometry and, at least once a year, the ignition temperature of cardboard (425 degrees F, for your reference).

My solar cooking experience has even redirected my career toward becoming an energy educator. At community events, I use solar cooking to represent the greenhouse effect as a means of engaging the public in conversations about greenhouse gas emissions and climate change. I was surprised by how many people were truly amazed that the sun could actually cook delicious food. I knew that I had them hooked, not only with the tantalizing smell of apple cobbler, but with the idea that everyone could cheaply harness the power of the sun to cook a meal. Solar cooking saves a small amount of money (anywhere from 20 to 60 cents per hour) by avoiding the consumption of fossil fuels and reducing the cooling costs associated with indoor cooking. By solar cooking, customers can save money and reduce carbon emissions. With adults, as with my sixth grade students, these demonstrations always lead to further discussions of social responsibility, energy conservation and sustainable living.

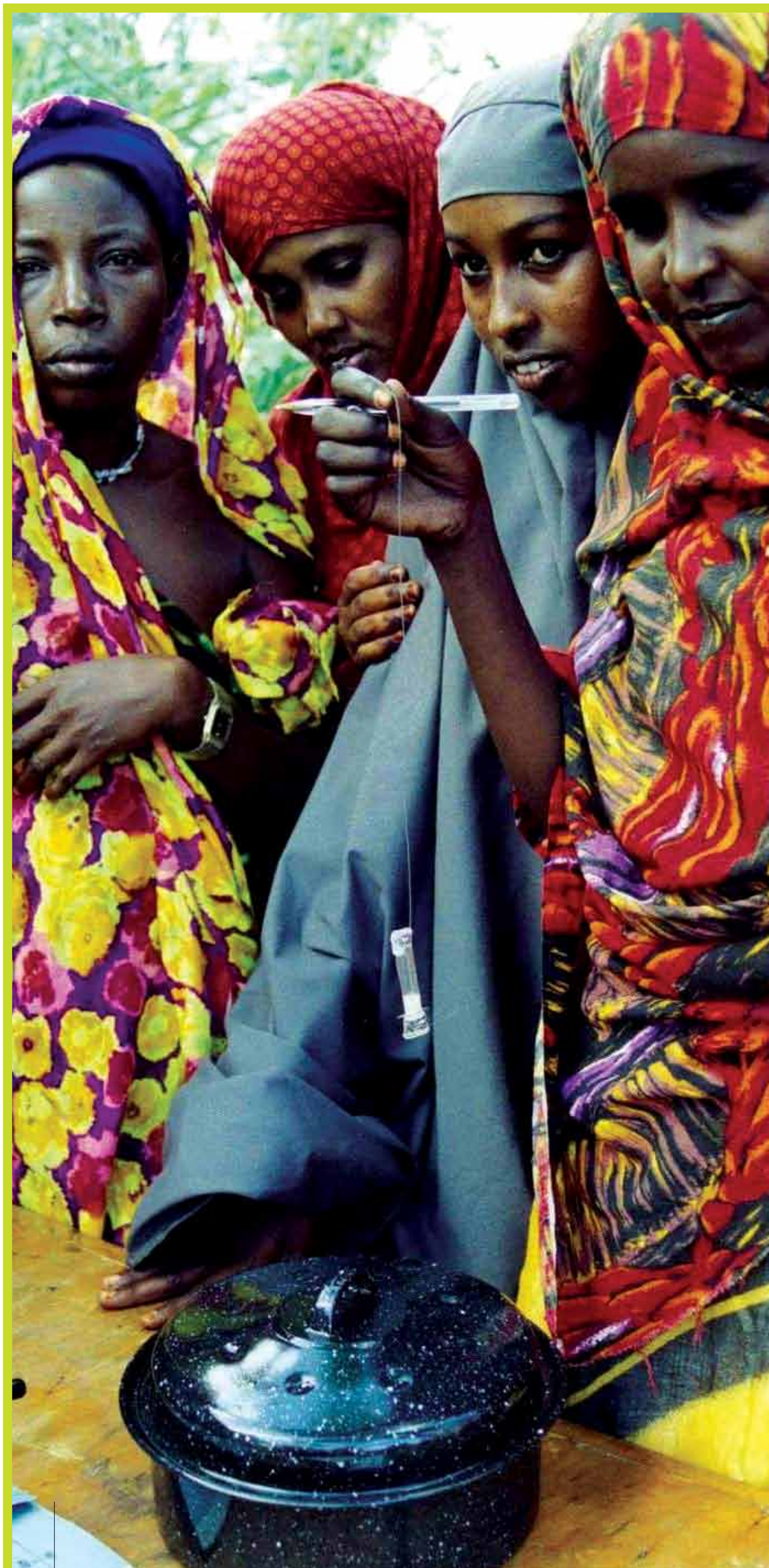

Image 5: ***Women using a WAPI (water pasteurization indicator) to test their water.***

Image 6: ***WAPI***

Image 7: ***Faustine Odaba in Kenya who runs a solar cooker cooperative.***

Image 9: ***Suzette cooking for Thanksgiving.***

At public outreach events, I eagerly address the misconceptions associated with solar cooking: that it is unsafe or that one needs to live in a hot region. I solar cook for my family all year long (Images 9 and 10). All one needs is two to four hours of clear, blue skies and access to direct sunlight. Of course the time required does vary with the type of cooker, the season and the cooker's latitude. Depending on the type of solar cooker used, cooking time is generally longer than conventional cooking, but it is nearly impossible to burn your food! Solar cookers come in many forms and varieties. Some expensive models can be purchased commercially, others can be made with recycled materials very cheaply, but what is common to all forms is that once purchased or assembled, there is no additional expense since the fuel, sunlight, is free. For information on food safety and general solar cooking information, visit: www.solarcookers.org.

While solar cooking may not be practical for everyday use in the United States, I have encouraged many groups to become passionate about solar cooking. For local foodies, solar cooking resounds well with the slow cooking technique. Solar cooking helps retain vitamins and keeps food moist. It is my desire to see solar cooking move beyond a hobby so that everyone who owns a barbeque will also have a solar cooker nearby, keeping their kitchen cool while they save energy. Outdoor enthusiasts also enjoy the benefits of portable solar cookers. They are perfect for camping, hiking and boating, bringing gourmet cooking and energy savings to the wilderness. The only caution is to never leave your food unattended, bears do love a good casserole.

Another practical situation for solar cooking is in natural disasters. Every family's emergency preparedness kits should have simple solar cookers stocked so that families can have access to clean water and the ability to cook food. I will continue to use solar cooking to teach that all energy comes from the sun, and we should do our best to harness it directly. This direct energy provides a free way to become less reliant on the "old" solar energy stored in oil, gas and biomass. Besides allowing humans to become less dependent on fossil fuels, solar cooking can also help save millions of lives and improve the well-being of women and children in at risk countries. It is my desire that people everywhere become more knowledgeable of solar cooking and the broad-reaching the benefits of this free energy. ■

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Solar Cookers International: 1919 21st Street, Suite # 101, Sacramento, California, 95811, USA

All statistics contained in the article come from the World Health Organization.
All photographs courtesy of Solar Cookers International and Jonathan Knox.
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Image 10: ***Stew cooked in Sacramento, CA – November 2012.***

Image 8: ***Women solar cooking in Kenya.***

Gone with the Wind

By Jaime Smith

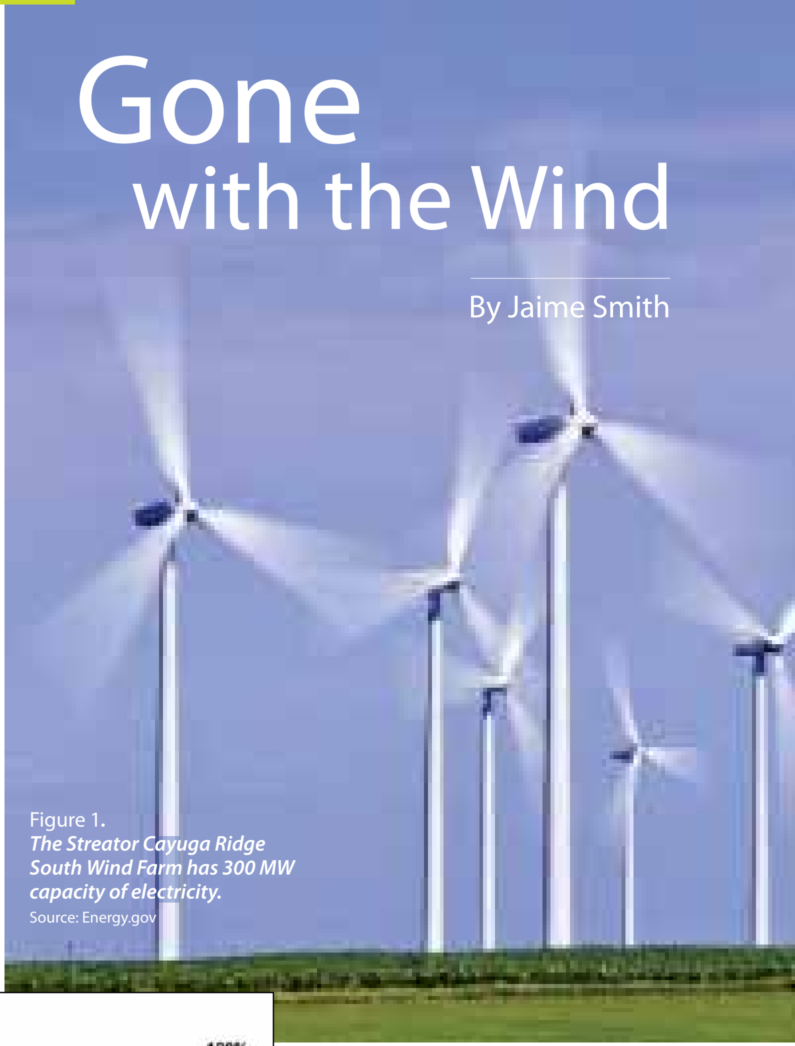

Figure 1.
The Streator Cayuga Ridge South Wind Farm has 300 MW capacity of electricity.
Source: Energy.gov

In a society with such a hearty appetite for clean, or "green," energy solutions, the winds of change are churning. Wind energy in the United States has increased at a rate of 25% per year over the last decade, and if this rate is maintained, 20% of all American energy will be derived from wind by the year 2030.[1] With electricity generation being the largest source of air pollution in a nation dealing with rising energy costs, the timing is ripe for a renewable energy option that is also cost efficient.[2]

Wind energy has been touted by climatologists, environmentalists, and some politicians as the next best thing in green energy solutions. So, what exactly is wind power, and is it the answer? Wind is a 100% natural source of power that has been around since the dawn of time. One can actually think of wind energy as a form of solar energy because wind is created as a result of uneven heating of the Earth's surface by the sun. As warmer air rises, cooler air moves in beneath it, and this movement generates wind.[3] With the proper technology, the kinetic energy associated with wind can be harnessed and converted to electricity. In this simplistic description, wind power seems to be a good solution, freeing our nation from dependence on oil and other harmful forms of energy.

Aside from being generated by a plentiful, natural source, wind energy is associated with numerous other advantages. Wind does not pollute the environment, nor does it contribute to global climate change with dangerous emissions of carbon dioxide.[4] Furthermore, not only is there tremendous potential to generate massive amounts of wind power using industrial turbines, but there is also great potential to generate smaller amounts of energy using single-home turbines. Just as solar panels have been installed on many American homes to reduce the environmental impacts of energy production, the installation of residential turbines is a real possibility that could lead to homes that are completely energy self-sufficient. Moreover, wind power is cost effective, and prices continue to decrease. After the initial technology is in place, power is essentially free.[4]

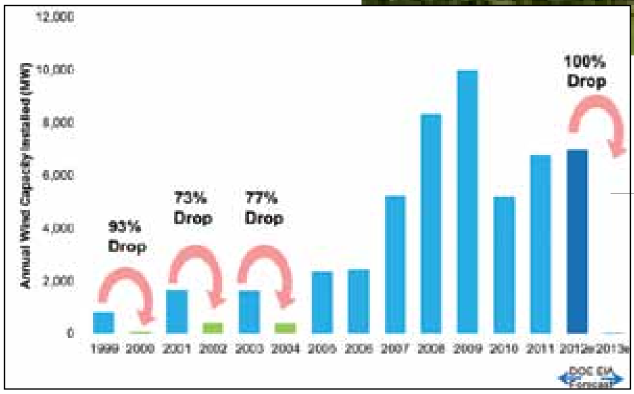

Figure 2.
Historic Impact of PTC expiration on Annual Wind Installation.
Source: EIA.gov (Energy Information Association)

So, what is preventing wind power from becoming the answer to America's energy demands? Some opponents of wind energy, such as the North American Platform Against Wind Power (NA-PAW), argue that there are physical limitations to wind. Moreover, even if wind could meet global energy demands, they argue it will contribute to climate change.[5] However, as recently as September 2012, research from climatologist Ken Caldeira and his colleagues at the Carnegie Institution for Science concluded that there is enough energy available from wind to meet the demands of the entire world.[6] In a study that examined geophysical limits of wind power and any potential effects on global climate, Caldeira stated, "Looking at the big picture, it is more likely that economic, technological or political factors will determine the growth of wind power around the world, rather than geophysical limitations."[6]

One political factor that could stymie wind energy production is the expiration of the production tax credit (PTC). The PTC, which had been in existence since 1992, was an incentive for green energy generation that allowed wind farmers to lower their tax bills, depending on the amount of energy they produced. The PTC had been renewed four times since its inception and allowed for the production of nearly 500 wind manufacturing facilities in 44 states.[7] When the credit had been allowed to expire on three previous occasions between 1999 and 2003, wind capacity nationwide plummeted.[7] If history repeats, the PTC expiration will stop wind production in its tracks and lead to myriad job losses.[7]

Following November's elections, those in the wind energy industry have reason to be hopeful for the future. Voters elected wind

power champions from both parties into office, including Representatives Dave Reichert (R-WA), Steve King (R-IA), and Tom Lantham (R-IA) and Senator Dean Heller (R-NV). With support for wind energy from the Obama administration, the American Wind Energy Association (AWEA) is optimistic about a PTC renewal.

