

# TEACHERS CLEARINGHOUSE FOR SCIENCE AND SOCIETY EDUCATION NEWSLETTER

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## Prosperity Without Growth?

In the lead story of our Fall 2004 issue titled “Economics as if Earth Mattered,” Art Hobson calls for including the environmental cost of resources in the cost of doing business. In his follow-up commentary, Kevin Laws observes that economists call this “pricing in externalities” and remarks that “The only debate (even among economists) is political, not economic.”

Our Fall 2009 issue contained a report on how David MacKay’s *Sustainable Energy – without the hot air* charted how his native United Kingdom could make a transition to an energy future that met the requirement of sustainability. Now Tim Jackson – in *Prosperity Without Growth?* – maps out how the same United Kingdom can achieve an economic future that meets the criteria of sustainability.

You can read what Jackson has to say in three versions: 1) the summary at the beginning of his book, 2) a 136-page pdf available from the homepage of the Sustainable Development Commission, <<http://www.sd-commission.org.uk/>>, and 3) a 280-page book, titled *Prosperity Without Growth: Economics for a Finite Planet*. The larger book (ISBN 9781844078943) can be ordered online at <[www.earthscan.co.uk](http://www.earthscan.co.uk)>. It contains an additional chapter, “A Lasting Prosperity,” and forewords by Herman Daly, Bill McKibben, Mary Robinson, and Pavan Sukhdev. What follows is based on the 136-page pdf.

Growth is the uppermost concern in what Jackson writes. Although it is the traditional basis of economic prosperity, it is also ecologically unsustainable – Jackson finds no evidence that economic growth can decouple from materials or energy consumption or carbon dioxide emission. He also feels that growth is responsible for the world’s current economic crisis.

On the other hand, prospects are not bright for what Jackson calls “de-growth.” In terms of current economic

conventions, he finds it unstable, thus prompting him to title one of his chapters “The Dilemma of Growth.”

At various points, though, he presents graphs that show that, beyond a point, increasing the Gross Domestic Product of a country doesn’t increase happiness, life expectancy, or education or reduce infant mortality. These are all foundational to what I would call the BIG question, which Jackson brings up early in his introductory chapter:

In a world of finite resources, constrained by strict environmental limits, still characterised by ‘islands of prosperity’ within ‘oceans of poverty,’ are ever-increasing incomes for the already-rich really a legitimate focus for our continued hopes and expectations? Is there some other path towards a more sustainable, a more equitable form of prosperity? (p. 17)

Interestingly, it is in the current economic crisis, which Jackson blames on conventional economic growth, that Jackson finds a way out of his aforementioned dilemma. Mindful that restoring the world’s economy to what it was before the crisis would simply restore an unsustainable situation, he observes that the only implementation of Keynesian economics that would *not* result in traditional economic growth is targeted public spending (as in the US stimulus plan), but he notes that even here a different macroeconomic structure is needed.

In his search for a new macroeconomic structure, Jackson finds the pickings slim, indeed. But he does find two run by Canadian economist Peter Victor, one which leads to collapse, the second to what he calls “resilience.” The difference between the two scenarios is that the latter shifts investment from the private to the public sector, stabilizes population, and reduces the number of working hours per person. Jackson also cites work of d’Alessandro “that there is a narrow ‘sustainability window’ through which the economy must pass if it is successfully

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# An EDITORIAL: What the World Needs Now: Scientific Literacy

"The life-enhancing potential of science and technology cannot be realized unless the public in general comes to understand science, mathematics, and technology and to acquire scientific habits of mind; without a scientifically literate population, the outlook for a better world is not promising."

These words appear prominently in the American Association for the Advancement of Science's *Science for All Americans* project. However, surveys show that adults in every nation are overwhelmingly illiterate about science.

It's ironic that the twentieth century took us to the moon but also gave us nuclear weapons, thus bringing our survival into question. Science offers the possibility that we could all live like kings and queens, yet technology and the population explosion have made the human footprint enormous and threatening. We've appropriated 40% of Earth's plant growth, degraded 45% of the land, appropriated half of the runoff water, changed planetary chemistry by doubling Earth's "fixed" nitrogen production, raised species extinction rates to between 100 and 1000 times their previous rate, and increased atmospheric carbon dioxide to 39% above any level in the past 800,000 years. It's with good reason that thoughtful scientists have dubbed the present geological epoch the "Anthropocene." Scientists have helped create these problems, and scientists must help solve them.

Science education has a big role to play in any solution. But science education has too often meant only the education of science and technology professionals. What about the other 90 percent? They vote on such issues as global warming and species preservation. Will they "acquire scientific habits of mind," or be scientifically illiterate?

Consider any science department within any research university. The chances are that their top priority is faculty research and graduate students. Undergraduate departmental majors, along with other science and technology students, get second priority. Scientific literacy for the other 90 percent, namely the non-scientists who will be our politicians, teachers, journalists, businesspeople, and so forth, and who will determine the direction of our culture, ranks lowest if it's taught at all. These backward priorities are built into the hiring, promotion, salary, and tenure processes of essentially all research science departments.

It's as though we scientists were huddled in a sinking lifeboat, discussing our own research. We'd better help shore up the lifeboat! We must find room in our curricula and in our lives to discuss the health of this rare jewel of a planet.

- Art Hobson

(Editor's Note: A frequent contributor to this *Newsletter*, Art Hobson chairs the Physics and Society Education Group of the American Association of Physics Teachers. This piece is reprinted with permission from the Purdue University College of Science's magazine, *Insights*, Spring 2010.)

The TEACHERS CLEARINGHOUSE FOR SCIENCE AND SOCIETY EDUCATION, INC., was founded at The New Lincoln School on 11 March 1982 by Irma S. Jarcho, John L. Roeder, and the late Nancy S. Van Vranken. Its purpose is to channel information on science and society education to interested readers. To this end it publishes this *Newsletter* three times a year. Thanks to funds from tax-deductible contributions, the Clearinghouse is happy to be able to offer its services for a one-time nominal charge. In order to continue offering its services for a nominal charge, it also solicits underwriting of its publications by interested corporate sponsors. All correspondence should be addressed to the editor-in-chief at 194 Washington Road, Princeton, NJ 08540-6447 or via e-mail at <JLRoeder@aol.com>. The Clearinghouse is sponsored by the Association of Teachers in Independent Schools, Inc., and is affiliated with the Triangle Coalition for Science and Technology Education.

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## CORRECTION

The last line in the right column of p. 39 in our Winter 2010 was cut off in the hard copy that was sent out. The complete last sentence should read as follows: "Yet he does find hope to mitigate against climate change in the "wedges" proposed by Socolow and Pacala."

# NYC holds Fourth Annual Solar Summit

A \$932,000 grant from the US Department of Energy to enable the first three Solar Empowerment Zones in New York City was announced at the beginning of the Fourth Annual NYC Solar Summit, held at John Jay College of Criminal Justice on 9 June 2010. Named for their locations, the three zones – Greenpoint-Gateway (in Queens), Downtown Brooklyn, and Staten Island East – were chosen by “an advisory group consisting of representatives from several NYC agencies, Consolidated Edison, the New York Department of Public Service, NYSERDA [New York State Energy Research and Development Agency], and the New York Power Authority” and were identified by their solar access to enable reduction of peak demand and their need for greater photovoltaic solar electricity generation.

These Solar Empowerment Zones will provide the following services to achieve their goals:

- Technical assistance from solar ombudspersons to building owners and operators who are considering solar energy.
- Guidance from ombudsmen to navigate through the City, State, and Federal incentive programs and paperwork that help make solar systems more affordable.
- Free monitoring devices installed on solar systems in the Zones to communicate with the utility grid and inform system owners of their system’s performance.
- Coordination among permitting agencies, Con Edison, and NYSEERDA to create a more streamlined and uniform permitting process.
- Outreach programs for organizations and business in the Zones on energy efficiency and how to go solar.
- Assistance to develop applications for state Renewable Portfolio Standard funding.

According to Tria Case, Executive Director of the Center for Sustainable Energy, this announcement will be followed by the announcement of additional Solar Empowerment Zones. The hope is for between 45 and 90 Megawatts generated from photovoltaic cells atop New York City’s 1.6 billion square feet of rooftops.

## Feasibility of Exporting Solar to the Grid

Many speakers at the Summit addressed a question which was of concern two years ago at the Second Summit (reported in our Spring 2008 issue): the feasibility of

exporting large amounts of solar electricity to the grid. Alison Kling, NYC Solar Coordinator for the City University of New York (CUNY), called attention to the conclusion of the *Million Solar Roofs* report in 2007 that solar electricity *could* be exported to the grid.

The critical situation that can result when solar electricity is injected into the grid is that if more power is injected than is used, a signal of negative power flow results. In a network grid such as is used in New York City and other large cities, Kate Anderson of the National Renewable Energy Laboratory (NREL) pointed out, this causes this section of the system to shut down. Anderson reported on an NREL study, using In My Backyard software ([www.nrel.gov/eis/imby/](http://www.nrel.gov/eis/imby/)), of ten of Con Edison’s 61 networks. In this study, the software was used to calculate the potential generation of solar electricity by overlaying photovoltaic systems on roofs of Google maps.