The Women's Council on Energy and the Environment's 2009 Woman of the Year and Chief Executive Officer of AWEA, Denise Bode, said, "We're pleased to see the popular support we've always seen in polling validated by the election of so many champions of wind energy who've stepped out on our behalf, Republicans and Democrats. We heard a lot about wind energy in this election, and it proved to be a winning issue because it is so popular with the American people."[8]

However, there is a flip side to every coin. Those opposed to wind power and the extension of the PTC cite disadvantages to this renewable energy option. Eric Rosenbloom, of the American Wind Energy Opposition (AWEO), believes wind plants are not designed to sufficiently supply the grid. That is to say, wind turbines respond only to the wind, and when production drops, other conventional energy sources need to increase their output to the grid.[9] In Rosenbloom's view, this means that wind power could actually cause more burning of fossil fuels to supply energy during periods of unpredictable fluctuations.[9] Another disadvantage that Rosenbloom cites is noise. Those living near wind farms equate the noise emission from the turbines to that coming from low-flying airplanes or helicopters.[9] In recent years, turbines have been made quieter with better gears, but the generators still produce a low-frequency hum and throbbing vibrations that travel long distances.[9] The National Wind Coordinating Committee (NWCC) recommends that wind turbines be erected more than one-half mile from any residential dwelling.[9]

One of the loudest voices of opposition to wind energy comes from the bird advocates. The U.S. Fish & Wildlife Service (USFWS) estimates that almost a half-million birds are killed each year by collisions with wind turbines.[10] In comparison, estimates are in the hundreds of millions of birds per year killed by collisions with buildings, planes, or altercations with domestic and feral cats, according to USFWS.[10] That aside, AWEA has expressed support for USFWS's land-based Wind Energy Guidelines released in March 2012 that hold wind energy to a higher standard for wildlife protection than any other industry nationwide.

Having recently experienced the wrath of Hurricane Sandy along the East Coast, many Americans find themselves contemplating the full effects of climate change and how clean energy options might ease this burden. Caldeira and former Microsoft executive Nathan Myhrvold conducted a study asking the question: What effect will clean energy alternatives have on global temperatures? They found that "achieving substantial reductions in temperatures relative to the coal-based system will take the better part of a century and will depend on rapid and massive deployment of some mix of conservation, wind, solar, nuclear, and possibly carbon capture and storage."[11]

In other words, we desperately need anti-carbon energy alternatives, we need them now, and wind is a solid option. ■

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Bio-Energy for the 21st Century and Beyond

By Heather R. Luckarift

The explosive growth in the world's population over the last 50 years (Fig. 1) parallels with an equally explosive increase in the demand for energy, which cannot be sustained by the finite supplies of conventional fuel sources (such as petroleum and fossil fuels). While natural gas, coal, and oil still account for more than 80% of the world's energy consumption, renewable energy technologies that capitalize on the Earth's sustainable resources are beginning to play a significant role in energy production (Fig. 1, inset). Examples of such renewable energy sources include solar energy (photovoltaic "solar" panels), wind power (wind turbines), hydropower (waterwheels and hydro-electricity derived from dams), and the use of natural biomass as fuel.[1,2]

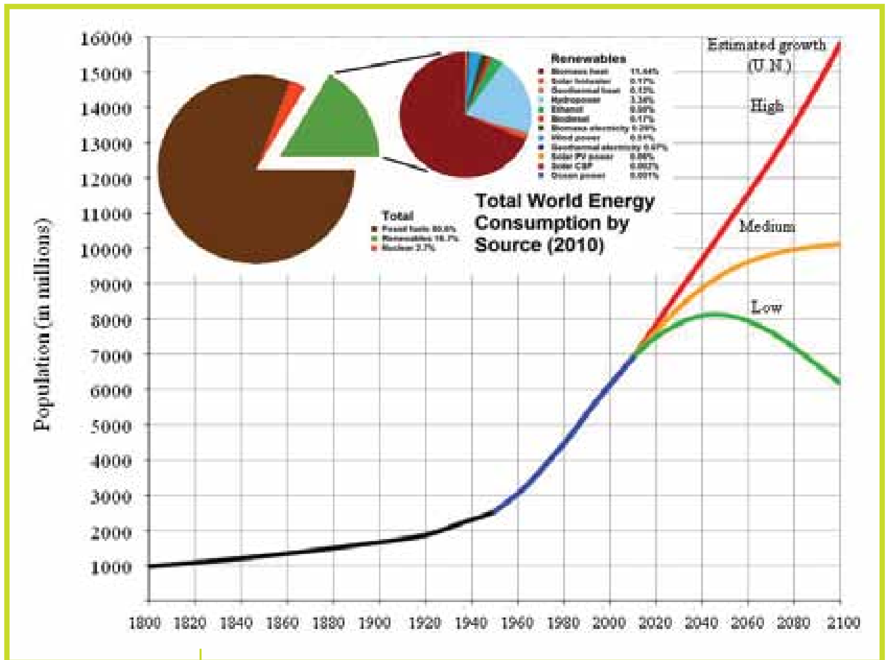

Figure 1. ***World population estimates from 1800 to 2100, based on 2010 projections provided by the United Nations and US Census Bureau historical estimates. Inset: Total energy consumption by source, 2010.***
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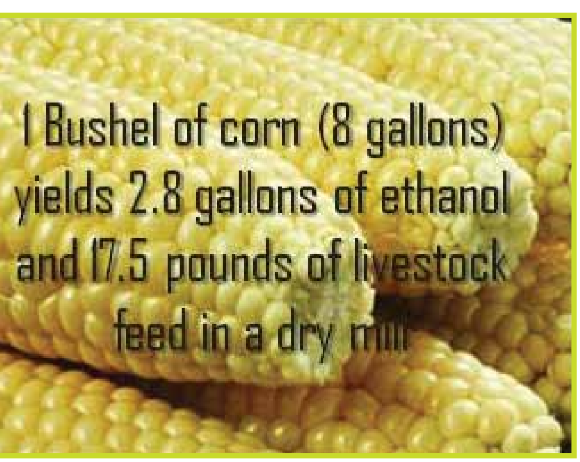
Biomass (including trees, plants and grasses) is, theoretically, a carbon-neutral fuel; in other words, carbon–in the form of carbon dioxide–is fixed through photosynthesis and used for growth. The carbon is then returned to the environment–again as carbon dioxide–during combustion. The use of biomass for energy production in this way is certainly not new; wood burning was the primary source of energy long before the Industrial Revolution and in many developing countries, remains a significant source of fuel for heating and cooking.

Furthermore, the cellulose in plants (typically sugarcane and corn) can be converted to usable forms of energy and used in transportation fuels. Biodiesel, for example, can be blended with conventional diesel (up to about 20% biodiesel by volume) without requiring modification of standard diesel engines.[3] Most people are aware of the recent inclusion of ethanol in automobile-grade gasoline. In fact, much of the gasoline in the United States is blended with ethanol that is derived from biological processes.[4] The process uses a combination of fermentation (similar to making alcohol in beverages) and heat to break down starch and sugar in plants. Using this process, one bushel of corn yields approximately 2.8 gallons of ethanol.[5]



Brazil is one of the world's largest producers of bio-ethanol (after the United States).[6] The success of Brazil's sustainable biofuel program is based in part on the use of sugarcane as a plentiful and inexpensive feedstock. Production is also very efficient as waste from sugarcane processing (known as bagasse) is used to produce heat and power.[6]

Most gasoline in the US today is mixed with approximately 10% ethanol, but an increasing number of vehicles in the U.S. are now marketed as using "flexible-fuel," which means that these vehicles can use ethanol:gasoline mixtures with up to 85% ethanol (E85; not to be confused with the 85 octane rating, which is a measure of fuel performance).[7,8] This ability allows consumers to select fuels based on fluctuations in price and availability. The regional retail price for E85 fuel varies across the U.S., with lower prices in the Midwest region due to proximity to regional corn crops and ethanol production facilities. There is still limited infrastructure for the widespread use of such flex-fuels. There are currently about 3,000 gas stations in the U.S. that sell E85, with the majority concentrated in the Corn Belt States.[9] The Obama Administration, however, has set the goal of installing 10,000 E85-compatible fuel pumps nationwide before 2015.[10]

The localized availability of biofuels produced from crops demonstrates one of its primary disadvantages; a significant quantity of land is required for crop growth. Crop growers then face competition between the ever-increasing demand for fuel and the ever-increasing demand for food. In recent months, drought has severely limited the growth of grain crops, and as a result, the price for corn has increased by over 60%, with subsequent increases in the price of both food and fuel.[11] Since regular fuel is 10% ethanol (made from corn), the food industry and the automobile industry are competing for the same grain. The meat in chicken sandwiches and hamburgers comes primarily from animals that are corn-fed. As a result, certain fast-food chains are fighting against the push for increased biofuel production because this means an escalating effect on the price of grain.[12]

As an alternative, biofuels can be produced from algae. Algal species are diverse, ranging from unicellular organisms to multicellular plants (such as kelp and seaweed). Algae assimilate carbon dioxide through photosynthesis (in the same manner that plants do), but they do not require fertile soil or fresh water for growth. As a result, algae grow in oceans, lakes, rivers, and wastewater streams, provided that sunlight is available (Fig. 2).[13]

Figure 2. ***Algal blooms in a freshwater stream (left panel) and as "red tide" in seawater (right panel).*** Adapted from images in the public domain.

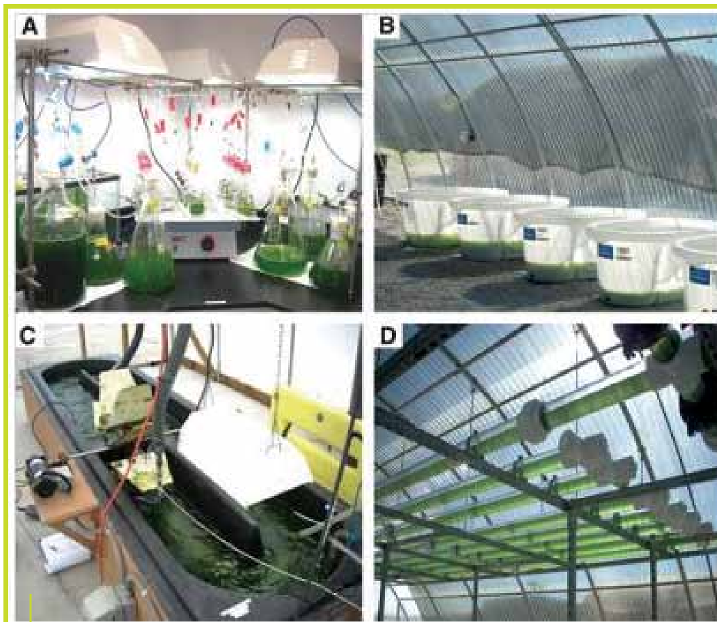


Figure 3. ***Aquatic and marine species of algae at various culturing scales, demonstrated at the Air Force Research Laboratory, Tyndall Air Force Base, Florida: (A) Bench top flasks (50–2,000 mL); (B) Open pond reactor (~50 gallons); (C) Open raceway pond (100 gallon); (D) a prototype photobioreactor (300 gallon).***

Production of algae for oils and energy conversion has primarily focused on species of Cyanobacteria. The growth rate of algae in large-scale industrial bioreactors is significantly faster than the growth rates of agricultural crops (Fig. 3).[14]

Algae contain energy-dense storage compounds, such as long-chain fatty acids, that can account for up to 80% of their cell weight. These energy-dense oils can be extracted and converted to biodiesel.[15] This technology shows tremendous promise and research is now being driven to establish an efficient, reliable, and cost-effective process for algal biofuel production. The U.S. Department of Energy estimates that it would require only 15,000 square miles (less than 0.5% of US land) to cultivate sufficient algal biofuel to replace all of the petroleum fuel in the United States.[16] In 2011, a Continental Airlines Boeing 737 became the first American plane to fly passengers while using biofuel derived from algae. The airplane did not require any modifications in order to use the fuel, and the cost of the biofuel was reportedly the same as regular jet fuel.[17] Many commercial airlines, including Alaska Airlines, have since incorporated biofuel and biofuel blends into their operations.[17]

Many species of algae (and some bacteria) can also be manipulated to produce hydrogen as a fuel, but several biological and engineering challenges must be overcome before this promising technology becomes a practical reality. One disadvantage of biohydrogen (and hydrogen as a fuel in general) is that the

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Figure 4. ***A microbial fuel cell operating in seawater (Developed by the Air Force Research Laboratory and the US Naval Research Lab).***
Source: Heather Luckarift.

fuel is not easy to store or ship. Hydrogen must be compressed or liquefied, and currently that process can require more energy than the fuel itself contains.[18]

Bacteria can also be used to derive power in microbial fuel cells. A typical microbial fuel cell consists of anode and cathode compartments akin to a conventional battery. As bacteria oxidize organic matter, electrons are produced and run from an anode to a cathode within the device to create an electric current. Such microbial fuel cells can be used to generate electricity from wastewater, specifically downstream of industrial processes, such as food processing and brewing.[19] This technology has developed to where practical applications are now being realized. In our own work for the Air Force Research Laboratory, we have demonstrated that microbial fuel cells are able to generate autonomous power in seawater (Fig. 4).[20] Similar research shows microbial fuel cells that can power sensors for monitoring environmental parameters and a robot that turns sewage into electricity![21,22]

Energy from biology is a promising technology, but long-term development and cultural changes will be required for biofuels to completely replace our current demand for existing fuels. The U.S. Department of Defense is currently one of the world's biggest users of oil, and the "military biofuels initiative" proposes a shift to biofuels. The U.S. Navy and U.S. Air Force have both committed to introducing 50/50 biofuel blends by 2020. The military's stance on using biofuels, along with an increasing acceptance of biofuels as a viable energy source, could help transform the way our nation thinks about energy.