Anderson reported that in the Herald network (so named for its inclusion of Herald Square, a dense area characterized by a low ratio of rooftop area to power consumption) the maximum ratio of solar power generation to load is only 0.0431. In this network, Anderson noted, there will never be any problem caused by a negative power flow signal. But in the Flushing network, where power consumption for a given rooftop area is less, this maximum ratio is 1.63, clearly a source of possible problems.

Marie Berninger, a Con Ed engineer, discussed protocols which could allow for solar electricity to pass back into the grid as distinguished from a negative power signal that represents a real problem. On the other hand, Steven Caputo of the NYC Mayor’s Office of Long-Term Planning and Sustainability was skeptical that New York City would ever generate enough solar electricity to accommodate base load; this is why, he said, peak load was included in the criteria for selecting the Solar Empowerment Zones as an achievable objective.

Two other speakers spoke to the need for monitoring the amount of solar electricity injected into the grid. NYC Councilman Daniel Garodnick noted the need to develop a system to identify the amount of solar electricity injected into the grid so that it doesn’t destabilize the grid. These sentiments were echoed by Margaret Jolly, Con Ed Ombudswoman, who observed that if Con Ed’s customers generate electricity, not as many underground

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# Solar Summit

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wires are needed to transmit it. But right now Con Ed doesn't know how much power its customers put into the grid, and she applauded better monitoring of this as a goal of the Solar Empowerment Zones.

## Keynoters Claim the Time is Right for Solar

Councilman Garodnick and Robert LiMandri, Commissioner of the NYC Department of Buildings, the morning keynoters, looked at solar electricity in the context of the continuing oil leak in the Gulf of Mexico. Garodnick noted how Jimmy Carter during his presidency saw solar as an opportunity for a great leap forward or a curiosity representing the road not taken. While the latter has characterized the last 30 years, Garodnick lamented, he claimed that it's time for the former to come true.

Picking up where Garodnick left off, LiMandri felt that the time had arrived for solar electricity to make a difference. He cited a citizen so enthusiastic about savings on his electric bill that he's persuading his neighbors to follow him in installing photovoltaic cells. LiMandri reported that 516 kW of solar electricity were installed in NYC during the past year. He hopes to see online issuance of permits for solar installations as now exist for electricians.

But for lunchtime keynoter, New York State Congressman Maurice Hinchey, the earliest attention paid to solar energy came long before President Carter. He recalled opening his keynote speech at the 2008 Solar Summit with a quotation on behalf of solar energy by Thomas Edison, and saw it even more relevant in view of the leaking Gulf oil well. What would be the consequence of a broken solar panel, he mused. Even as Edwin Drake dug his first oil well in the nineteenth century, Hinchey reported that photovoltaic materials were being studied and investigated. Another early focus on solar was solar hot water systems during World War I and the 1947 book, *Your Solar House*. But cheaper, more prevalent fossil fuels then stifled these solar initiatives. No more, Hinchey went on – the days of cheap fossil fuels are over.

After comparing the installed solar electric capacity of Germany and Japan compared with that in the U.S. and his role in founding The Solar Energy Consortium (which he also described in his 2008 speech), Hinchey expressed his desire to see the U.S. displace China as the leading manufacturer of photovoltaic cells (though they are installing few of them on their own territory). He also

called for the Senate to pass the 2009 Energy Security Act that has already passed the House.

## Other Programs to Increase Solar in NYC

Other programs to increase solar energy in New York City were addressed by other speakers. Jeff Peterson of NYSEERDA described the New York State Geographical Balance Program, which applies to biogas and fuel cells as well as photovoltaics. This program focuses on systems greater than 50 kW, as opposed to photovoltaic incentive programs for systems smaller than 50 kW.

The importance of this program was emphasized by Denise Nelson of Con Ed. The solar potential of New York City is large, with many flat roofs, she noted, but largely untapped. Moreover, Nelson cited, the higher electric energy cost in NYC makes solar even more attractive there. Westchester County, with fewer roofs than NYC, has proportionately more installed solar electricity. Like LiMandri, Nelson would like to streamline the application process by building relationships among agencies to make it easier for consumers – ideally to develop one application that can be filed online.

The use of In My Backyard software to determine NYC's solar electricity generation potential has already been cited, but this paled at the Summit in comparison with the NYC Solar Map, which was described by Jake Garcia of Hunter College. This map is being made in the same way in which one has already been created in Boston. LIDAR photography, which shows building height and pitch as well as roof area, will be combined with measured insolation, to determine NYC's solar electricity generation potential even more precisely than that determined by NREL.

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## FORTHCOMING SCIENCE & SOCIETY EDUCATION MEETINGS

3 Jul-14 Aug 2010, Sixth Annual World Nuclear University Summer Institute, University of Oxford, UK. Contact World Nuclear Association, <[www.world-nuclear.org](http://www.world-nuclear.org)>.

15-17 Sep 10, The World Nuclear Association's 35th Annual Symposium, Central Hall Westminster in London. For further information, visit <[www.world-nuclear.org](http://www.world-nuclear.org)>.

29 Nov - 3 Dec 10, Materials Research Society Fall Meeting, Boston, MA. Visit <[www.mrs.org/fall2010](http://www.mrs.org/fall2010)>.

# Physics Education and Nuclear Weapons from the Pakistani Point of View

Pervez Hoodbhoy and Abdul Nayyar of Pakistan were recipients of the 2010 Joseph A. Burton Forum Award from the American Physical Society and addressed the Society at its meeting in Washington, DC, on 16 February. The subject of Hoodbhoy's address – "Science and Subversion – Experiences from Pakistan" – clearly revealed his concerns about physics education and physics-related issues in his home country.

Noting that physics has changed our world both by explaining it in terms of simple laws and by developing the means to make us extinct, Hoodbhoy recalled how Victor Weisskopf and Philip Morrison drew him to change his undergraduate major at M.I.T. from electrical engineering to physics. He first started teaching physics in Pakistan in 1973 and reported finding students merely copying what he said but without grasping what had attracted him to physics at M.I.T. In view of this, he wondered what he could do for Pakistan like Carl Sagan did for the English-speaking world with *Cosmos*, especially since Urdu does not lend itself as well to science as does English. (Hoodbhoy reported that while usage of English has increased in India, it has decreased in Pakistan, to the point that he teaches in Urdu, so that his students will understand better.)

Hoodbhoy said that he produced two 13-part series, although the only time he could get state facilities to produce them was between midnight and 7 a.m. The overwhelming public response showed an audience interested in learning science as a process striving to unlock the secrets of the universe rather than as dry problems with no excitement.

At the same time, he was surprised by such misapplications of science as using relativity to calculate the velocity at which heaven was moving away, especially after a coup which overthrew Ali Bhutto and sought to make Pakistan an Islamic republic. Other examples of this were attributing the interactions of particles to Allah and the roundness of astronomical objects to the roundness of the lenses through which they are viewed, which obscured their true shape, which was like the diamonds from which God fashioned the universe.

Even after writing a book to counteract these ideas, Hoodbhoy found earthquake victims feeling that the earthquake was retribution for their sins and was dismayed to find his students agreeing with them by citing

the Koran. Only a few students, he said, who were afraid to speak out in class, came to support him privately.

Recalling the meeting of his fellow Pakistani, Nobel Laureate Abdus Salam, with the Saudis, who wanted technology without science, because of the ideas engendered by science, Hoodbhoy expressed the need he feels to infuse his society with science. It was in this sense, he said, that he considers "science as subversion."

Hoodbhoy's most recent video production has been a documentary film, *India and Pakistan Under the Nuclear Shadow*. Although it has not been shown on television, it has been shown many places in both Pakistan and India. (Besides, the present multiplicity of channels doesn't insure the viewership that the single channel did for his first series, he said.) Hoodbhoy concluded by expressing his concern about violent fanaticism and religious hatred.

Speaking on "Informing the nuclear debate in Pakistan," Nayyar noted that nuclear debate was not a public issue until the 1980s, because Pakistan denied what it had been doing since India's 1974 nuclear test. After the Soviet invasion of Afghanistan in 1979, he added, the U.S. turned its back on what Pakistan was doing to develop nuclear weapons – a process that was a symbol of national pride which glorified A. Q. Khan and elicited no dissent from Pakistan's scientific organizations.

Currently, Nayyar went on, Pakistan's nuclear weapons do not rank high in public priority, amidst Pakistani political crises and a bad economic situation. Yet there is no external pressure for Pakistan to disarm, because the U.S. needs Pakistan's help (although it is helping Pakistan secure its nuclear facilities). But, said Nayyar, Pakistan fears that U.S. policy in Afghanistan is trying to take over Pakistan's military independence, and it fears an Indian arms build-up and is concerned about a fissile material gap relative to India. Nayyar cited terrorists and an ideological shift toward fundamentalism as problems related to Pakistani nuclear weapons. He called for nuclear restraint, security from internal breakdown, resolution of Indian-Pakistani differences, and global diasarmament.