Biofuels can pave the way to a future of sustainable energy supplies, but ultimately, combinations of renewable energy technologies, changes in the way we think about energy recycling, and improved infrastructures will be needed to satisfy future energy demands.

The viewpoints discussed within this article are solely those of the author and do not reflect opinions of any employer or affiliated organization. ■

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Walk out to your garage or the street outside your home, key open the door to your owned or rented vehicle, buckle up, and start the engine. If you're lucky, you can reach your destination at a rate of less than a mile per minute, a feat of which early Americans could only dream!

Most of us drive internal combustion engine (ICE) vehicles that run on some form of fossil fuels, but chances are you are at least familiar with the concept of "green" cars like hybrid and electric vehicles (EVs). Rising fuel costs, concern over foreign energy dependence, climate change, technological developments and government support have come together in recent years to make the transportation environment ever friendlier for hybrid and electric vehicles. In fact, 2012 was deemed "The Year of the Green Car" by Auto Analyst Alan L. Baum and Luke Tonachel, a senior analyst from the Natural Resources Defense Council,[1] due to record high sales of fuel-efficient vehicles and developments in the auto industry.

Our currently ubiquitous ICE cars are the victor of a survival-of-the-fittest race that happened over a century ago, beating out electric and steam vehicles. The fact that our roads are dominated by gas-powered cars today was not a foregone conclusion in the past, and judging from current trends, may not be a given in our future, either. As these "alternative" vehicles begin reaching for increasingly larger pieces of the American transportation pie, are we ready to accept them as more than just novelty products? Let us take a joyride down the bumpy roads traversed in our never-ending search for balance between mobility, economy and environmental consciousness, and follow the development of electric vehicles from the very beginning of the American auto industry into the unknown of our transportation future.

The Automobile: The Early Days

Imagine a chunky horse-drawn carriage with large wooden wheels beneath a boxy body, a seat for the driver and a manure-producing horse leading the way. Now take away the horse, put a clunky gas or steam engine or a large lead-acid battery under the carriage to drive the wheels and install a steering system for the driver. This is what the first substantial vehicles that graced American soil looked like.

European engineers busily developed, patented and produced various types of self-propelled vehicles in the 1880s. Here in America, William Morrison constructed a six passenger electric carriage in Iowa in 1891.[2] The Duryea brothers of Massachusetts built Duryea "motor wagons" in 1893 and 1894, and spearheaded American auto production with their 13 gasoline powered "wagons" in 1896. Henry Morris and Pedro Salom unveiled their first electric carriage, the Electrobat, in Philadelphia in 1984,[4] and would go on to found the Electric Vehicle Company and later create New York's first taxicab fleet.[3,4]

As individual inventors and engineers began promoting their horseless carriages, the first American auto companies were born. The life of the auto company was not an easy one; the needs of the public determined their success. In the 1890s to 1900s, road conditions were poor, transportation options were limited and the streets of big cities were "awash with horses, urine, manure and flies."[5] With these factors in mind, the budding automotive industry attempted to woo the public with a smorgasbord of new-fangled horseless vehicles with different attributes. Steam-powered vehicles were fast but hard to operate and required constant fueling with water.[5] Early gas-powered ICE vehicles allowed for greater travel distances but were smelly, noisy and hard to start. ICE vehicles were also dangerous, as operators were known to break their arms when starting the vehicles manually using hand cranks; early commentators predicted their failure in the market.[5,6] Electric vehicles were quiet, clean and safe, but often slower, limited in travel range, and more expensive.[3,6] At the time, there was no clear indication that any vehicle type would eventually come to dominate the national, and indeed global, transportation market.[3,5] Electric cars were actually the crowd favorite. Of the 4,200 automobiles sold in 1900, less than 1,000 of them were powered by gas.[6] By 1904, a third of all horseless vehicles in the cities of New York, Chicago and Boston were electric.[3]

Carriage Wars: Why Early Electric Cars Lost the Race

Early electric vehicles experienced a golden age in the early 1900s, but several key issues caused the public to become increasingly reluctant to use them. While electric vehicles could make the 50 mile trip between Boston, MA and Providence, RI without running out of battery power, this was not the case for longer trips. Great roadways were being built by 1914, highlighting the lack of charging stations between cities such as New York and San Francisco. With no existing electric grid for the quick installation of charging stations, a vicious cycle started: charging stations were not built due to the lack of electric vehicle buyers, and consumers were reluctant to buy the cars due to the lack of charging facilities. In contrast, the abundance of fossil fuels, especially after the discovery of oil in Texas, made powering ICEs easy and seemingly almost free.[3]

Developments in ICE vehicle technology also began to eat

Driving the Future:

The Evolution of Hybrid and Electric Cars

By Vania Cao

Charging Station.
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away at the desirability of EVs, especially after the advent of the electric starter in 1912. With the danger of operating ICEs lessened, EVs began to recede from popular demand, taking up the reputation of a lady's car or a luxury for comfort and leisure.[3] Henry Ford's famous assembly-line put the final nail into the electric vehicle's coffin. After he inundated the market with affordable gas-powered cars, the internal combustion engine took over as the dominant automobile.[5] During World War II, the use of electric vehicles increased due to the shortage and consequent rationing of gasoline,[3] but they never regained the popularity of their heyday in the 1920s.

After the American economy recovered from the Great Depression of the 1930s, concerns about conserving fuel were low. Oil was cheap and easily had; ICEs in turn developed to emphasize speed and power, shaping American expectations for their automobiles. In 1956, the Interstate Highway System was established and kick-started American romanticism of the open road, raising the bar for vehicle range and reliability. It took until the Clean Air Act of 1963 for the electric vehicle to return to the public conscience as an example of environmentally clean transportation.[3,5]

The main theme for electric vehicles has always been this: as long as gasoline was cheap and easily available, electric vehicles were doomed to live in the shadow of the ICE. However, new pressures and innovations began to favor electric and electrified cars, especially after the price of gasoline skyrocketed during the 1973 Oil Embargo. In 1975, Congress passed the Corporate Average Fuel Economy (CAFE) bill requiring auto manufacturers to increase the fuel economies of their fleets.[7] This international fuel crisis triggered American concern over energy resources and helped stimulate a national drive toward reducing dependence on foreign oil and investing in alternative energy sources.

In recent times, fuel prices have reached the 3-5 dollar per gallon range, and consumers are increasingly more receptive to high fuel-efficiency vehicles. Alan Baum, principal of Baum and Associates and a market researcher specializing in the automotive industry and fuel economy, has seen consumers become more inclined to take the price of fuel and a vehicle's fuel economy into consideration. "The auto industry has become supportive [of increased fuel economy] because the consumer has become supportive," he said. "Of course, that's abetted by the fact that regulations are going in that direction."[8]

The Toyota Prius hybrid was aggressively marketed to the American public in 2000, and by 2008, its worldwide sales topped 1 million.[6] Zero emissions all-electric cars have become more fashionable as well; the Nissan Leaf, introduced in 2010, won the 2011 World Car of the Year, and the Tesla Model S was named the Motor Trend Car of the Year for 2012.[6] The popularity of these and other electrified vehicles are a sign that more attractive alternative fuel vehicles will appear in the near future!

Reemerging Electrified Cars: Trends and Challenges

Modern hybrid and electric cars are a far cry from their early 1900 ancestors. For example, a 2010 Chevy Volt charges from house current in 8 hours, and drives silently and smoothly with instant-on torque.[6] The advent of computer technology has made electrified cars easy to operate and manage, and with the help of computers, their driving range has stabilized at around 100 miles per charge. The heart of all electric cars -- the battery -- has evolved. Lead-acid and nickel-metal hydride batteries no longer have a monopoly on all electrified vehicles; the lithium ion battery is becoming the industry standard for plug-in vehicles.[6] As batteries are the most costly component of an electrified vehicle, increasing their capacity and lowering their cost have been vital to making the entire class of vehicles more affordable for the average consumer.

As with most markets, demand and supply of electric vehicles are linked in a cycle that feeds upon itself. The early electric vehicle suffered from lackluster sales partly due to concerns stemming from the lack of widespread charging stations. So called "range anxiety" is still present today; there are only about 5,000 public charging stations around the country, nothing compared to the existing 150,000 gas stations feeding the bulk

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Fuel Efficient Vehicle Schematic.
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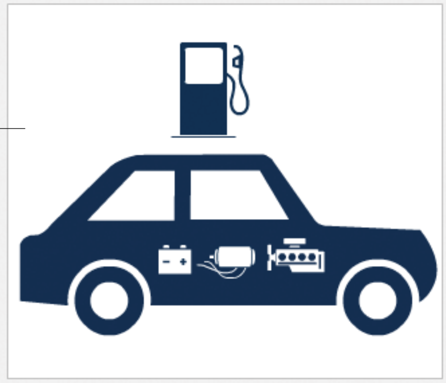

Fuel-Efficient Vehicle
Most hybrid electric vehicles have an internal combustion engine and electric motor. These vehicles are powered by an alternative fuel or a conventional fuel, such as gasoline, and a battery, which is charged by regenerative braking.

of America's current fleets.[9,10] Baum pointed out that range anxiety sounds worse than it is. "What we've found is that range anxiety tends to dissipate once people actually have the [electric] vehicle," he said. "But that's only for people who've actually purchased the vehicle; you need to have these charging stations in place so people can get over the range anxiety enough to buy the vehicle."[8]

Electrification Incentives and Infrastructure

The success of the modern electric car will depend greatly on the existence of a supportive infrastructure. Through various efforts, the number and availability of charging stations for electric and plug-in vehicles is steadily growing,[9] and Baum[8] noted that pockets of the country are coming "online."

The federal government has indeed been playing an important role in backing the electrification of America's cars. Starting in 2005, federal tax credits have been awarded for hybrid vehicles purchased between December 31st 2005 and December 31st 2010, and plug-in hybrid and electric vehicles bought in or after 2010.[11]

The Department of Energy (DOE) has devoted much of its resources to vehicle electrification and infrastructure efforts. "After battery cost, infrastructure is the single biggest hurdle," said Patrick Davis, vehicle technologies program manager at the DOE. "Because we have an existing infrastructure for gasoline and diesel, any new technology coming on the market has to deal with the infrastructure challenge."[12] Davis added that other electrification issues that the DOE has been addressing include lowering the cost of critical technologies such as batteries, building permits for installation of charging equipment, policies that incentivize electric cars such as specialized parking and HOV lane access, and training for officials and first responders to handle electric drive infrastructure maintenance and emergencies.[12]

The Energy Independence and Security Act of 2007 and the Recovery Act of 2009 spurred technological developments and clarified energy policies friendly to electric vehicle usage. The Recovery Act included a $400 million Transportation Electrification Initiative to promote the adoption of electric vehicles, with a goal of installing over 20,000 individual charging stations around the country and deploying 13,000 electric vehicles in the largest demonstration of electric cars in the world.[12,13]

The Road Ahead for Hybrid and Electric Vehicles

Arguably one of the most important technological inventions of the last century, the ICE has become so much a part of our everyday lives that we rarely think about what life would be like without it. The gasoline-powered automobile has shaped lives, economies and countries, but as the needs and concerns of the market change, electrified cars are rising once again. Although history has shown us how popular they can be, perhaps we have yet to see the real golden age of electric cars as we head into a world that is ever hungrier for energy.

"Electric drive is very important," said Davis. "There is essentially no drive system more efficient than electric, so it doesn't really matter what kind of electric drive you're talking about: these are the choices we have to get the most efficient vehicles on the road, to reduce petroleum dependency, and reduce greenhouse gas emissions."[12]

Is there going to be yet another winner-takes-all fight between gasoline and electrified cars? Baum thinks not. "All of these vehicles, including the regular ICE, including diesel engines, [including electrified vehicles], will meet consumer's demands, because consumer's demands are different," he said. He believes that the ICE will remain the primary share of the market since they are also improving in fuel economy, but over time, more hybrids, plug-ins and battery electrics will be needed to meet fuel economy standards. He scoffs at predictions that these alternative fuel vehicles are just a temporary fad based on current sales volume. "Have some of the automakers made projections that they weren't able to meet?" he asked. "Absolutely. Does that mean they will abandon the technology? No."[8]

This past summer, the Obama Administration unveiled a strict new average fuel economy standard: by 2025, the average car and light truck is expected to have a fuel economy of 54.5 miles per gallon, double the efficiency of vehicles made in 2008.[14] This will make light-weight, turbocharged engines and especially battery innovations the focus of future vehicle electrification developments.[12]

"In 5 years, we've reduced the cost of battery technology by 50%, from about $1,000/kilowatt hour to about $500/kilowatt hour now," said Davis. "In the next couple of years we'll reduce it to about $300/kilowatt hour. The cost of batteries is coming down, and that's going to be huge…to get cost competitiveness where it needs to go."[12]

Some may wonder: with all the impetus for greener technology, are we going to eventually see the death of the ICE car?