## FREE PDFs AVAILABLE

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# “Understanding, Not Necessarily Believing Evolution”

Regarding “Creationism vs. Evolution” as a dead end, Lee Meadows advocates a third approach suggested by the above title of his presentation to the national conference of the National Science Teachers Association in Philadelphia on 20 March 2010, in which he uses an inquiry approach that acknowledges the limitations of sciences. He has found that this approach has helped him both resolve conflict in his own personal beliefs and to enable students to experience understanding evolution while still respecting their religious beliefs.

Meadows explained that he grew up in a fundamentalist family in Oxford, MS, with what he called supernatural experiences. Although biology was his first love, he found that people at church wouldn’t answer science questions and that people at school wouldn’t answer religious questions. So he became a teacher of physics and chemistry.

Meadows related that resolution of his science vs. religion dilemma came only when he released himself from the fundamentalist insistence on agreement between the two – he’s now a Presbyterian, he said, although a conservative one. He added that he wrote an article on this topic, which was published and honored by the *Journal on College Science Teaching*. He has recently updated the article for *The Biology* and has written a book, *The Missing Link*, published by Heineman.

Meadows feels that a first goal of teaching evolution should be to help students manage (but not resolve) their conflict between science and religion. This, he acknowledged, precludes Richard Dawkins’s insistence that science disproves the existence of God, because the limitations of science don’t allow this. Meadows added that he feels that any kind of exclusion is dangerous.

Meadows continued to elaborate on the role of the limitations of science. Science is limited to explaining

evidence collected from the natural world through natural processes, and he noted that this places creationism and intelligent design outside the purview of science.

On the other hand, some matters cannot be explained in a scientific way, he observed; and, outside their areas of expertise, he maintained, scientists should not be accorded any special credibility. These matters are the supernatural experiences which characterized his youth, and Meadows claimed that science can’t discount or exclude them. He added his belief that religious beliefs are good and that science teachers should impart this feeling to students as part of enabling them to have a fulfilling experience as a human.

Meanwhile, Meadows reminded us, the evidence for evolution is piling up – paleontologists are adding to it every day. In teaching evolution by inquiry, he said that it’s essential to provide evidence collected by these paleontologists (he recommended the Tree of Life website). He expressed his agreement with Theodosius Dobzhansky that things in biology can be understood only in the context of evolution, and that’s why he feels it’s important for students to understand it, although it’s not necessary for them to believe it. Yet he added his recognition that even with inquiry (which he considers to be the missing link in the title of his book), some students will “hit a wall.”

Meadows concluded by asking rhetorically whether understanding requires belief. He responded that he knows good science teachers who are creationists, and that they understand evolution without believing it. He invited his listeners to visit his website, <[www.leemeadows.blogspot.com](http://www.leemeadows.blogspot.com)>, for a lesson plan with evidence for whale evolution laid out in terms of five steps of inquiry, with an accommodation for resistant students and graphic organizers.

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## Engaging AP Chemistry Students with the life of Fritz Haber

Fritz Haber received the Nobel Prize in Chemistry for developing a way to synthesize ammonia directly from elemental hydrogen and nitrogen, a process that also enabled his native Germany to manufacture synthetic fertilizer during World War I. What is perhaps less well known is that Haber was persuaded by a later German government to participate in the development of chemical warfare during World War II. At the 2010 Science Council Of New York City (SCONYC) Conference on 24 April at Stuyvesant High School, Terri Campbell of Valley Central High School presented a 34-minute film devoted to this latter phase of Haber’s life and engaged us

in ways she engages her AP Chemistry students with the film after they complete their AP Examinations.

Among Campbell’s activities to engage students in the life and work of Haber are the following:

- 1) Asking students to order eight separate paragraphs about Haber’s life and work from Doris Simonis, *Lives and Legacies: Scientists, Mathematicians and Inventors* (Oryx Press, 1998), p. 93.

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# Channel 10 weatherman addresses global warming

Glenn Schwartz, chief meteorologist of NBC 10 in Philadelphia, began his featured talk on 20 March 2010 to the National Science Teachers Association at their national conference in the city of brotherly love by showing the shrinkage of the Shepard Glacier from a large white mass in 1913 to virtually nothing in 2005. He also noted that this was paralleled by melting Arctic ice, with the most stable ice (more than two years old) melting at a faster rate, although fluctuations punctuated the trendline.

Although the subject of his talk was “Explaining Global Warming to the Mass Audience,” he explained at the outset that he is a meteorologist, not a climatologist or paleontologist. Meteorologists are used to fluctuations, he said, showing how a graph of global temperatures averaged over five years displayed a clearer trend than a graph showing the separate average temperature for each year. But even more serious is the accelerated melting of the ice sheet over Greenland, with predicted sea-level rise by the end of the century ranging from 0.1 to 0.8 meters.

But while this evidence may be persuasive to many, Schwartz noted that there are many global warming “skeptics,” and he observed that Al Gore drew fire from them by parlaying global warming issues into the political arena with his *An Inconvenient Truth*. Schwartz himself disagreed with Gore’s attribution of Katrina to global warming.

Schwartz noted that global warming skeptics have aimed at a moving target. First, they claimed that there was no warming at all. Once that was established, they argued that it was not due to humans, according to certain satellite data. But once those data were corrected to reflect the true temperature readings, the skeptics claimed that the satellites were defective. Also drawing fire from the skeptics is Michael Mann’s reconstructed global temperature history with the “hockey stick” shape of the graph representing escalating global temperature in the most recent decade. The skeptics even went so far, Schwartz said, as to compare recent global temperatures against James Hansen’s high-temperature scenario while

completely ignoring his midrange and low temperature scenarios, both of which came close to the actual temperatures.

Also problematic for the cause of reasoned debate about controversial issues, Schwartz conceded, is the media’s love of controversy, and he acknowledged that this usually does not favor the cause and process of science. Nevertheless, in trying to put global temperature into perspective, Schwartz emphasized that other causes are acting to affect global temperature. The reason 1998 is the warmest year on record, he said, is the existence that year of an El Niño, and cooling trends result from obscuration of sunlight by volcanic emissions. He even opined that global temperature increase following passage of the Clean Air Act resulted from removal of particulate pollution from the atmosphere.

Schwartz also addressed one of the biggest difficulties with global warming data – cause for attack by many a global warming skeptic: the 800 year lag of carbon dioxide increase behind global temperature increase, which suggests that higher temperatures increase carbon dioxide emissions rather than the other way around. Citing Milankovich, Schwartz acknowledged that another cause is needed to initiate global temperature increase before it gets entangled in a positive feedback loop with carbon dioxide. But, Schwartz noted, though another cause is needed to initiate the temperature increase, the carbon dioxide is needed to keep the increase going.

Yet, after sifting through the data and possible causes, Schwartz noted at the end of his talk that there is warming of the Earth, and that humans have something to do with it. Yet scientists can do no more than to follow the procedures of science to present their data and the conclusions they draw from it. If scientists become activists, they open themselves to losing their scientific credibility. Likewise, Schwartz conceded, he can’t say on the air many of the things that he said in his talk, not only for the sake of adhering to science but also for the sake of not losing his audience.

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## Fritz Haber

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- 2) Giving students a list of quotations from the film and asking students to identify who speaks them in the film.

The film focuses on the quandary faced by Haber between loyalty to family and service to government – his

wife pleads with him not to go and later commits suicide. Campbell acknowledged that this oversimplifies the actual events but shared an interview with filmmaker Daniel Ragussis in the Spring 2010 issue of *Chemical Heritage* that he would like to present the details of Haber’s life more faithfully in a feature-length version. More information about the film, *Haber*, is available online at <[www.haberfilm.com](http://www.haberfilm.com)>.

# Going Green at Horace Mann

by Bernice Hauser  
Primary Education Correspondent

I thought the readers of this *Newsletter* might be interested in sharing what various schools have done and how they are embracing the ethos of sustainability and “going green.” The synopsis below offers a lens into the highlights of the activities that the Lower Division and Upper Division of the Horace Mann School in Riverdale, NY, have activated as well as some practices already followed by the school. In addition, there have been numerous assemblies and meetings devoted to this topic; timely films have been shown and discussed, and special speakers have been invited to address the topic with the students. A committee has been formed — students faculty, staff, administrators — under the aegis of the Administration. The *Horace Mann Sustainability Policy Committee* has regularly scheduled meetings to discuss initiatives that immediately can be put into place, and those which necessitate more long-range directives and planning. This spring the Upper Division student activist club, GreenHM, among other goals, inaugurated a campaign to foster the use of personal water containers to decrease and eventually eliminate the use of all bottled water on campus.

The Horace Mann community is becoming increasingly attuned to its relationship with the environment through such events as Earth Day/Earth Week Celebrations, recycling programs throughout the school, and creation of the monarch butterfly habitat, the Trevor O’Neil Arboretum and the vegetable garden on the Lower Division campus. The Lower Division has also installed a dual-sided composter not only for composting vegetable and fruit matter from the kitchen but also for teaching the students about composting. This spring, a vegetable garden will be put into place on the Upper Division campus. The school is using compact fluorescent light bulbs, recycling plastics, paper cardboard, glass and using biodegradable plates, cups and utensils whenever possible. It has installed many low flush toilets and hand blowers in myriad bathrooms. Every renovation project uses building materials that have been saved and to the extent possible, recycled furniture. On all campuses all

the lighting ballasts have been changed to energy savings types, all heating and air-conditioning and ventilation equipment and inside lighting have been put on timers, outside lighting has been put on photoelectric sensors. Any recently installed windows contain double insulated glass. Horace Mann has also enrolled in a program called Energy Curtailment which works with the School in times of electrical emergencies by shutting down as much electrical equipment as possible. The school continues its pursuit in increasing ways and means to help sustain the environment.

The new lodge recently built at our John Dorr Nature Lab in Washington, CT, received a silver rating under the LEED Green Building rating system instituted by the US-Green Building Council. This new lodge will be a learning tool for the students. According to Glenn Sherratt, the Director of the Dorr Nature Lab, “Students will monitor the amount of electricity produced and used and the amount of water used each day as well as how the building functions with regard to green features.” The building of this lodge is a demonstration of the commitment of the school to environmental stewardship through high performance building design and operations.

Many green-related aspects get incorporated into the curriculum — for instance, one year eighth grade students enrolled in an energy elective that included building solar panel model houses and cars, and an Upper Division student for her Independent Student Project/Elective chose to discuss, present, and write on *Experiment on Roof Top Planting*. If approved, Upper Division students may also enroll in the Mountain School or the Island School for one trimester. These schools’ thrusts are on environmental dilemmas and paradigms. All courses, workshops and assemblies continue to be sensitive toward this topic. A photography class at Horace Mann had an exhibition of WATER photographs in the HM Gallery in conjunction with the initiative to preserve clean waters for our planet. The school offers its Upper Division students AP Environmental Science, a science research elective, and Topics in Biology in its efforts to increase knowledge, awareness and appreciation for the diversity of environments that either decimate the planet’s resources or shore them up.

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## National Geographic pursues “Greendex”

For the past two years National Geographic and the international polling firm GlobeScan have polled 1000 consumers online in each of several selected nations about their behavior in the areas of housing, transportation, food, and consumption of goods. The poll has in-

volved 65 variables, 24 related to housing, 17 to transportation, 8 to food, and 16 to consumption of goods. Fourteen nations were surveyed in 2008, with three more added in 2009.

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# NSTA Symposium addresses water issues

One of the features of the National Science Teachers Association National Conference in Philadelphia was a Symposium on “The Future of Quality Waters” on 20 March 2010. The first speaker, Water Resource and Environmental Engineer Dan Wible, addressed issues of stormwater management. He was followed by *New York Times* reporter Charles Duhigg, who pointed out how water quality is being sacrificed to clean the air.

Wible pointed out how developers in the past have managed water by building detention basins. But, while they control the rate of runoff, he said, they don’t control the volume of the runoff, its duration, or its pollution. He went on to point out that if water is managed as a resource rather than as a waste, there will be reduced runoff and pollutant load. One approach to this is Low Impact Development/Design (LID), which spreads out the impact of rainfall rather than concentrate it into a detention basin. Favored techniques for doing this are trees (the “ultimate stormwater control manager,” in contrast to grasses, which don’t provide a deep enough root system), infiltration (of the stormwater into the soil), and porous pavement, which Wible said percolates almost all the rainfall incident onto it in order to infiltrate it into the soil below. But, he cautioned, porous pavement must be maintained by vacuuming, typically twice a year, lest the pores become clogged.

Other devices that Wible cited for managing stormwater included infiltration trenches, berms, and beds, rain gardens, and vegetated swales and roofs. Systems which capture and reuse water are especially appropriate for areas with low rainfall. Wible was very wary about high rainfall overwhelming combined storm- and wastewater sewers to send some wastewater directly to its ultimate destination without treatment (a phenomenon I witnessed on a tour of the Lexington, KY, water treatment plant on a rainy day in 1972). Particularly useful in restricting stormwater flow into the sewers are sidewalk planters.

Duhigg focused on the quality of water resources, which were subject to no legislative control before the Clean Water Act of 1972. But the Clean Water Act has not made that much difference since then, Duhigg re-

ported, since his Freedom Of Information Act requests had shown more than half a million violations of the Act since 2004, with less than 3% of the violators punished. One such violation is pumping mine waste into the ground, leading to arsenic contamination. Another problem is newly-developed chemicals like atrazine, used as a pesticide for corn, which is believed to cause birth defects in low concentration.

Other sources of water pollution cited by Duhigg included the overwhelmed sewer systems already discussed by Wible; manure from agriculture, seeping into underground aquifers; and coal-fired power plants. In the last case, Duhigg observed that scrubbers spray water into emitted smoke. This, he said, transfers pollution from the air to water, which, in turn, meant that water quality is being sacrificed to clean the air.

Duhigg then turned to the Safe Drinking Water Act of 1974, which regulates 91 contaminants, but not all that he said should be, since there are hundreds of contaminants that are dangerous at small concentrations, and none have been added since 2000. This Act has been violated by 20% of our sewer systems since 2004, with no punishment of violators, Duhigg said; and it imposes no restriction on manganese, linked to Parkinson’s disease.

Duhigg then went on to say that corporations have pushed back against efforts by the Environmental Protection Administration to strengthen drinking water standards, because this would also strengthen the standards to which Superfund sites must be cleaned. The most prevalent water pollutant in drinking water is arsenic, allowed in 10 ppb concentration, but at this level, Duhigg said that even 1 person in 600 will contract cancer.

Most Americans don’t think that the U.S. has water problems, Duhigg lamented, especially because of the latent period for contracting cancer. Thus concern about water pollution lags behind concern about air pollution. Regarding what individuals could do to safeguard their drinking water, Duhigg pointed out that bottled water is not an environmentally-sound answer, because of its plastic packaging. Moreover, he added, it’s unregulated. Instead, Duhigg recommended a water filtration system.

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## “Greendex”

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While such a poll cannot substitute for actual data on energy use for housing, transportation, agriculture, and production of goods, it is sobering to note that the United States had the lowest “Greendex” in three of the four categories investigated – and in “food” it ranked 13<sup>th</sup> out

of 17 (in 2009). If you would like to check out the “Greendex” and even respond to the online survey to find your personal “Greendex,” visit <<http://www.nationalgeographic.com/greendex/index.html>>. You can also download a copy of the 14-page *Greendex Highlights Report* (online at <[http://www.nationalgeographic.com/greendex/assets/Greendex\\_Highlights\\_Report\\_May09.pdf](http://www.nationalgeographic.com/greendex/assets/Greendex_Highlights_Report_May09.pdf)>) or the *Full Greendex Report* (296 pages).

## PPPL Director updates fusion

“Fusion Energy: Why, How and When?” This has been a big question with an uncertain answer ever since humans attempted to transform energy from hydrogen nuclei by getting them to fuse, the type of reaction that energizes stars. Stewart Prager, Director of the Princeton Plasma Physics Laboratory (PPPL), addressed this question in the Laboratory’s “Science on Saturday” series on 20 February 2010.

The quest for fusion energy, Prager suggested, is like building a cathedral. It takes a long time, but it will have a lasting effect. While the first motivation to produce fusion energy was shortage of fossil fuels, he said, a second motivation has come from trying to meet the challenge of climate change.

Generating fusion energy on Earth is like trying to make a star here, he went on, but the mass required to make a star doesn’t exist on Earth. This would therefore make the hydrogen fusion reactions in stars – the fusion of ordinary hydrogen nuclei – unlikely on earth. A more likely reaction would be the fusion of the heavier isotopes of hydrogen – deuterium (hydrogen-2) and tritium (hydrogen-3).

The difficulty of achieving nuclear fusion is the electric repulsion of positively-charged nuclei. Giving the nuclei that are to fuse sufficient velocity requires temperatures of a hundred million degrees (Celsius), and sustaining the fusion reaction requires that the “plasma” of hydrogen nuclei be confined for a sufficiently long time at a sufficiently high density. This can be achieved in pellets where the density of hydrogen nuclei is 10 billion times as great as that of a gaseous plasma, with energy injected by lasers; or it can be achieved by controlling a plasma by properly-configured magnetic fields, also heated by electromagnetic waves. The product of density, temperature, and confinement time has been tripling every 1.8 years, Prager said. The most recent promising configuration is for a donut plasma with a small hole and a strongly-curved magnetic field, like that of the National Spherical Torus eXperiment at PPPL.

Ever since it was realized in 1958 that fusion energy had no military significance, Prager observed, international collaboration has characterized fusion energy. The present international consortium of the European Union (contributing 45%), China, Russia, (South) Korea, Japan (25%), India, and the United States (17%), is focused on building ITER (International Thermonuclear Energy Reactor, also the Latin word for “the way”) in France to develop a sustained fusion reaction. If all goes according to plan, Prager concluded, he foresees the first demonstration of a sustained fusion energy plant by 2035 – less time from now to the end of a mortgage.