"There's no doubt that electrification is not only important but the trend of the future," Davis said. "I think it's easy to say electrification will be much more prevalent in the market than it is now, if not dominating [the market], but it's just hard to say in what time frame that will happen."[12]

Baum is optimistic that in the future, electric vehicles as well as other alternative cars will make the ICE less dominant, especially as the demand for energy around the world increases.[8] "Frankly, a lower fuel cost is the auto industry's biggest nightmare," he said, "because they have committed to this improvement in fuel economy, and it requires fuel prices to be at or above where they are today. If fuel prices go to a $1.50 per gallon, they're [in trouble] because that's not the world they're planning for." ■

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Plug-ins, hybrids, battery-electrics. What does it all mean?

Take a quick look and breakdown the jargon, starting with the vehicles that are closest to the pure internal combustion engine cars with which most of us are familiar.[3,5,6]

Conventional Hybrid is a concept harking from the days of Ferdinand Porsche's Mixte hybrid of 1901. These vehicles improve gasoline fuel economy by having two power sources onboard, relying mostly on their gas engines and using their electric batteries as a secondary source for power boosts. The batteries on hybrids are recharged during driving and regenerative braking, and although they will lose some charge capacity over time, they are meant to last the lifetime of the vehicle. The Toyota Prius was the first hugely popular hybrid vehicle to hit the American market, and since then, more automakers are offering hybrid versions of their vehicles. Some of these now also allow drivers to switch to pure electric power during low speed driving, but the ICE engine is the primary driver, making them less "green" than some may think.

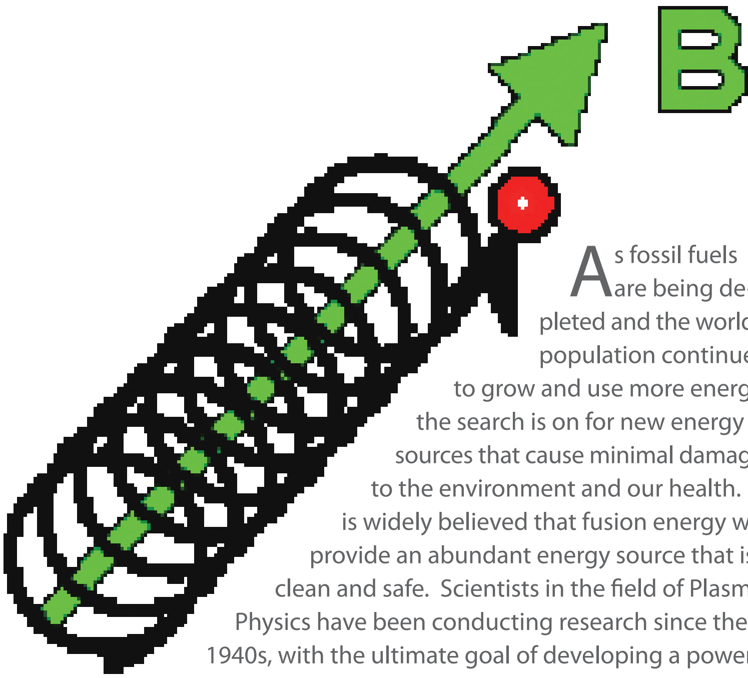
Plug-in Hybrids are a little greener and the next step closer to an all-electric vehicle. Plug-in hybrids also have both an electric and gas motor, but the electric motor is the primary driver, while the gas engine usually acts as the backup. Plug-ins can run like a fully electric vehicle for a certain number of miles, after which they switch to the ICE to either drive the wheels (Toyota Prius Plug-in Hybrid) or act as a generator to replenish the battery power (Chevrolet Volt). True to their name, these cars must be plugged-in to recharge their batteries to full capacity. If their battery power is fully depleted during operation, plug-in hybrids can fall back on their gas engines, operating like "regular" hybrids.

Battery Electric Vehicles are the greenest vehicles available as far as tailpipe emissions are concerned. These cars rely on electric power alone to power their motors, and like any smart phone or laptop, they need to be plugged into the local electrical grid once their batteries run out to replenish their power. Currently, colder temperatures and running accessories like lights and A/C will reduce vehicle travel range per charge, but onboard computer technology works to conserve range depending on the terrain. These cars have 70% fewer moving parts than cars with gas engines, meaning less regular maintenance for the owner, but since they are still relatively niche products, some claim they are more costly to maintain and repair. A few examples of battery electric vehicles include the Nissan Leaf, the Ford Focus Electric and the Tesla Model S.

Fusion: Harnessing the Power of the Stars

By Amy Keesee

Interviews with Women of Achievement Working in Plasma Physics



Gyromotion of a charged particle around a magnetic field line.
Source: http://tempest.das.ucdavis.edu/pdg/ECE/index.html

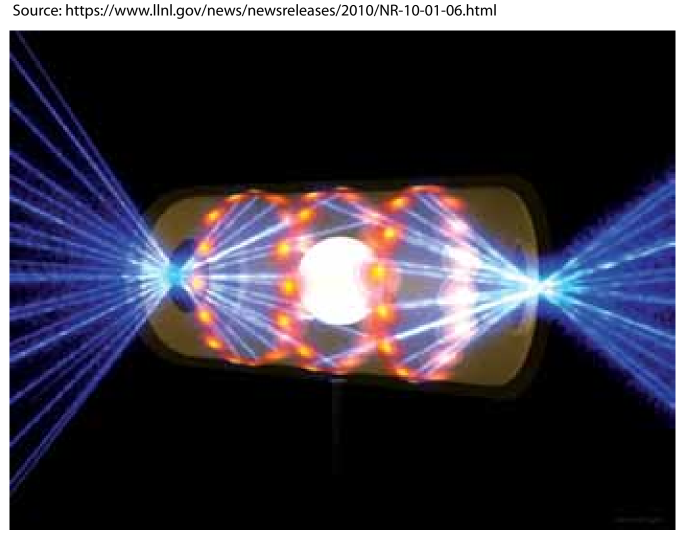
As fossil fuels are being depleted and the world's population continues to grow and use more energy, the search is on for new energy sources that cause minimal damage to the environment and our health. It is widely believed that fusion energy will provide an abundant energy source that is clean and safe. Scientists in the field of Plasma Physics have been conducting research since the 1940s, with the ultimate goal of developing a power plant model that can be commercialized. However, the field still faces significant hurdles in realizing this goal.

In contrast to a fission reaction where heavy elements, such as uranium, are split apart, a fusion reaction involves forcing together light elements, such as hydrogen and helium. The difference in mass between the before and after states is converted to energy through Einstein's famous equation, E=mc2. Fusion is the source of energy that powers the stars, including the sun. Of course, it requires massive amounts of energy to overcome the Coulomb force that typically keeps the particles apart from each other. In order for fusion to occur, the particles are subjected to temperatures of hundreds of millions of degrees Celsius. The gravity of the incredible amount of mass that makes up a star forces these particles together in the star's core. Here on Earth, scientists are pursuing two paths towards fusion reactions for energy production: magnetic confinement fusion and inertial confinement fusion. Each type of confinement serves to prevent the plasma from touching the cold walls so the particles are able to achieve the high temperatures necessary for fusion.

As atoms are heated to the extreme temperatures required for fusion, they become ionized (at least one electron is stripped from the atom). The fusion reaction that is most promising occurs between the heavy isotopes of hydrogen, deuterium (hydrogen with one proton and one neutron) and tritium (hydrogen with one proton and two neutrons). A collection of ions and electrons is called plasma, the fourth state of matter. Because ions and electrons are charged particles (negative charges for electrons and positive charges for ions), they will be tied to magnetic field lines due to the Lorentz force. This force acts on charged particles moving perpendicular to the magnetic field in a direction that is perpendicular to both the particle motion and the magnetic field. Thus, the particles move in circles (gyrate) around the magnetic field lines. Because of this property, plasma can be trapped by a magnetic field, hence the term "magnetic confinement."

A variety of magnetic confinement devices have been studied. Some devices are linear, but most devices have a chamber in the shape of a torus (donut). Because the Lorentz force only acts perpendicularly to the magnetic field, particle motion parallel to the axial magnetic field can lead to losses at the ends of a linear device where the particles collide with the walls and become cool. A helical magnetic field confines plasma in a toroidal device. The International Thermonuclear Experimental Reactor (ITER-pronounced "eater") is a large toroidal experiment under construction in France that will enable the development and testing of the technical components required for a commercial fusion reactor.

Artist's sketch of NIF laser beams entering a hohlraum containing a target pellet (white circle).
Source: https://www.llnl.gov/news/newsreleases/2010/NR-10-01-06.html



Dr. Elena Belova is a research physicist at Princeton Plasma Physics Laboratory. Her research uses computer models to improve our understanding of the physics of magnetic confinement devices. In 2005, she received the Katherine Weimer Award from the American Physical Society Division of Plasma Physics. This award "recognize[s] and encourage[s] outstanding achievement in plasma science research by a woman physicist in the early years of her career." I had the opportunity to ask her about her research in the area of magnetic confinement fusion.

Q: What are the major obstacles/challenges to using magnetic confinement fusion for commercial energy?

A: Developing materials suitable for fusion reactors has long been recognized as one of the major challenges. Materials are needed that can withstand the products of the fusion reaction. Methods of keeping the burning plasma from damaging its surrounding walls and extracting fusion energy from it need to be developed. These challenges have to be met safely and reliably, while simultaneously keeping the cost of fusion electricity economically competitive.

Q: You were awarded the 2005 Katherine Weimer Award. Describe your work that was recognized and how it relates to fusion energy.

A:The award was given for my contribution to understanding the FRC (field-reversed configuration-another device concept) stability properties. I have developed the 3D nonlinear HYM code, and I used this code to study stability in FRCs. FRC is a magnetic confinement concept with no toroidal field. It has some advantages over the tokamak (another toroidal device), but global stability is one of the major challenges of this concept. The award also recognized my contribution toward improving an analytical model for the ion gyroviscosity. This is important for accurate representation of finite Larmor radius effects (FLR, caused by the difference in mass between electrons and ions) in fluid models of plasmas.

Q: What aspects of fusion energy are you currently working on?

A:I now employ numerical simulations to study the effects of energetic particles on stability in different magnetic confinement devices, including National Spherical Torus Experiment (NSTX) and field-reversed configurations (FRCs).

Q: Describe how you became interested in becoming a scientist and what influenced you to choose fusion research.

A: In high school, I was interested only in mathematics and physics, and I particularly liked solving math problems. I was a regular and avid reader of a popular Russian science magazine (somewhat similar to Scientific American or Nature in the U.S.). I remember, in particular, reading a series of articles about inertial fusion. I got my B.S. and M.S. degrees from Moscow Institute of Physics and Technology. We were taught theoretical physics using Landau and Lifshitz's books as texts, and I was deeply impressed with these books and thought highly about theoretical physics and physicists, in general. I wanted to work in theoretical physics and somewhat randomly chose space plasma physics for my BS/MS thesis. I also got my Ph.D. in space plasma physics (from Dartmouth College), but ended up with a fusion-related post-doctoral position at PPPL, and have been working in fusion research ever since.

Q: Did you face challenges in your education or career, either in general or specifically as a woman? How did you overcome them?

A: When I was younger, I was told many times by friends and relatives that physics was not a good career choice for a woman because it would be hard to juggle family with a career in this field. I compromised initially by choosing an applied math major in college, but switched to physics within a couple of years. I didn't find balancing family and a career in physics to be the most difficult part (except maybe when going through graduate school with a very young child that did pose occasional difficulties). It really helps when you like what you are doing, I guess. The most difficult part for me was being a minority (at times, a singularity) and having to deal with prejudice, being

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treated differently than male co-workers. But this is a generational thing, I believe, and will get better in time. I do see a lot more female graduate students and post-docs around now compared to 15-20 years ago.

Q: What would you tell young students that are interested in working on fusion?

A: Learning things on your own is one of the most valuable skills one can acquire. It will help you no matter where you end up in the future. ■

In contrast to magnetic confinement fusion, inertial confinement drives the fusion process by rapidly heating and compressing the particles. This is how the hydrogen bomb works - by inertial confinement driven by X-ray radiation from a fission reaction. Current research towards inertial confinement fusion uses an array of high-power laser beams. The National Ignition Facility (NIF) in California was built to study the stability of the country's nuclear stockpile as well as test the inertial confinement fusion concept.

Dr. Yuan Ping is a laboratory researcher at Lawrence Livermore National Laboratory in California. She is an experimental physicist studying relativistic laser-plasma interaction. She received the Katherine Weimer Award in 2011. I had the opportunity to speak to her about her research in inertial confinement fusion (ICF).

Q: What are the major obstacles/challenges to using inertial confinement fusion for commercial energy?

A: First, ignition has to be demonstrated at NIF, the National Ignition Facility. Second, to be commercially competitive, the repetition rate has to be increased by many orders of magnitude. At present, NIF fires one shot a day. The technology for high-rep rate lasers exists in principle, but it needs to be scaled up at NIF. I feel these are the two major challenges.

Q: You were awarded the 2011 Katherine Weimer Award. Describe your work that was recognized and how it relates to fusion energy.