## Operation Shellshock saves NYS herps

New York State has 69 native species of “herps” (reptiles and amphibians). In delivering the keynote address to the 33<sup>rd</sup> Annual Conference of the Science Council Of New York City (SCONYC) at Stuyvesant High School on 24 April 2010, Lt. Dr. Richard Thomas of the New York State Department of Environmental Conservation’s Division of Law Enforcement emphasized the importance of protecting these “indicator” species, because of their sensitivity to the environment, including water and air quality, and not to regard them as slimy and evil.

Among the threats Thomas listed to these “herps” are habitat loss and fragmentation, disease, pollution, invasive species, climate change, and illegal collecting and commercialization. To address this last threat, Thomas and his partner carried out Operation Shellshock, to identify illegal markets spawned by people who love “herps” for the wrong reason and to identify loopholes in laws. Permits to have a limited number of common native “herps” can be obtained from New York State, Thomas pointed out. But the only “herps” allowed to be sold in pet stores are non-native species, and only those not regarded as dangerous. The target of Operation Shellshock is people who know the law but violate it to make money. All “herps” native to New York State are protected, he noted, even those raised in captivity elsewhere.

Biodiversity is fundamental to our existence as humans. We cannot forget that we are part of a life system on earth that provides both sustenance and enrichment. This life system is based on variety, with all living organisms serving a purpose toward ecological balance. Sometimes, however, we fail to recognize the significance of the less observed, and often misunderstood, animals with which we coexist.

- Richard Thomas

As a result of twenty years of work, much of it undercover, Thomas could report finding illegal trade “under the table” at reptile shows, on the Internet, and from illegal trappers. He was able to list the prices that New York State “herps” command, except for one snake, listed as priceless. He added that people offered \$3000 to catch a bog turtle couldn’t find any. And from 2000 witnessed violations, he said that 30 people have been charged, with a 100% conviction rate.

Thomas was also able to observe that over the course of the years of his work, he has seen increasing awareness of the importance of “herps.” He felt it especially important to address New York City science teachers about them, because of their ability to reach students.

# The Meaning of Race in the Post-Genome Era

Racial distinctions among humans have figured prominently in how some groups of humans have mistreated others in our past. We have now reached a point in human history which deplores such mistreatment. We have also reached a point in human history in which we know the molecular basis which determines our physiological makeup, including our “race.” This era has been titled by Princeton University President Shirley Tilghman as the “Post-Genome Era,” and in her Baldwin lecture (named after African American writer James Baldwin) to the Princeton University community on 9 March 2010, she spoke on “The Meaning of Race in the Post-Genome Era.” In doing so she sought to explore “whether the sequencing of the human genome, and the many studies that have followed in its wake to collect sequence information from humans across the globe, have provided any new insight into the meaning of race.”

Tilghman, a highly-distinguished biologist in her own right, began by reviewing relevant biological history. Her first stop in touring biological history was the work of Carl Linnaeus (1707-1778), “best known for his system of classification of plants and animals.” But Tilghman focused her discussion on Linnaeus’s division of humans “into five categories that were based on a combination of geography and skin color – *Homo sapiens Africanus*, *Americanus*, *Asiaticus*, *Europeanus* and – *Monstrosus*.” According to Tilghman, “he described Native Americans as red, choleric and combative; Africans as black, cunning and negligent; Asians as yellow, melancholic and stingy and Europeans as white, sanguine and inventive, and inclined toward tight clothing . . .,” and, “as for *Homo sapiens Monstrosus*, they included dwarfs, giants, troglodytes and lazy Patagonians.” Tilghman’s assessment of Linnaeus’s racial classifications is that his “error was to conflate race with character, making sweeping generalizations about the traits of categories of people based on prejudice rather than careful observation or measurement.” She noted that “this unscientific leap that attached moral values and behavioral characteristics to geographical and skin color differences would persist for centuries, and survive at least in part because it hid behind the mantle of scientific credibility.”

Tilghman next turned to the work of Franz Joseph Gall (1757-1828), founded the field of phrenology, which “argued that the brain was the organ of the mind” and erred in “claiming that both moral and intellectual capabilities of the brain are innate, and that human characteristics . . . can be mapped to specific regions of the brain.” She said that phrenology might have passed harmlessly as a “19<sup>th</sup> century relative of astrology . . . had it not been

for its inevitable use as a tool to discriminate against the Irish in Britain, and across the Atlantic to justify the institution of slavery.” Tilghman faulted phrenologists for betraying the most fundamental principle of the scientific method by beginning with their conclusion, “the superiority of the European or Caucasian people . . . and then set about seeking data that would confirm that conclusion.”

“The next chapter in the history of applying scientific understanding to the meaning of race was the eugenics movement in 19<sup>th</sup>-century Britain,” Tilghman continued. This movement was founded by Francis Galton (1822-1911), who “believed that the gradual improvement of the human species could be achieved by the state providing financial incentives to encourage early marriages and many offspring among people of high rank.” Galton’s work in England was implemented in the United States by Charles Davenport (1866-1944), who founded the Cold Spring Harbor Laboratory in 1910. Davenport claimed “that complex human traits such as high intelligence or personality characteristics such as slovenliness followed simple inheritance patterns that were linked to the color of one’s skin.”

Tilghman faulted all four of these men, several of whom were considered scientific giants in their own time, with “deep-seated racial prejudice that biased the way in which they framed their questions, designed their studies and analyzed their data.” She was able to do this because of what we have learned about the genetic variation in humans, which typically shows a variation in only three million of the three billion base pairs that comprise the human genome. Tilghman said that “we now know that 85-90% of the variation is shared among all humans, and only 10-15% define differences between populations. In other words, differences between individuals are significantly greater than differences between groups.” This is attributed to the fact that humans spent the first 150,000 years of the 200,000 years of their existence on the African continent, and, by doing so developed the genetic diversity which now characterizes humans all over the world. Only 10-15% more variation developed after humans migrated out of Africa. Thus Tilghman pointed out that “the degree of human variation is a continuum across the globe,” as “the first important finding of the post-genome era that pertains to race.” “The second finding” she went on, “is that genetic distinctions among individuals that we continue to define as members of different races based on physical and cultural characteristics are declining rapidly.” A “third finding is that positive selec-

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# Bassler describes bacterial communication

Comprising half the Earth's biomass, bacteria are Earth's oldest organisms. They have one cell and one chromosome, with a few thousand genes. We've known about them 400 years, as organisms that multiply by dividing, and regarded as being antisocial. Given this and their small size, it's amazing that they can do anything.

This is how Princeton University Professor Bonnie Bassler began her talk on "Tiny Conspiracies: Cell-to-Cell Communication in Bacteria" in the Princeton Plasma Physics Laboratory Lecture Series on 9 January 2010. She told us that she had one major goal in giving her talk – to persuade us that "Bacteria can talk to each other" – and a subgoal to persuade us that "Bacteria are multilingual."

Bassler pointed out that humans contain ten times as many bacterial cells in their bodies as their own human cells, and 100 times as many bacterial genes as human genes. Bacteria help digest food, make vitamins, and buttress our immune systems, she added – all invisible, beneficial tasks. Other types of bacteria, though, can be very harmful.

But, Bassler went on, bacteria produce their effects not individually but by acting in groups. She reported learning this from light-producing bacteria in nocturnal Hawaiian squids. They were observed to make light only when enough of them were present, and they were found to do this by emitting protein auto-inducers to each other,

a process called "quorum sensing." (The light made by the bacteria matches that shining on the squid so that it appears to cast no shadow and thus avoids capture.)

In the course of trying to make mutants of these bacteria to eliminate their ability to produce light, Bassler found a surprising additional result – that the bacteria have *two* sensing systems. The first system operates only between bacteria of the same species, but the second system is found to allow many bacteria to communicate with each other. Bassler suggested that the organization of bacteria for intra- and inter-species communication is "likely one of the first steps in the evolution of multicellular organisms."

Knowing about the quorum sensing ability of bacteria gives us a new way to render them ineffective in producing harmful effects. Attacking inter-species communication, Bassler stated, is equivalent to creating a broad-spectrum antibiotic. But acting against *intra*-species communication for a given bacterial species allows developing an antibiotic specifically against that particular species alone. Their approach has been to study the effects of a "library" of chemical compounds on test bacteria. Once successful molecules are identified, standard medical tests need to be run. Bassler also reported that her group is also trying to beef up the quorum sensing of beneficial bacteria.

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## Prosperity Without Growth?

*(continued from page 1)*

to make the transition to a non-fossil world." (p. 81) Moreover, this window is widened "if more of the national income is allocated to investment."

Jackson observes that "The state has clearly emerged as a vital 'first resort' when markets fall, as they did spectacularly during 2008." (p. 81) He sees the state as equally important to take the lead to bring about "structure changes of two kinds" which "must lie at the heart of any strategy to address the social logic of consumerism": "to dismantle or correct the perverse incentives for unsustainable . . . status competition," and "to establish new structures that provide capabilities for people to flourish." (p. 90)

"The principal role of government is to ensure that long-term public goods are not undermined by short-term private interests," Jackson writes (p. 97). Moreover, "Freeing the macro-economy from the structure requirement for consumption growth will simultaneously free government to play its proper role in delivering social

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## The Meaning of Race

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tion – genetic variation that is beneficial and therefore strongly selected when it arises in a population – can lead to marked changes in phenotype – appearance – without appreciable drift in genetic background. (She illustrated this last point with the Ainu of northern Japan, which look very different but are genomically very close to other Japanese.)

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and environmental goods and protecting long-term interests." (p. 98)

In the end, Jackson gives twelve recommendations for governments to use to carry out the following agenda:

- 1) Develop and apply a robust macro-economics for sustainability.
- 2) Redress the damaging and unsustainable social logic of consumerism.
- 3) Establish and impose limits on economic activity. (p.99)

When this agenda is achieved, we shall then have "a more sustainable, a more equitable form of prosperity."

# Physics World addresses energy issues

This *Newsletter* has covered special sections devoted to energy issues in various magazines, chiefly *Science*, *Scientific American*, and *American Scientist*. The most recent entry we have received in this field is the October 2009 issue of a British publication, *Physics World*. The tenth issue of their volume 22 is devoted to “The energy puzzle: a question of science, politics and communication.”

Lord Browne, President of the Royal Academy of Engineering, leads off with a piece on “Challenges in tackling climate change.” He begins by noting that the fourth IPCC report calls for halving greenhouse gas emissions by 2050 to keep the global temperature increase relative to pre-industrial times lower than 2°C and calls attention to the British commitment through its 2008 Climate Change Act to reduce greenhouse gas emissions by 80% by the same year. To accomplish this, he notes that for electricity there are several renewable choices along with nuclear and coal combined with carbon capture and sequestration (CCS); for transportation there are first and second generation biofuels and hydrogen fuel cells; and for heating there are combined power and heating and heat pumps.

Lord Browne also notes four political imperatives: 1) consider environmental integrity equal as a social priority with economic prosperity and national security; 2) pursue action mutually beneficial to economic prosperity, national security, and environmental integrity; 3) consider investment in climate change to be a public good; and 4) seek a global solution to climate change (more can be accomplished for less in the developing world).

Joseph Romm then picks up on the climate change issue with his own observations about the media. They treat climate change as a political issue rather than a scientific one, he laments, and he notes that climate change deniers have been more persuasive to Republicans than scientists. This causes him to fear a crisis in communication by scientists, which he feels need to engage the public on climate issues as they once engaged the public on the danger of nuclear weapons. Even though scientists may be attached for having a political agenda, Romm feels that they need to voice their concerns to the public before climate issues become as dangerous as nuclear weapons.

In taking us on a tour of “The road to sustainability,” George Crabtree and John Sarrao propose a three-part criterion for sustainability: “an energy technology must last a long time, do no harm and leave the environment unchanged.” They then evaluate solar electricity, CCS, nuclear, cellulosic biofuels, and electric transportation by these criteria. Solar and wind-generated electricity are sustainable in their operation, Crabtree and Sarrao say,

but not in their infrastructure, and CCS would enhance the sustainability of coal. A new generation of nuclear reactors run at higher temperatures and neutron fluxes could produce electricity at 50% efficiency, they write, but this requires new materials advances. And the radioactive waste products are a problem for nuclear electricity as carbon dioxide is a problem for fossil-generated electricity.

Regarding biofuels, Crabtree and Sarrao write that “it is now generally accepted that the energy balance and carbon footprint of corn ethanol and gasoline are only marginally different. . . . Cellulosic ethanol made from the stalks and leaves of plants offers more hope.” But they also acknowledge that “known chemical and enzymatic routes are too expensive and inefficient to be competitive” and “a cost-competitive route [for biofuels from algae] is not yet available.”

Technological breakthroughs are also seen as needed to advance other energy goals. Thermochemical reactions to reverse carbon dioxide and water to hydrocarbons require development of new cost-effective catalysts. And the challenges for electric transportation are development of higher energy density batteries, more efficient fuel cells, and high-density storage of hydrogen. “Existing sustainable technologies do not control materials and chemistry at the sophisticated levels needed to cost-effectively convert sustainable sources into useful energy,” they write, noting that these technologies are at a stage similar to that of the steam engine at the time of James Watt.

Gavin Schmidt next reconnects to the energy-related concern about climate change by weighing in on the topic of climate models. Models are limited by our ability to express quantitatively what we know about the operation of a system, he says. Climate models indeed suffer from this limitation, but only they are able to bring to bear all the possible determinants of climate to make the most reliable predictions for the future. For example, he notes that domestic coal and biomass burning in India that does not exist in Europe leads to different consequences of coal-generated electricity in these two regions (it can increase greenhouse gas emissions in Europe but reduce them in India).

Taking into account the 50% increase in energy the world will need by 2025, most of it in emerging nations “as the entire planet aspires to reach a Western standard of living,” Paul Michael Grant suggests that the world will need an “Extreme energy makeover.” To achieve this in an ecologically sound way, he foresees a Super-grid based on “hydricity” – mostly (85%, the other 15%

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# How Environmentalists Can Hamper Science

“Sounds and Fury: Scientific Method versus Ideology” was the topic addressed by Princeton University Geosciences Professor Lincoln Hollister in speaking to the Princeton Chapter of Sigma Xi on 18 March 2010. The example he considered was the clash between scientists and environmentalists over noise in the ocean.

In 2009, Hollister began, Ecojustice (formerly Sierra Legal, an arm of the Sierra Club) slapped an injunction on scientists in Oregon, forbidding their ship to sail to study black smokers, though they were eventually allowed to sail, but subject to severe restrictions. This, to Hollister, was symptomatic of how environmentalists are riled by noise due to airguns in the ocean, some for science, some for oil discovery, and some for Naval security.

Oil companies and the Navy are hard to stop, he continued, so the environmentalists go after scientists, which he characterized as “low-hanging fruit.” But they don’t go after other ships, which he said make plenty of noise in their own right. In contrast with 20-60 second pulses from airguns at 180-200 dB at the source, tankers or freighters at their source produce a continuous sound of 186 dB. Because 80 dB in water correspond to 118.5 dB in air, the 140 dB in air sound of a jet fighter taking off would correspond to about 200 dB in water.

Hollister conceded that airgun noise could mask communication among marine mammals and steer those mammals away and could also damage marine mammals’ hearing. But at a 1.5 km range, their intensity drops to

160 dB, which is below the damage threshold. Moreover, he said, scientists try to schedule their research for times marine mammals will not populate the area being investigated.

Hollister was equally incensed about the reaction of media. The American Geological Institute’s *Earth* ran an article claiming that airguns could produce a sound of 250 dB and damage marine mammals in their February 2010 issue. *The New York Times* on 15 November 2008 editorialized that the airgun sound was “ear-splitting.” *TIME* in its 28 September 2009 issue assessed airguns as producing 265 dB, and the Natural Resources Defense Council states that airguns use explosive blasts.

Yet, Hollister said, airguns have been used for scientific research for more than 40 years with no confirmed damage to marine mammals. One reason is that, to avoid shocking the mammals, the sound of the guns is built up gradually.

Hollister rued that environmental harassment of ocean science is making continued research less attractive to young scientists who don’t want to spend energy and money fending off ideologues – research that he said is needed to enhance our understanding of the environment. But in answering a question after his talk, he did acknowledge that government regulatory agencies are becoming more aware of the damage done to science by ideologues and are now becoming stronger in coming to the defense of scientists, as they did in the 2009 Oregon case.

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## **Physics World addresses energy issues**

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from solar and biowaste) nuclear-generated electricity, some of which is used to produce hydrogen fuel which is then cooled to enable electricity to be transmitted resistance-free while the hydrogen can also be drawn off as fuel. “Supercable” carrying “hydricity” can also be installed in fossil fuel pipelines when they are no longer needed.

In the last article Alan Smith and David Tolfree ask “Does nanotechnology have the energy?” and list the expected contributions of nanotechnology to renewable energy: 1) “third generation” solar cells using multiple layers with different bandgaps in order to exceed the 31% limit calculated by Shockley and Queisser for “first generation” cells made with only a single layer; 2) stronger lighter materials to make larger wind generators; 3) su-

percapacitors with higher energy density; 4) ways to store hydrogen, rated by the percentage of their weight they can store as hydrogen; and 5) energy conservation – e.g., harder-wearing surfaces and insulating “aerogels.”

The book review section contains a review of David MacKay’s *Sustainable Energy – without the hot air*, already described in our Fall 2009 issue. Recall that MacKay would electrify all transportation except air travel, but with the use of plug-in batteries rather than the hydrogen fuel cells indicated by four of the articles in the October 2009 issue of *Physics World*.