A: The work cited in the award certificate dates back to my thesis research on experimental demonstration of Raman amplification of short laser pulses in plasma. Using plasma as the gain medium offers an opportunity to achieve ultrahigh laser power beyond the damage threshold of solid-state optics used in conventional laser systems. At present, this topic is still an active area of research—the amplification has been improved by a few orders of magnitude and nonlinear pulse compression regime has been achieved. This Raman scheme can potentially produce the short, intense laser pulse required for fast ignition.

Q: On what aspects of fusion energy do you currently work?

A: I am currently working on fast ignition, an advanced scheme for achieving ignition in ICF. In this scheme, a high-intensity short laser pulse is employed to generate relativistic electrons to heat and ignite the fuel. This igniter laser lasts a few picoseconds, much shorter than NIF's nanosecond laser beams. That's why it is called "fast" ignition. The main advantage of fast ignition is that it decouples ignition from capsule compression, thus the symmetry requirement of the compression stage is substantially reduced.

Q: Describe how you became interested in becoming a scientist and what influenced you to choose fusion research.

A: I've liked physics and math since high school. When I applied for college in China, economics was really hot because China had just opened the door to market economy. Between economics and physics I chose the latter because I found that it is something I really enjoy. This enjoyment has accompanied me through the peaks and valleys in my career. I have never regretted my choice and feel lucky to be able to do what I like to do for a living. What triggered me to choose plasma physics was actually news in the media on fusion in early 1990s. It was about the Joint European Torus (JET) or the Tokamak Fusion Test Reactor (TFTR). It would be so cool to produce clean energy by simulating the reactions in the sun and solve the energy problem forever.

Q: Describe any challenges you faced in your education or career, either in general or specifically as a woman, and how you overcame them.

A:The biggest challenge has always been the balance between work and family. I had my first baby when I was still a graduate student. During the "baby time," I had to continuously reprioritize things, as I simply could not finish everything on the list. I am grateful to receive lots of help from my husband and my parents. Other challenges included the language and culture barriers I faced when I arrived in the USA to pursue graduate study at Princeton University. I attended ESL (English as Second Language) classes and practiced as much as I could with my tutors. Fortunately, this was only a short-term difficulty. Once I overcame it, it wasn't an issue any more. However at times, I still feel short of vocabulary when chatting with people on topics outside of my field.

Q: What would you tell young students that are interested in working on fusion?

A: Be positive and persistent. Your effort will bear fruit in one way or another. ■

While a number of challenges still remain, scientists continue to work towards accomplishing fusion energy's promise of a clean, safe, and abundant energy source. Unfortunately, the U.S. domestic fusion budget has recently faced deep cuts, in part to support our portion of ITER in France. As evidenced by Drs. Belova and Ping, the domestic fusion program has attracted, trained, and retained top-notch scientists from all over the world. Budget cuts, however, may severely limit our ability to solve the remaining challenges and train the next generation of scientists and engineers who could make fusion energy a reality.

What Do Policy, Emotions, Buildings, and Human Bodies Have in Common? Energy Research, of Course!

By Erinn C. Howard

Energy can refer to many different areas of research. As a result, the areas of research vary; however, they all have one thing in common. No matter what type of energy is discussed, it runs our world.

Renewable Energy Risk Perception

Human beings may be unable to adapt to the dramatic effects of global climate change. The only solution to this problem is to lessen the impact of climate change. The Kyoto Protocol called for the reduction of CO2 emissions (to 1990 levels by the year 2000)[1]. The protocol contained a binding commitment to reduce CO2 levels or exchange "carbon credits" with other nations achieving the low CO2 emission standards.

The European Union (EU) hopes to achieve low-carbon economy, and a key factor in such an economy would be the import of electricity made via renewable sources from other countries. Several studies have indicated that solar-produced electricity imported from Northern Africa has the ability to help the EU achieve its 2020 CO2 emissions targets, and also possibly its 2050 targets.

Dr. Nadejda Komendantova studies renewable energy sources[1]. In order for Northern Africa to transmit renewable-source solar electricity to the EU, so-called "mega projects," must be undertaken. These projects are likely to cost more than 1 billion U.S. dollars and could attract great public attention[1]. This attention can be positive (helping local communities, budgets, and the environment) or negative (cost overruns, politicized pricing and complex contracts). Komendantova has found that in order for these renewable-source mega projects to occur, private sector investment will be required. The Northern Africa region, however, has great difficulty in maintaining the high levels of private investment needed to create successful mega projects. In this context of renewable energy development, Komendantova has recently identified the risks that are barriers to the required private investment. Through the use of stakeholder interviews, he found that the highest perceived risks are regulatory, political, and force majeure (i.e., chance occurrences or unavoidable accidents, which include terrorism)[1].

Although political corruption and dealings with terrorists are difficult and multi-faceted problems, investors ranked regulatory risk as the most significant risk to their investment(s). The identification and promotion of policies and programs that reduce such risk can help combat regulatory risk. One example of this innovative thinking would be to help stakeholders manage risks by using financing schemes, such as public-private partnerships.

Komendantova suggests that North African countries work to create, carry out, enforce, and maintain solid regulations that are unlikely to change without warning. If regulations could be handled in a transparent and unwavering fashion, North African countries could undergo mega projects and therefore greatly promote renewable energy cooperation with the EU.

Engaging Women's Voices in Community Energy Discussions
In countries and locations where development work needs to be done, most people can agree that women's opinions and knowledge also must be part of the development process. The problem with engaging women in developing nations is that many within these populations are living in poverty and are illiterate. Many women also do not speak the dominant language of the region, further complicating communication and active participation in community development.

To better include such marginalized populations, researchers have developed the concept of "applied theater." Applied theater is a relatively new idea, and it intends to engage marginalized people (such as women in developing countries) in transforming their own lives through non-traditional performance. It may sound a little touchy-feely, but the research of Dr. Beth Osnes has found that applied theater can be profoundly effective[2]. Osnes is co-founder of Mothers Acting Up (MAU), a group that empowers women to act on behalf of making a better world for their children, and has developed a vocal empowerment workshop with the purpose of engaging marginalized women in community discussions.

Most recently, Osnes has focused on community discussions regarding the use of fuel-efficient cook stoves. She collaborated with the Peace Corps and non-governmental organizations (NGOs) in Panama and Guatemala and instigated community-performed skits to trigger community discussion about these cook stoves. Families in these areas often have no access to electricity and rely on open wood fires for cooking. Lorena-style cook stoves are good replacement options to open wood fires because they increase fuel efficiency, decrease common diseases from smoke, and help decrease infant death in areas where they are used (likely due to decreased smoke inhalation).

Using her MAU vocal empowerment workshop, Osnes was able to organize and encourage dozens of women, children, and some men to devise plans for acting on their concerns by using their voices. Action plans, likely obstacles, and possible solutions to those obstacles were rehearsed in the workshop. The process promoted critical engagement and provided a way for participants to "rehearse" different versions of their own individual and collective realities.

The basic workshop framework has two participant-directed skits titled "Life Without a Cook Stove" and "Life With a Cook Stove." At various times in the skits, Osnes would "stop time" and promote discussion by asking questions about what was occurring and why. Osnes was able to help participants overcome timidity, miscommunication, and language barriers by allowing them to rehearse using their voices and bodies. After departure from Panama and Guatemala, the communities began to organize their own workshops, and community dialogues were initiated that included both men and women in equal participation.

The success of Osnes' workshop has supported the concept that theater can be used to support women's participation in community happenings affecting them. The use of theater can visually convey information and handle miscommunications that occur in developing countries where language barriers, illiteracy, and poverty prevail.

The Decision Making Process of Building Energy Managers

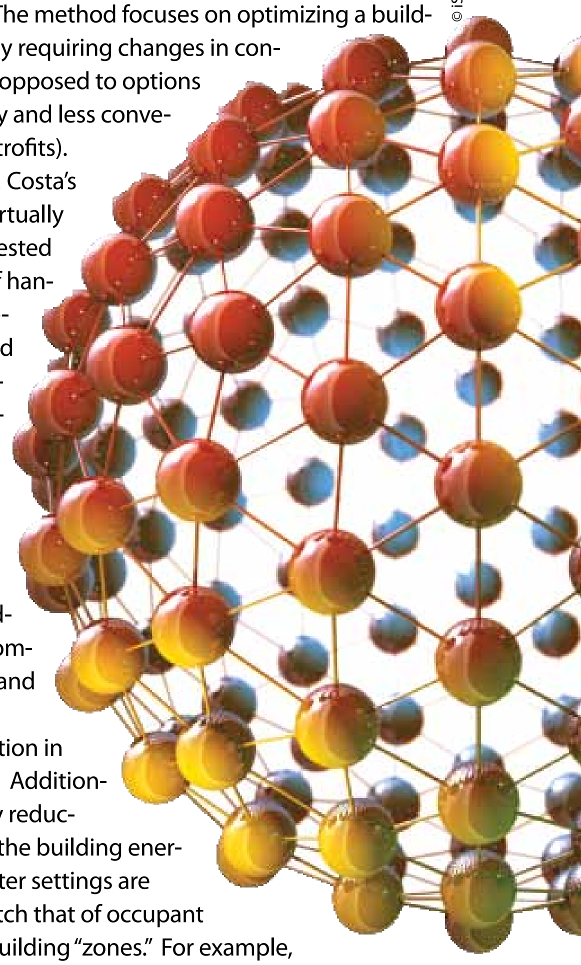
Prescriptive building design has historically ruled the architectural world in the United States. Building prescriptively means that design freedom is limited by fire and building codes, which "prescribe" how an architect or engineer can construct a building. This prescriptive approach, however, has failed miserably at delivering buildings that are operationally energy efficient. How to solve this problem? The answer is performance-based building design.

In performance-based building design, prescriptive rules are thrown out and replaced with mutually agreed upon design, construction, and safety goal objectives. This allows for far more design and building possibilities. In such building designs, building code officials must assess how a structure and its occupants will perform in a fire, for example, instead of simply determining if a structure has met a list of prescriptive building requirements (e.g., certain number of fire extinguishers, etc.).

How can a performance-based design be used for already-constructed buildings? In the U.S., there's an energy-savings approach to buildings called Continuous Commissioning® (CC). In essence, CC is a process by which a building's performance is set and one verifies and documents whether this performance is met continually. The CC process starts with a building energy audit that looks at what measures can be taken to improve energy efficiency. Next, there are several steps to refine and implement these measures. When CC experts audit buildings and undergo this process, they are successful at improving building systems. The problem is that nearly no tools are available for building energy managers to conduct the suggested improvements.

Enter the research of Dr. Andrea Costa3. Costa proposed and tested a new performance-based method, termed the Key Factors Methodology. This method helps energy managers identify the most energy-efficient strategy to run a building that optimizes occupant comfort. Costa's method adapted a building energy simulation (BES) model that can ascertain building environmental and energy performance. BES models, which often help reduce greenhouse gas emissions, are usually used during building design; Costa has modified the models to function during building operation.

Adapting and using BES models during building operation offer continuous and consistent energy predictions, while increasing support to energy managers, and enhancing building operation strategy. The key factors used in Costa's Key Factors Methodology are building parameters that influence the environmental and energy performance of a building (e.g., light level and thermostat set points). The Key Factors method allows an energy manager to examine the effects that various changes make in a virtual environment. The method focuses on optimizing a building's operation strategy requiring changes in controlled parameters, as opposed to options that are far more costly and less convenient (e.g., building retrofits). A case study that used Costa's Key Factors Method virtually (via a computer test) tested eight different ways of handling building parameters. The results ranged from great energy savings and occupant discomfort, to zero energy savings and extreme occupant comfort. In this study, the building manager opted for a set of building parameters that combined energy savings and thermal comfort, and yielded a 1.96% reduction in energy consumption[3]. Additional changes and energy reductions can be made by the building energy manager if parameter settings are changed to better match that of occupant schedules in various building "zones." For example, the kitchen could be made to use more energy for occupant comfort during lunch hours, but made more energy efficient in off-hours.



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The Key Factors Methodology that Costa and colleagues developed is an innovative solution to reduce energy consumption in structures that have already been erected (while not introducing new and costly energy reduction measures). The method allows building energy managers to examine the outcome(s) of various lighting and thermal strategies to determine the best way to keep energy use low and occupant happiness high.

As we can see, the topic of energy covers many different areas of research. Whether referring to renewable energy, or energy related to policy or building design, it is clear that energy runs our world and is a diverse topic for STEM research. ■

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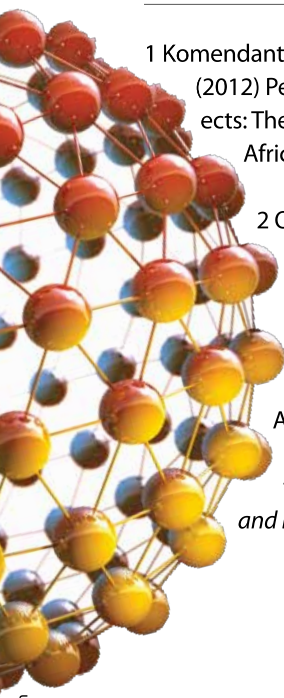

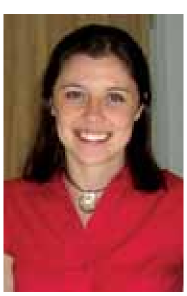

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Each year, both K-12 and higher education professionals attempt to make education as societally relevant and current as possible for students across the United States. This could include conforming to state standards, certification credential building, or even bringing contemporary global issues and dilemmas to the forefront of discussion. It is therefore not surprising that more American classrooms are venturing into discussions and projects related to energy.