(Editor’s Note: If you would like to read the full articles in the October 2009 issue of *Physics World* but are unable to access it, send an e-mail request to <JLRoeder@aol.com> for a pdf of this issue.)

# News from Triangle Coalition

## U.S. Education Secretary Announces Phase 1 Race to the Top Winners

This week, U.S. Secretary of Education Arne Duncan announced that Delaware and Tennessee have won grants in the first phase of the Race to the Top competition. Race to the Top is the Department's \$4.35 billion effort to dramatically re-shape America's educational system to better engage and prepare our students for success in a competitive 21st century economy and workplace. The Race to the Top state competition is designed to reward states that are leading the way in comprehensive, coherent, statewide education reform across four key areas:

- \* Adopting standards and assessments that prepare students to succeed in college and the workplace;
- \* Building data systems that measure student growth and success, and inform teachers and principals how to improve instruction;
- \* Recruiting, developing, rewarding, and retaining effective teachers and principals, especially where they are needed most; and
- \* Turning around their lowest-performing schools.

Forty states and the District of Columbia submitted applications for the first phase of grants. Delaware and Tennessee were selected from among 16 finalists who presented their proposals to panels of peer reviewers earlier this month. "We received many strong proposals from states all across America, but two applications stood out above all others: Delaware and Tennessee," Duncan said in announcing the winners. "Both states have statewide buy-in for comprehensive plans to reform their schools. They have written new laws to support their policies. And they have demonstrated the courage, capacity, and commitment to turn their ideas into practices that can improve outcomes for students." Delaware will receive approximately \$100 million and Tennessee \$500 million to implement their comprehensive school reform plans over the next four years. As with any federal grant program, budgets will be finalized after discussions between the grantees and the Department, and the money will be distributed over time as the grantees meet established benchmarks. The U.S. Department of Education will have about \$3.4 billion available for the second phase of the Race to the Top competition. Applications for Phase 2 of Race to the Top are due on June 1, 2010.

### FREE PDFs AVAILABLE

If you would like a pdf of this issue or any issue beginning in 2009 to share with friends, just send an e-mail request to editor John Roeder at <JLRoeder@aol.com>.

## intelitek Curriculum Selected for ITEEA's Engineering By Design Robotics Engineering and Automation PathwayExtension

The International Technology and Engineering Educators Association's (ITEEA) STEM Center for Teaching and Learning and intelitek have announced a curriculum partnership. ITEEA has chosen intelitek's Robotics Engineering and Automation program as the curriculum for ITEEA's Engineering by Design (EbD) Robotics Engineering and Automation PathwayExtension. The EbD Program is a model used by schools developing themes in the STEM cluster that are seeking to increase all students' achievement in science, technology, engineering, and mathematics through authentic learning. The program is built on constructivist models and creates awareness and competence over time as it builds on learned knowledge and skills. EbD is the only standards-based national model for Grades K-12 that delivers technological and engineering literacy. The intelitek Robotics Engineering and Automation program consists of two 36-week courses that deliver comprehensive, standards-based instruction via relevant activities and compelling online curriculum.

Both ITEEA and intelitek are members of the Triangle Coalition. ITEEA is the professional organization for technology, innovation, design, and engineering educators. Its mission is to promote technological literacy for all by supporting the teaching of technology and engineering and promoting the professionalism of those engaged in these pursuits. The ITEEA STEM Center for Teaching and Learning provides models for standards-based curriculum, instruction, and assessment and is developed through a consortium of states. intelitek's mission is to improve student outcomes in education by transforming the classroom for schools, colleges, universities, and industrial training. intelitek seeks to engage students, empower instructors, and support administrators in the quest to equip learners of all types with relevant skills. intelitek is committed to putting the best technology at the service of educators to prepare a wider range of students with career- and college-ready skills and the desire to use such skills to improve the world around them.

*(Editor's Note: The preceding two items were excerpted from the Triangle Coalition Electronic Bulletin for 1 April 2010 and reprinted with permission.)*

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# Triangle Coalition

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## Albert Einstein Distinguished Educator Fellows Discuss “The Medical School Model” to Advance Teacher Development”

Recently, a group of Albert Einstein Distinguished Educator Fellows presented their views and experiences on the use of a medical school model in teacher preparation and professional development programs for the Woodrow Wilson Center for International Scholars' Program on America and the Global Economy (PAGE). PAGE began its efforts by exploring the role business is playing in improving mathematics and science education for minorities and women in today's schools. PAGE recently broadened its focus to include teacher preparation, the question of national standards, and the successes achieved by school systems in the United States and in other advanced economies. The Fellows panel discussed "the medical school model" to advance teacher development and preparation in public and private schools. This method emphasizes classroom experience and mentoring opportunities for teachers. High school and middle school teachers across the country already are experimenting with this model. Jonathan Davies, a high school science teacher in Oregon and Fellow at the Department of Energy (DOE), said his school's version involves teachers and administrators making "rounds" to other classrooms. These rounds allow teachers to see different teaching methods and work together with administrators in an open, collegial atmosphere. Tracey Edou, a middle school math and science teacher in Seattle and a DOE Fellow, argued the model will work properly only if schools address several challenges. These include finding adequate substitute teachers to enable rounds, departing from judgmental attitudes and style preferences, having a supportive administration, and committing to sustained efforts. Camsie Matis, a high school math teacher in New York and Fellow at the National Science Foundation (NSF), estimated teachers need about six years to get acclimated, yet most student teaching tenures are only a few months, in contrast to the medical profession. A new teacher, she said, is "like an intern in an emergency room with no mentor." She suggested implementing "chief resident" teachers to encourage results and "EMT teachers" to help save failing schools.

(Editor's Note: The preceding two items were excerpted from the *Triangle Coalition Electronic Bulletin* for 15 April 2010 and reprinted with permission.)

## NSF Releases National Impact Report of Math and Science Partnership Program

The National Science Foundation has released the *National Impact Report on the Math and Science Partnership Program*. Launched in 2002, the Math and Science Partnership (MSP) program at the National Science Foundation is a research and development effort to build capacity and integrate the work of higher education, especially its science, technology, engineering, and mathematics (STEM) disciplinary faculty, with that of K-12 to strengthen and reform mathematics and science education. The MSP program seeks to improve student outcomes and significantly reduce achievement gaps in the mathematics and science performance of diverse student populations. The program was reauthorized as part of the America COMPETES Act of 2007 and provided with additional appropriations in the American Recovery and Reinvestment Act of 2009 and the fiscal year 2009 federal budget. NSF's MSP program coordinates its effort with the Mathematics and Science Partnerships program of the U.S. Department of Education. The shared expectation is that effective innovations in mathematics and science education will be disseminated into wider practice.

Through the MSP program, NSF awards competitive, merit-based grants to teams composed of institutions of higher education, local K-12 school systems and additional supporting partners which can include other stakeholders in educational excellence in the STEM fields. According to the report, as measured on state assessments, schools participating significantly in MSP projects continued to show improvement in student mathematics and science proficiency over the four-year time period from school year 2003-04 to 2006-07. The sustained increase in mathematics proficiency was found to be statistically significant at the elementary, middle, and high schools levels. A new solicitation for the MSP was also recently released. NSF expects to make an estimated 17-27 total MSP awards, including 3-5 Targeted Partnerships, 3-5 Institute Partnerships, 5-7 MSP-Start Partnerships, 3-5 Phase II Partnerships, and 3-5 RETA awards, pending availability of funds. The anticipated funding amount is approximately \$42,000,000 in FY2011, pending availability of funds for the MSP program. The 20-page report is available online at [www.nsf.gov/pubs/2010/nsf10046/nsf10046pdf?WT.mc\\_id=USNSF\\_80](http://www.nsf.gov/pubs/2010/nsf10046/nsf10046pdf?WT.mc_id=USNSF_80).

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# Triangle Coalition

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## Despite Gains, Obstacles Still Exist for Diversity in STEM Education, Says Shirley Malcom

Despite modest improvements over the past decade, underrepresented minorities still face significant institutional and cultural barriers pursuing science and engineering degrees, AAAS Education and Human Resources Director Shirley Malcom warned in recent testimony on Capitol Hill. With rising higher education debt among undergraduates, a lack of minority representation among faculty and peers, and "failures of (science education) policy, from the individual school and district to the state and federal government," Malcom said that the country is not developing the next generation of scientists and engineers that will drive U.S. innovation. Speaking before the U.S. House Subcommittee on Research and Science Education, Malcom called on lawmakers to expand federal initiatives that have successfully broadened participation in science education – like the National Science Foundation's Alliances for Graduate Education and the Professoriate – which have increased the number of PhDs for underrepresented minorities at participating institutions.

Malcom said that producing leaders for science, technology, engineering, and mathematics (STEM) in industry, government, and faculty will require more focus on PhD degree production. She cited surveys suggesting recent increases in diversity for physical sciences fields have been driven by more underrepresented minority participation in chemistry, while physics participation remains low. In addition, most underrepresented minorities' improvement is being driven by women, while males are under-participating across many STEM fields. Malcom also called for more initiatives to increase the participation in STEM education for women and persons with disabilities. Despite being at parity with men for STEM bachelor degrees (except in physics, computer science, and engineering) and an increasing number of doctoral degrees, women are not present among STEM faculty at the levels that might be expected.