It might be surprising to some educators how globetrotting the lessons related to energy production, renewable energy forms, and service learning related to energy issues ventures are becoming. After all, there are more American higher educational institutions establishing collaborations with universities and corporations outside the United States than ever before. This includes creation of study abroad opportunities with energy curricula as focal points.

K-12 Educational Resources

For those looking for ideas on how to educate high school students about wind turbines, alternative forms of energy, the energy crisis, or even the sciences behind understanding energy, one can venture to the Internet. In fact, a preliminary search led to many curricular websites from the federal government (including the Department of Energy or DOE[1]); state-level government such as Texas[2]; and educational agencies such as one dedicated to Connecticut-based educational curriculum planning[3].

The website example from Texas contains materials for use in middle and high school classrooms, inclusive of lab and hands-

Energize Students' Education: Energy-Related K-16 Resources and Study Abroad Endeavors

By A.B. Diefenderfer

on materials about energy types, ranging from "hydropower to wind energy"[2]. The Connecticut-based curriculum ideas continue into topics ranging from "climate change to energy efficiency and green jobs"[3]. Additional lesson plans can be found through the DOE's "Energy Education and Workforce Development Teach and Learn" feature of "K-12 Lesson Plans and Activities".[4]

In addition, the State Energy Conservation Office in Texas facilitates workshops for educators as part of the "Energy Education Curriculum Program"[5]. The workshops include supplemental workshop materials and even opportunities for "continuing education credits"[5]. These are only exemplars of what is out there for STEM and non-STEM educators alike to create and implement education regarding energy topics in the American K-12 classrooms.

As the National Energy Education Development Project (www.need.org) documents, "National Energy Education Day was recognized by a Joint Congressional Resolution…President Jimmy Carter [also] issued a Presidential Proclamation stressing the need for comprehensive energy education in our schools, a reduction of our dependence of fossil fuels, and increasing use of renewable energy technologies and energy efficiency"[6]. Ever since, both governmental and non-profit agencies have supported and fostered collaborative lesson planning with educators desiring to include energy topics within their classroom experiences.

Higher Education and Energy Education

It follows that the topic of energy is germane in numerous K-16 classrooms. In community colleges and the nation's four-year colleges and universities, in classes that range from engineering to environmental science, and from geography to technology, there is room for discussion of energy issues, energy conservation, and alternative forms of energy. In fact, certificate and degree programs are forming in various energy programming areas at the collegiate level. For example, The University of California-Davis' Energy Institute provides some insights into the curriculum possibilities for majors, minors, and graduate certificates[7].

Initiatives are in place to increase national-level planning inclusive of workshops on topics including "clean energy education"[8], looking at how topics are and could be explored within all sectors of U.S. education, including within higher education. What might be surprising, however, is how much American higher educational institutions are taking the push for energy-related education and learning overseas.

Energy Education in Study Abroad Opportunities

In keeping with the hands-on experiential learning we see in the K-12 curriculum lesson plans proposed by state and federal governmental agencies, study abroad opportunities expose college and university students to immersion experiences. Some of these programs are collaborative learning endeavors organized and facilitated by American universities and their overseas educational counterparts. Non-U.S. based institutions of higher education single-handedly offer others. Yet other programs combine independent learning experiences led by international educational programmers (such as SIT who leads a program to Iceland to discuss renewable energy)[9] and international corporations.

For an example of collaborations between American institutions and international corporations, one could reflect upon the collaboration of the Price College of Business at the University of Oklahoma and the experiences students can have "visiting BP, ConocoPhillips, and Shell" representatives and offices in Reading, United Kingdom[10].

Students studying chemical engineering can find energy curriculum within a program on "Energy Systems and Sustainability" through the University College London[11]. Students at the University of Illinois have studied collaboratively with institutions of higher education in Greece on trips that cover renewable energy topics like biofuels[12]. Renewable Energy is a focal topic in programs at the University of Bonn in Germany, collaborating with the U.S. institutions of Northwestern and Arcadia Universities[13].

In fact, Northwestern offers several study abroad opportunities related to energy, including a second program in China, the "Wanxiang Fellows Program"[14], as part of Northwestern's Ini-

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tiative for Sustainability and Energy. The programming in Germany focuses on the connections among "energy policies and global players such as UN agencies, and other invested agencies such as non-governmental organizations, associations, and corporations" [13], while the programming in China includes "experiential field trips (i.e. solar manufacturing plant, electric vehicle battery factory, and energy storage stations)"[14].

Additional energy-related programming between Chinese and American institutions includes the programming offered through the University of North Texas. The website for this program mentions that "topics that will be covered during the program include: renewable energy, solar energy, wind energy, geothermal energy, biomass energy, and zero energy buildings"[15].

Europe and Asia do not offer the only energy curriculum-based study abroad opportunities for American college and university students. Texas Tech lists Peru[16] as one destination, while Northeastern University includes programming in Brazil through their offering "Sao Paulo: Alternative Energy Technology and Brazilian Culture"[17].

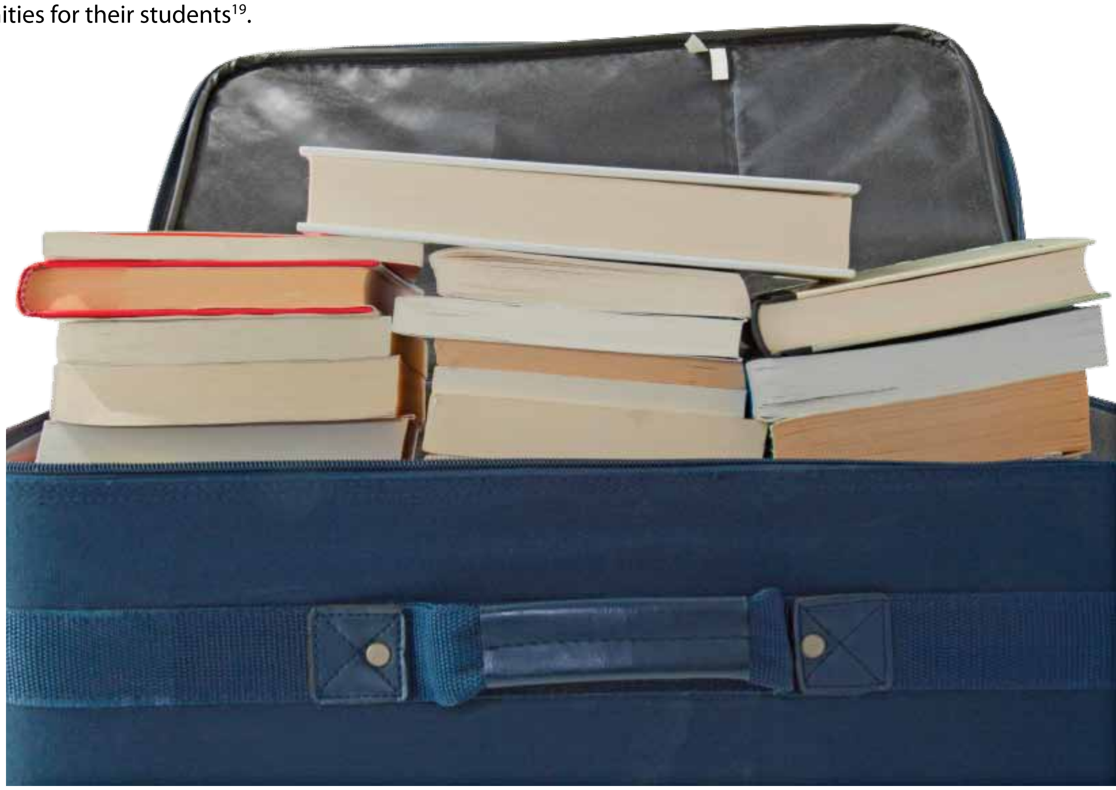
Programming has been available in recent years for internships in the Dominican Republic and Panama through Florida International University's School of International and Public Affairs and a "U.S. Department of Education-sponsored project researching the potential for small business in Florida to export alternative energy products and services in these host countries"[18].

Costa Rica is another destination, with a technical college (Madison Area Technical College) among the ranks investing in study abroad opportunities for their students[19]. Australia is another possibility for students through a program at the University of New South Wales in engineering and management within energy fields[20].

Ultimately, college students can select amongst myriad opportunities exploring international energy initiatives from multidisciplinary perspectives in truly global opportunities ranging in locations from South and Central America, to Europe, Asia, Australia, and to discussions of business, engineering, and even hands-on lab experiential learning related to energy education and industry.

In closing, the K-12 and higher education realms benefit from educational programming, curriculum, and governmental/business/higher educational initiatives. One can explore online lesson plans proffered by state and federal governmental agencies, or peruse study abroad catalogs to locate energy study abroad opportunities. Additionally, K-16 educators entertain participation in teacher workshops related to teaching students about renewable and alternative energy options (as well as contemporary dilemmas concerning current and future energy options).■

A.B. Diefenderfer earned a M.S. Social Sciences (interdisciplinary program in anthropology, history and geography) and a B.A. Anthropology. A member of the American Anthropological Association and AWIS, she contributes to science advocacy by serving on review committees and judging regional science fairs and educating students about archeology through workshops.



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Evolving Roles in the

By Kelly Dolezal

"If you need some time to think about this decision, take it," one of my advising professors said. I nodded and smiled. I had just told him that, after privately agonizing for the better part of a year, I decided to leave my Ph.D. program with a Master's degree. My love for science had kept me in a Ph.D. program for 3 years, but I had finally admitted that I was extremely unhappy with my research project and being at the bench full-time. I truly appreciated his support.

But when he continued by saying, "I don't know if you and your husband want to start a family, but of course that can be very difficult, especially for women," I suddenly became angry and embarrassed. I had every intention of nurturing my career alongside any future additions to our family, and I hadn't thought I'd ever presented myself in a way that would imply otherwise. Secretly, though, I did doubt how I could do it all, and it was profoundly depressing to hear him imply that I was an unavoidable casualty simply because I might one day become a mother.

Inequality in the Home

My professor may have only been echoing what he'd heard of other women's struggles, like another faculty member who reported, "[F]emale graduate students are telling us over and over again across the nation that they are not going to become faculty members because they do not see how they can combine work and family in a way that is reasonable"[1]. This attitude seems to be shared by many working mothers, the results of which are shown by a shift in the desire to work part-time. In 1997, 48% of working moms reported that working part-time was best for their family, but by 2007, that number had risen to 60%[2]. The perception seems to be that there is simply not enough time to parent and work full-time.

The root of these concerns is an unequal division of labor in the home. Male and female scientists both work an average of 60 hours each week[3]. However, female scientists with children additionally report doing 54% of the child-care in their homes, while male scientists only report doing 36%[3]. Extra responsibilities at home may also alter how those 60 hours of work each week are spent. If a married, female scientist has a baby before she has had her Ph.D. for 5 years, she works fewer hours in the lab (40 hours versus 50 hours for other groups) and is less likely to present research at conferences (55% presented in the past year versus 76% in other groups)[1].

In addition to time spent on child-care, inequality in the amount of housework that female scientists do compared to male scientists adds up as well. Female scientists with partners reported doing 54% of the housework, while male scientists with partners reported doing only 28%. To make up for this difference, female scientists pay to outsource twice as many chores as their male counterparts, starting with 10% of chores as assistant professors and increasing to 20% as full professors. This is a smart move for female scientists; outsourcing these duties in dual-career couples is positively correlated with the number of articles published articles per year. However, this also means a loss of pay for female scientists compared to their male counterparts[3].

Evolving Roles

These statistics need not be prophetic, and some actually show an evolution of our roles as spouses and parents that is edging ever nearer to full equality. For example, only 25% of women in heterosexual couples earned more money than their partners in 1987, but this percent increased to 40% in 2009[4]. The amazing truth is that this increased time spent on careers does not necessitate less quality time spent with children. According to time diaries from mothers in 1965, 10.6 hours per week were spent on childcare, and only 1.5 hours were spent reading, playing, or doing educational activities. Surprisingly, time diaries from all mothers surveyed in 2003-2006 showed an increase in those hours to 12.9 and 3.3 hours, respectively, and dual-career mothers still spent 2.3 hours playing or reading with their children, almost an hour more each week than the 1965 mother. Fathers have also nearly tripled their time spent with their children, increasing from 2.6 total hours and 1.2 quality hours spent with children in 1965 to 6.5 total hours and 2.4 quality hours in 2003-2006[2].

Dual-Career Family

This focus on children has been possible in large part because total time spent on housework has decreased for everyone. In 1965, women spent a fastidious 34.5 hours per week on household chores and men spent an additional 4.4 hours, but dual-career moms in 2003-2006 spent only 14 hours per week on these chores, and men in 2000 reported spending an additional 9.7 hours[2]. While not quite equal, the roles are indeed equilibrating.

How to Evolve Faster

The widely-held perspective that working mothers are naturally more burdened than fathers can be presented as the following logical argument.

1. If taking care of a household and children takes an extraordinary amount of time,
2. and women are more likely than men are to take on these duties,
3. then women have less time to pursue careers, and
4. are handicapped in terms of career-building.

Even if statements 1-3 are true, many institutions are putting together packages to keep the careers of female scientists from suffering. For example, the University of California's "Faculty Family Friendly Edge" which offers a flexible-part time option and tenure-clock extension for either spouse who takes time off to be a primary caregiver[5]. Therefore, changes to how society values parenthood are slowly changing the conclusion of career-handicap.

Perhaps statements 1 and 2 could be modified, so that women don't necessarily have less time for careers than men. Men and women have already started dividing childcare and housework more evenly than in past decades, and choosing to make a focused effort in each home to do so as completely as possible could knock statement 2 out of the equation. As for statement 1, if each spouse specializes in the duties at which they are most efficient, outsources time-consuming but unrewarding chores, or removes them completely, housework could be pared down to the minimum burden. When schedules are freed from unnecessary housework, the remaining time for childcare can expand significantly. If the 12.9 hours on average spent by all mothers on childcare[3] was spread over five weekdays, that adds up to just under 3 hours per night, perhaps from the hours of 6-9 pm, leaving the whole weekend for additional fun family adventures, private time with a spouse, or career-building trips.

The Future Stories of Dual-Career Families

I do not have children, and so I know that my naïve and optimistic voice might be less credible than this female professor's heart-breaking advice to first-time faculty: "To be honest, for a woman with tenure track responsibilities, it's a pretty impossible situation. There are wonderful times, but my kids DEFINITELY suffer from the amount of time that I have to spend on my work"[5]. I can only say that my husband and I plan to do everything we can to constantly modify our own situation in a way that works best for our family and both of our careers.

What I want most as a woman in science is for the stories and statistics of inequality to be replaced with ones of egalitarianism and success, so no woman feels that she is doomed to a life of hardship before she even tries. With the help of advocates like AWIS, we can identify the struggles of women in science, as well as their often complex causes. However, we also have to look into our own hearts and homes, and make the changes in our attitudes and actions to create the futures we desire. We're scientists, after all; we know what it takes to evolve. ■

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Money, Money, Money, Money: Energetic PIs Finding Funding, Part 2

By Karen Elkins

Join any gathering of principal investigators (PIs) for a departmental meeting, a lunch, or a beer, and it won't take long before the conversation turns to everyone's constant preoccupation: getting grants in order to keep their labs alive, not to mention their people (and themselves) employed. From time immemorial, PIs have grumbled mightily about the realities of a life in science that depends on finding funding.

Complaints peak after getting back deflating reviews that don't appreciate the PI's treasured ideas, and that leave them out of the money. Some of the whining is understandable: it's no exaggeration to say that more people than ever are submitting more grants, and that the percentage of grants funded, especially those from the National Institutes of Health (NIH), are at historic lows.[1] In Part 1 of this two part column,[2] we discussed some grant writing logistics and mechanics. Here, we consider the bigger picture – sources, strategies, review processes, and some broad do's and don'ts. We'll hear from Dr. Sally Rockey, NIH's Deputy Director for Extramural Research and Director of the Office of Extramural Research (OER). Her main message to new investigators? "The thing that wins you the grant is the idea. Go out on a limb, think high risk, get your collaborators in place because that's going to reduce the risk......and come in with that whiz-bang idea. And wow the panel, so that they feel like they have to throw themselves off the Washington Monument unless they fund this thing." Leaving aside the minor detail that NIH review panels don't recommend funding directly, her point is clear: put forth the best ideas you possibly can, and let your enthusiasm for those ideas shine through.

Sources and Strategies

Oddly, it's become harder rather than easier to find online resources and databases to mine for ideas about where to find money. Some are listed at http://sciencecareers.sciencemag.org/funding, although as noted there are many that require paid subscriptions (try accessing through your institution's library). Google, knowledge of the major advocacy groups in your discipline, and conversations with funded colleagues about their sources remain equally useful.

Consider developing a portfolio of grant applications (hopefully resulting in a portfolio of funded grants) using strategies similar to developing a portfolio of projects.[3] As Dr. Rockey emphasized, it's smart to diversify. Seek out a mix of agencies (government, non-profit, and commercial), with different funding cycles and time frames, so that when the prospects from one are poor, another might be better. But while sending essentially the same proposal to different places simultaneously is common, don't get lazy: re-write in order to target each version to each source, carefully matching your text to an organization's stated goals and review criteria. Dr. Rockey also offered a major and important caution. On the practice of submitting many NIH applications, she says, "My thought has always been to put in your best idea, and really concentrate on that application. Or put in 2. But don't put in 3, 4, 5, 6, because that's the point of diminishing returns. You cannot spend any amount of time on [multiple] applications, making them the best that they can be."

It is also smart to diversify the levels of ambition and risk in the range of projects. Start small with some submissions, and don't try to hit a home run the first time or every time. While whiz-bang ideas are certainly the ideal goal, if everything you submit is a high-risk proposal, your odds of success will stay equally risky. Sometimes it's both necessary and appropriate to ask for money to develop relatively straightforward projects, such as new technical approaches or baseline data that lay the ground work for a flashier phase. Whether high, medium, or low risk, the key is to be direct and honest in how you describe the purpose and relative significance of a project, without trying to claim it as something it's not.

The NIH Grant System: Understand How Your Proposal Will be Reviewed

Many, if not most, funding agencies follow the NIH review model of having two or three assigned reviewers for each grant (usually in roles described as primary, secondary, and tertiary). Before a face-to-face meeting, assigned reviewers write and share detailed critiques according to five major criteria (significance, innovation, approach, investigator, and environment). At the meeting, the reviewers then lead discussions of the grant's strengths and weaknesses before the larger panel. Typically other panel members have not read the grant, or at most have scanned the abstract; this reality highlights the importance of crafting a carefully written and compelling summary. All panel members vote on scoring, so the tenor of that discussion, as led by those assigned reviewers, is crucial.

Because my institution is among those that cannot accept NIH grants, most of my opinions come more from my experience as a reviewer than from writing NIH grants myself. Indeed, reviewing grants remains my single most scientific-life-affirming professional activity. Despite the many negative stories floating about of bad behavior among study section members, my own experiences have been almost universally uplifting, and always eye-opening. I mention my personal experience here because it leads to my most fervent recommendation for aspiring grant writers: get yourself on a review panel, somewhere, somehow, and/or participate in mock review panels led by experienced reviewers. Experiencing the process first-hand, which is a unique blend of written criticism and oral argument, is invaluable in thinking about how to write for reviewers. So, ask colleagues to nominate you for service with agencies and specific grant administrators with whom they work. For NIH, you can also volunteer directly (see http://enhancing-peer-review.nih.gov/volunteer.html). Perhaps even better, the NIH Center for Scientific Review is currently piloting a program that adds "early stage reviewers" to panels (see http://cms.csrweb.nih.gov/PeerReviewResourcesNew/Reviewers/EarlyCareerReviewers/). New investigators, including those who may not yet have independent funding, are assigned as tertiary reviewers with a relatively light workload, but otherwise participate fully in review activities. This provides training and exposure to develop a new cadre of reviewers, while drawing on fresh points of view. Review the latest on the website, or find a current study section panel member to recommend you directly to an NIH scientific review officer for this service.

Keys to Success: Advice From the Top

In response to a question seeking central advice for new investigators in this challenging climate, Dr. Rockey had ready responses,

Be creative and innovative: If you haven't noticed by now, this is a major recurring theme (aka, it's the idea, stupid!). "Absolutely, without a doubt, that's #1," said Dr. Rockey, referring to the power of a creative idea.

Collaborate: A major criteria in any grant review relates to proposing the best possible experimental approaches to an important scientific problem, but not everyone can possibly know everything. "New investigators in particular have to be willing to go out there and seek out those collaborations [with strong, established investigators]......even if it means being on others' grants as opposed to being a PI on their own grant," Dr. Rockey stressed. Further, in her view, any risk of being perceived as giving up independence was outweighed by the advantages of finding the right collaborators, given that "Science is rarely done by one individual in a single laboratory anymore....Those that propel to the forefront of their field are those that collaborate early and often." Her statement is clearly supported by hard data, as touched on briefly in a previous column.[4]

Have persistence, and diversify: This almost goes without saying, but is still worth stating explicitly: "Think about other federal agencies, but also about foundations and industry. It's very, very important that they get their laboratory funded in whatever way they can," especially since the average NIH success rates in 2012 was about 17%.

Understand NIH and federal agencies: Understanding that an organization's process has a direct bearing on fashioning your proposal is important. In addition to explanations on the NIH website, a chapter in the HHMI/BWF book, Making the Right Moves, does a good job of outlining the overall NIH grant process.5 One way to learn more about NIH funding policies and practices is to take advantage of NIH Regional Seminars (see http://grants.nih.gov/grants/seminars.htm#upcoming). Every year, OER sponsors two NIH Regional Seminars on program funding and grants administration. These events are designed to demystify the application and review process, clarify Federal regulations and policies, and explain new developments.

Understand your own institution: Separately from understanding how a funding organization works, Dr. Rockey also noted that new investigators often overlook the value of having a grip on the opportunities and processes in their own back yard. "Oftentimes they [new investigators] are so desperate to get money in, seeking out collaborators across the country, that they lose sight of who they can work with next door, and also just how their institution works. I think that's really, really critical, to get into the culture of their own institution."

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What Goes Wrong, and What Not To Do

In Dr. Rockey's view, there are two main things that kill grant applications from new investigators: being overly ambitious, and lack of skills. Writing out a detailed and realistic timeline for all planned experiments, and subjecting that to scrutiny by colleagues who can evaluate it dispassionately, can help with the former problem; this is often an issue even for experienced investigators. It pays to remember that less is more! The issue of skills and expertise is best addressed by seeking out those all-important collaborations. Referring to new PIs, Dr. Rockey said, "They don't have expertise in certain areas, and we don't fund them because of that. And the best way to pick up those skills is to get them from someone else." Not coincidentally, incorporating strong and appropriate collaborators is also the best available means to mitigate many kinds of risks in an ambitious proposal.

It's also worth pausing to think about things to avoid or leave out. For starters, don't shade the truth in any way: don't alter any results (including airbrushing out undesirable data points), and don't omit inconvenient conflicting data, either yours or that of others. Those tenets would seem to be obvious, but according to a recent Nature article,[6] maybe not. In a survey of [3],247 mid- and early- career scientists, a jawdropping 10% or more admitted to behaviors amounting to frank scientific misconduct such as "changing the design, methodology, or results of a study in response to pressure from a funding source." A similar proportion engaged in merely unsavory actions such as "withholding details of methodology or results." Even more discouraging, mid-career scientists were more likely to adopt one of a list of "top 10" bad practices than early-career scientists, suggesting the temptation to cheat increases over time – perhaps coincident with the increased pressure to obtain funding. Suffice to say, scrutinize the data that you present and the text that you write ruthlessly for any hint of bias or lapses into blowing smoke, and scrub relentlessly.

Beyond outright spin, or failing to acknowledge data or hypothesis not in line with your own, I personally find grants whose writing style drips with excess hyperbole and drama to be a major turn off. Sentences along the lines of "This incredibly innovative and novel work, when completed, will save the world" are rarely true, and deflate credibility immediately. It's always appropriate to clearly state your views on the significance of the work and the usefulness of the outcome, and especially to communicate your excitement for the subject matter. But these descriptions have more impact when tempered with honesty, and when conveyed in an even-handed tone. When in doubt, understatement beats silly exaggeration any day.

Putting it All Together

Although there are plenty of rational reasons to dread wading into the grant pool, there's even more basis to breath deep, dive in, and freestyle toward all the positives. When structured by means of a detailed plan and a reasonable amount of time, writing a grant should be a stimulating opportunity that really focuses the mind on the quality and breadth of your scientific project portfolio. Ideally, the process reinforces your excitement for your creative ideas. You can relish the thrill of going out on a scientific limb, while managing the attendant risks. Along the journey, you can enjoy the team that is your lab, the colleagues that are your neighbors, and the collaborators that are near and far. And when that funding finally arrives, adventures in creating new knowledge are just beginning, all while you enjoy the satisfaction of being a successful master of your domain. ■

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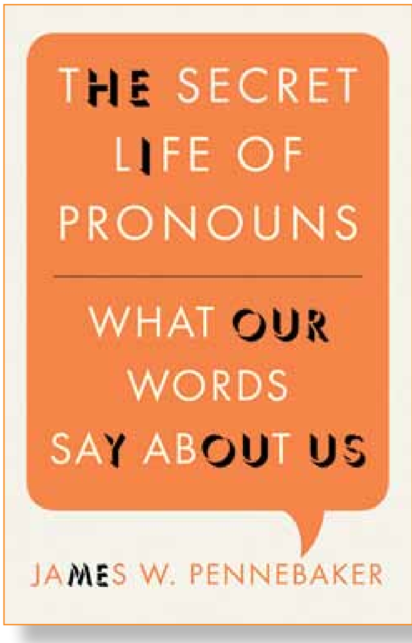
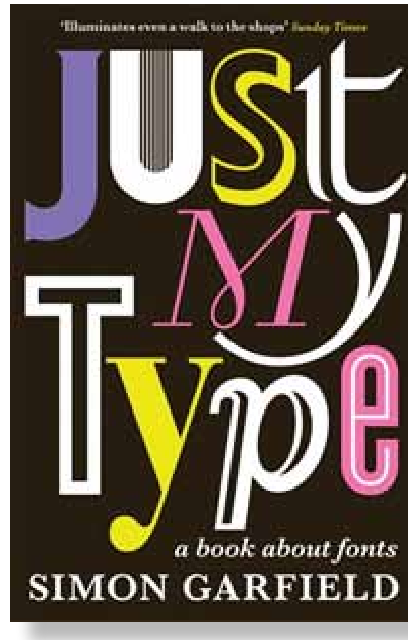


The Secret Life of Pronouns: What Our Words Say About Us.

James W. Pennebacker.
loomsbury Press, New York, 2011.
Hardcover, 352 pages,
$ 28.00
ISBN 978-1-60819-480-3

Just My Type: A Book About Fonts.

Simon Garfield.
Gotham Books (Penguin Group USA),
New York, 2010.
Hardcover, 355 pages,
$ 27.50
ISBN 978-1-592-40652-4



The *Secret Life of Pronouns* and *Just My Type* are both delightful books, well-written and with touches of humor, covering topics which might otherwise be highly technical. *The Secret Life of Pronouns could* be of special interest to language and psychology enthusiasts. *Just My Type* would appeal to all who have marveled and at the same time anguished in indecision at the vast array of "fonts" in the computer drop-down menu.

Social psychologist James Pennebacker was intrigued by reports that persons who talked about personal traumatic events had better physical and mental health compared to persons who remained silent about such events. Wanting further corroboration with these reports, he asked people to write several narratives about their traumatic experiences. Control subjects wrote about events which had no personal emotional impact. In The Secret Life of Pronouns, Pennebacker reports that some persons in the first group did indeed show health benefits. He questioned whether the manner in which these persons expressed their thoughts was the basis for the therapeutic effectiveness.

Pennebacker, together with a graduate student who had experience in computer programming, developed a system which they named Linguistic Inquiry and Word Count (LIWC). Several "dictionaries" classified words according to various psychological concepts. For example, anger words ("hate," "kill," "rage"), cause-effect thinking words ("because," " reason"), and positive and negative emotion words. The various types of pronouns also were categorized. What emerged from LIWC's analysis of the writings was that persons who used more positive emotion words, and a moderate number of negative emotion words, experienced health benefits. Interestingly, persons who used many negative emotion words or who used very few such words had little change in health.

Taking these studies a step further, Pennebacker and his colleagues began to analyze the style of writing. Style is determined especially by the use of function words (pronouns, prepositions, and articles), which when used standing alone, have little meaning. This is in contrast to content words that denote and modify objects or actions. (for example," table," "to drive," and colors). Content words are used to convey meaning; function words connect content words. An important finding from this new analysis was that as people changed their use of personal pronouns from first person singular (I, me) to other pronouns (we, they, you), the greater was their health benefit.

Pennebacker analyzed whether men and women use words differently. An analysis of thousands of written items indicated that women use first person singular pronouns ("I" words) and cognitive words that indicate ways of thinking ("understand," " know," " think") more than men do. Women and men use first person plural words ("we" words) with similar frequency. The author points out that there are different meanings to the word "we." One is the personal "we" -- self plus close others. There is also an impersonal ambiguous "we" -- which can mean "you," or may refer to a larger cohort in general. "We" can be used to "bring the speaker closer to others," or to "distance him/herself from others." Men use articles ("a", "the") and nouns, referring to a particular object, more than women. Men and women use positive emotion words equally. Based on the use of particular function words, computer analysis by LIWC can identify the gender of the writer with 76 % accuracy.

A person's style of using words can vary in different situations. Studies in *The Secret Life of Pronouns* explore word usage by persons who are lying, persons in positions of power, and persons in romantic relationships. The book concludes with "a Handy Guide for Spotting and Interpreting Function words in the Wild."

Inside the cover of *Just My Type* is a "Periodic Table of Typefaces" patterned on the Periodic Table of Elements. A typeface is the design of a set of letters and other characters. Typefaces give rise to fonts, which are complete sets of the characters of the type-

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face in one individual size and style. The distinction between typeface and font diminished with the advent of computers. Because typefaces are vector-based, computerization can scale them to various sizes without losing their format.

The evolution of many typefaces is described in *Just My Type*. Comic Sans was devised in 1994 by Vincent Connare, a "typographic engineer" at Microsoft. "Microsoft Bob," a user-friendly software package, was being prepared. It employed the Times New Roman typeface, produced by Stanley Morison around 1930 for *The New York Times* newspaper. Connare deemed this typeface too "unfriendly," so he set about developing a softer typeface. The result was Comic Sans which was given to the people working on Microsoft Bob. Unfortunately, the Comic Sans dimensions were slightly larger than those of Times New Roman and it could not be adapted to fit. Microsoft Bob was released with Times New Roman. Comic Sans subsequently was successfully used in Microsoft Movie Maker.

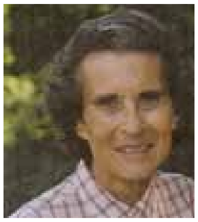
To check the final functionality of a new typeface or font, pangraphs are used. These are phrases that use all of the letters in the alpha-bet. The most familiar, appreciated by beginning typists, is "The quick brown fox jumped over the lazy dog." Making it even more familiar and bringing it into contemporary times is a video on YouTube (youtube.com/watch?v=00E_LV_aTo) in which a fox (though not quite brown and not too quick) does indeed jump over a complacent dog. ■

Write An Effective Funding Application:
A Guide for Researchers & Scholars.
Mary W. Walters.
The Johns Hopkins University Press, Baltimore, 2009.
Paperback, 151 pages, $23.00. ISBN 978-0-8018-9356-8

Preparation of a funding application should begin months before the application deadline. Author Walters proposes a timeline for completing each of the required parts of an application, then guides the writer through the finalization of the proposal.

The Story of Charlotte's Web:
E.B. White's Eccentric Life in Nature and the Birth of an American Classic.
Michael Sims. Walker & Company, New York, 2012.
Paperback, 296 pages, $16.00. ISBN 078-0-8027-77546.

This is a marvelous biography of author E.B. White. Perhaps best known for his children's stories *Charlotte's Web* and *Stuart Little*, White was also a prolific contributor to New Yorker magazine, served as a contributing editor, revised *Strunk's Elements of Style*, and wrote many articles and books for adult readers.



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West Virginia

AWIS-West Virginia Explores Different Career Paths

By Amy M. Keesee

AWIS-West Virginia (AWIS-WV) hosted a panel of women scientists entitled "What Can I Do With a Science Degree?" The panelists were: Mary Jo Egbert, PMP, AWIS-New Jersey chapter member and president of DynoVelocity (a project management consulting and computer system validation firm); Meredith Drosback, Ph.D., American Institute of Physics Congressional Fellow in the Senate Commerce, Science, and Transportation Committee; and Mary Beth Adams, Ph.D., member of AWIS-WV and supervisory soil scientist for the U.S. Forest Service. Each panelist described her educational background and how she ended up in her current position, and then the audience - consisting of undergraduate and graduate students and a few faculty members from a variety of STEM fields - had an opportunity to ask questions. The event wrapped up with a "power networking" session where each attendee was encouraged to meet one new person. A number of students joined the chapter following their attendance at the panel, indicating the impact and importance of these types of events.

Panelists describe exciting opportunities for people with science degrees *(Photo by Buzz Meade)*

Katie Rabidoux, astronomy graduate student and AWIS-WV member, provided the following summary. "The panel of women discussing their experiences in science careers outside academia was informative and insightful. I liked that the speakers represented a range of career stages, job choices, and fields of study. The strongest messages I took away from their discussion were the

Professor Sarah Keller (2nd from right) and attendees at the AWIS-WV luncheon *(Photo by Amy Keesee)*

importance of being your own advocate, and that there are strong benefits to seeking out collaborations with colleagues in different fields. I learned that it is important to have trust in your own knowledge and your ability to apply that knowledge to solve problems. While the panelists were all candid about the challenging aspects of their work (such as long hours or uncooperative colleagues), they unambiguously loved their jobs. I found their enthusiasm for their career paths outside academia inspiring, and as a result of this panel I will be more open-minded about my employment options after I graduate."

Jerry Carr, Jr., physics graduate student, attended the event with his wife, a nurse practitioner, and commented "My wife, Nicole, and I thought the panel was excellent. I went primarily to learn more about Dr. Drosback's career path. She presented her fellowship work as both challenging and rewarding. I left with a greater understanding of how scientists can help shape policy."

AWIS-WV hosted a luncheon with Professor Sarah Keller, the West Virginia University Phi Beta Kappa Visiting Scholar. She described her educational and career path to her current interdisciplinary research position as a biophysicist. Attendees participated in a lively discussion about communication, negotiation, and ways to promote yourself and your science. ■

Chicago

AWIS-Chicago, University of Chicago and Baxter Draw More Than 300 Chicago-area High School Students at "Personal Journeys in STEM" Event

Over 300 Chicago Public Schools (CPS) high school students spent a Saturday in November 2012 exploring potential careers in STEM at an event hosted by the University of Chicago, AWIS-Chicago, and Baxter. The "Personal Journeys in STEM" day included a discussion with renowned Chicago author Rebecca Skloot, sponsored by AWIS and University of Chicago. Skloot discussed her book, The Immortal Life of Henrietta Lacks, and described her 10-year journey to write the true story of the HeLa cell line. Students also received a unique behind-the-scenes tour of the University of Chicago's new hospital, The Center for Care and Discovery (http://careanddiscovery.uchospitals.edu/), including its state-of-the-art neurology intensive care unit (ICU), gastrointestinal endoscopy and robotic surgery suites, and had time to connect with other students about their own experiences in STEM.

Skloot shared the story of her own childhood journey and how she came to author her best-selling nonfiction book. She encouraged teachers, parents, and students to follow their passions and look for "what" moments—times in life that make you stop, think, and wonder why things are they way they are. "Many of you are here because you have specific goals," Skloot said. "I say to all of you, 'follow those goals,' but also follow your curiosity and let it take you where it will. Don't have tunnel vision!"

During the event, STEM professionals from Baxter, AWIS-Chicago, and University of Chicago took time to share their personal journeys and expertise with students, as part of Baxter's Science@Work: Expanding Minds with Real-World Science initiative. Science@Work is a

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Rebecca Skloot, bestselling author of The Immortal Life of Henrietta Lacks
(Photo by University of Chicago)

multi-year commitment to CPS to support teacher training and student development in healthcare and biotechnology.

"The objective for the day was to educate and inspire students in our community about STEM by telling them about our own journeys," said Baxter's Chief Science and Innovation Officer Norbert G. Riedel, Ph.D. "It's an important way of providing real-world experience for students, in the hopes of enabling future generations to advance medicine, technology, and engineering."

Experts from a variety of disciplines, including engineering, information technology, law, medicine, and research and development spent a portion of Saturday's session in small groups discussing their academic backgrounds, career paths, challenges they have faced in their profession, and the key skills needed to excel in the field.

"We were able to give our students personal experiences and insight into their future careers and passions," said Lindblom Math and Science Academy Resident Principal Aubrey Monks. "One of my favorite moments was when we returned back to Lindblom and a student said, "I've changed my mind. I will definitely be getting my Ph.D.!'" ■

San Diego

AWIS-San Diego on the Impact of Their Scholarship Program

By Brea Midthune and Hoang Nhan

To fulfill our mission of community involvement and stewardship in supporting women pursuing careers in STEM fields, AWIS-San Diego (AWIS-SD) puts great effort and pride into its scholarship program. Since its inception, we have awarded over sixty $1,000 scholarships to female STEM students throughout San Diego County. Though primarily led by our committed and hardworking Scholarship Committee, this is one effort that relies on the expertise of many AWIS-SD members to reach our goal of sponsoring more and more young women in science.

We reached out to past AWIS-SD scholarship recipients to gain more insights into the impact that our scholarships have had in their lives. While we typically split our scholarships between undergraduates and graduates, we found that 85% of respondents had finished or are currently enrolled in STEM Ph.D. programs. Notably, ALL of the respondents are still in STEM-related fields and plan to stay in them for the foreseeable future. When asked the broad question of how the AWIS-SD scholarship has benefited their careers, almost all responses were exceptionally positive and can be categorized into three sentiments. One third of the women commented on the monetary value and used it directly toward their research, with several respondents using it to travel internationally. These endeavors ranged from cruising the South Atlantic to collect marine samples to traveling to Sierra Leone to study the interaction between fisheries, livelihoods, and food security in West Africa, the findings of which were later synthesized into a United Nations Environment Programme (UNEP) document. This researcher wrote, "…the AWIS scholarship helped advance UNEP analysis and programming in the area."

Another third of the recipients also commented on the financial benefit of the award but emphasized its impact in their daily lives. These women, mostly undergraduates, were simply thankful for the extra support for daily living expenses, allowing them to forgo an extra job, join more extracurricular activities, or simply have peace of mind during a stressful time in their lives. Stated simply by one recipient, "[The] AWIS-SD scholarship has helped relieve the financial burden and provide resources for me to focus on achieving my goal."

Finally, the last third did not comment on the actual monetary value of the award but placed a different value on the scholarship. For these women, the AWIS-SD scholarship offered an affirmation for their past success and an encouragement for their future pursuits in a competitive and often daunting field. "Now looking back, the AWIS-SD scholarship really helped me tremendously in a way that I never imagined. It was the recognition of my achievements and goals that encouraged me to advance my career in science and engineering, especially when facing challenges and setbacks that we all have to deal with at some point in our careers."

It is very rewarding and reassuring to know that the AWIS-SD scholarship program has made such a positive and long-lasting impact in the lives of many aspiring young women scientists, mathematicians, and engineers. It reaffirms our commitment to supporting such deserving women. We are sincerely grateful to our corporate sponsors for their generous support of our chapter and scholarship program. ■

2010 AWIS-SD scholarship recipients pose with gala keynote speaker, Dr. Sherry Seethaler (middle) *(Photo by Anita Iyer)*

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Where available, local chapter membership provides networking opportunities and educational activities. You must become a member of AWIS to belong to a local chapter. Additional chapter dues apply. To find a chapter near you visit **http://awis.org/chapters**.

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Age Group: ◯ 18-22 ◯ 23-29
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