(Editor's Note: The preceding two items were excerpted from the *Triangle Coalition Electronic Bulletin* for 29 April 2010 and reprinted with permission.)

letter on the Web

and click on "Resources,"  
and Society Education."

## Twelve Foundations Commit \$500 Million to Education Innovation

To dramatically improve student learning outcomes, twelve national foundations have committed \$500 million in 2010 funds to leverage the U.S. Department of Education's \$650 million Investing in Innovation (i3) Fund aimed at similarly aligned investments, making more than \$1 billion available to help expand promising innovations in education that support teachers, administrators, technology tools, and school design across all K-12 schools -- public, private, and public charter. The foundations' investments are a continuation of longstanding efforts to foster the innovation education sector. Those efforts include programs that revamp teacher and principal training, spur integrated technology tools for teaching and learning and create capacity for alternative high quality schools, as well as new models for school design. While each participating foundation will maintain independence in determining which programs to fund, the combined \$1.1 billion in resources now available to non-profits, state and local education agencies, traditional public schools, and public charter schools will catalyze and grow cutting-edge ideas.

Participating foundations include The Annie E. Casey Foundation, Bill & Melinda Gates Foundation, Carnegie Corporation of New York, Charles Stewart Mott Foundation, Ford Foundation, John D. & Catherine T. MacArthur Foundation, Lumina Foundation for Education, Robertson Foundation, The Wallace Foundation, The Walton Family Foundation, The William & Flora Hewlett Foundation, and the W.K. Kellogg Foundation. The foundations also are launching the Foundation Registry i3, a new online application that aims to simplify the private funding application process for potential grantees and increase access and visibility for new, especially smaller, applicants. It also aims to improve the ability for foundations to examine investment opportunities and better coordinate efforts with the U.S. Department of Education around the i3 Fund. While the Registry i3 will enable applicants to register their proposal just once to reach a broad set of foundations for potential support, each foundation will maintain its own decision-making authority to determine which programs fit within their investment strategies. The Registry i3 is now available at <<http://foundationregistryi3.org>>.

(Editor's Note: The preceding item was excerpted from the *Triangle Coalition Electronic Bulletin* for 6 May 2010 and reprinted with permission.)

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## New NCTM Publication Directs Math Education Research Based on Teachers' Needs

Triangle Coalition member, the National Council of Teachers of Mathematics (NCTM), has published "Linking Research and Practice: The NCTM Research Agenda Conference Report" to shape research and bring it to classroom and school-level decisions. Education research findings can improve mathematics teaching, learning, and curriculum. However, the research needed by classroom teachers and the research being conducted in mathematics education often differ. The new report presents priorities for mathematics education research based on the needs of mathematics teachers, administrators, and other school- and district-level educators. The publication is intended for researchers, funding agencies, and others who make decisions about mathematics education research. It is organized around ten "research-guiding questions" on issues that include student thinking, assessment, and teacher preparation. The report, which includes reflections on making the connection between those who research mathematics teaching and learning and those who teach and make decisions about teaching mathematics, is available online at <[http://www.nctm.org/uploadedFiles/Research,\\_Issues,\\_and\\_News/Research/Linking\\_Research\\_20100414.pdf](http://www.nctm.org/uploadedFiles/Research,_Issues,_and_News/Research/Linking_Research_20100414.pdf)>. "Linking Research and Practice" is based on the work of mathematics education researchers, teachers, and other school-level educators who attended a research agenda conference sponsored by the National Science Foundation and developed by NCTM. Fran Arbaugh, associate professor of education at the Pennsylvania State University, presided over the one-week conference of 60 researchers and school-level practitioners. Attendees met in working groups to discuss and determine research topics and issues that are important to school-level practitioners but lack a strong research base. The work of the conference was based on hundreds of questions previously collected from focus groups of teachers across the country.

The National Council of Teachers of Mathematics has 100,000 members and 230 Affiliates in the United States and Canada. It is the world's largest organization dedicated to improving mathematics education from pre-K through grade 12. The Council recommends that math education for all students go beyond the basics to include higher levels of mathematics. The Council's Principles and Standards for School Mathematics provides guidelines for excellence in mathematics education.

## Strategic Report Says STEM Education Needs to Start as Early as Pre-Kindergarten

Students need to begin training in the sciences and math as early as pre-kindergarten for success in today's global economy, according to a report recently released by Wheelock College's Aspire Institute. The report, "Strengthening STEM Education in the Early Years," was commissioned by the John Adams Innovation Institute of the Massachusetts Technology Collaborative and recommends the establishment of a Greater Boston STEM Educator Consortium to provide additional teacher training. "The report offers an actionable roadmap for students to adapt to the opportunities of the 21st century economy," said Mitchell Adams, executive director of the Massachusetts Technology Collaborative. Within the past year, national and local calls to strengthen STEM education have intensified. President Obama recently announced a \$250 million initiative as part of his Educate to Innovate Campaign to train math and science teachers. The federal Race to the Top funding includes STEM as the only "content" area referred to as a "competitive preference priority."

In Massachusetts, Governor Patrick recently created the STEM Advisory Council to advise on STEM education issues. "It is imperative that we continue to invest in STEM education in order to prepare our students for the jobs and careers of the future," said Lt. Governor Timothy Murray, Chair of the Governor's Science, Technology, Engineering, and Math (STEM) Advisory Council. "This report lays out clear recommendations and action steps to promote education in these fields as early as pre-kindergarten and I look forward to including these ideas in our ongoing dialogue." U.S. students consistently trail behind their peers in countries, such as China, Japan, Singapore, South Korea, Russia, England, and the Netherlands in math and science academic performance. And while Massachusetts as a whole performed well above the national average in math and science on the most recent National Assessment of Educational Progress (NAEP), it is among the states with the largest achievement gap between different racial/ethnic and income-level student subgroups in these same areas. The report is available online at <<http://www2.wheelock.edu/wheelock/Documents/News/Foundation%20for%20the%20Future%20Report.pdf>>.

(Editor's Note: The preceding two items were excerpted from the *Triangle Coalition Electronic Bulletin* for 13 May 2010 and reprinted with permission.)

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## National Governors Association and State Education Chiefs Launch Common State Academic Standards

The National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) have released a set of state-led education standards, the Common Core State Standards. The English-language arts and mathematics standards for grades K-12 were developed in collaboration with a variety of stakeholders including content experts, states, teachers, school administrators, and parents. The standards establish clear and consistent goals for learning that will prepare America's children for success in college and work. The release of the standards marks the conclusion of the development of the Common Core State Standards and signals the start of the adoption and implementation process by the states. The year-long process was led by governors and chief state school officers in 48 states, 2 territories, and the District of Columbia. The final standards were informed by nearly 10,000 public comments and by standards in other top performing countries so that all students are prepared to succeed in our global economy.

Since the initial draft of the standards was developed, Triangle Coalition member, the National Council of Teachers of Mathematics (NCTM), has been engaged in the process as a reviewer and has provided extensive comments and detailed suggestions to the developers and writers on every successive draft over the past year. The Council has diligently monitored the development of the CCSS and advised the NGA and CCSSO throughout the process, pointing out common ground between the common core standards and NCTM's own K-12 mathematics standards publications. As an example of mathematics recommendations, the high school standards call on students to practice applying mathematical ways of thinking to real world issues and challenges, to prepare students to think and reason mathematically. The high school standards set a rigorous definition of college and career readiness, by helping students develop a depth of understanding and ability to apply mathematics to novel situations, as college students and employees regularly do. In the coming months, each state will follow its own procedures and processes for adoption of the Common Core State Standards. The NGA Center and CCSSO recognize that meaningful and effective implementation of the Common Core State Standards is critical to achieving these goals.

To that end, the two organizations are continuing to work closely with a range of partners on how to best support states and districts as they move from adoption to implementation. More details and a PDF of the standards are at <<http://corestandards.org/the-standards>>.

(Editor's Note: The preceding item was excerpted from the *Triangle Coalition Electronic Bulletin* for 3 June 2010 and reprinted with permission.)

## NCES Releases Report Examining Graduation, Dropout Rates

The National Center for Education Statistics has released "Public School Graduates and Dropouts from the Common Core of Data: School Year 2007-08." The new report presents the number of high school graduates, the Averaged Freshman Graduation Rate (AFGR), and the dropout data for grades 9 through 12 for public schools in school year 2007-08. The counts of graduates, dropouts, and enrollments by grade are from the National Center for Education Statistics (NCES) Common Core of Data (CCD) nonfiscal surveys of public elementary/secondary education. Among the findings:

- Across the United States, excluding South Carolina, a total of 2,965,286 public school students received a high school diploma in 2007-08, resulting in an Averaged Freshman Graduation Rate (AFGR) of 74.9 percent. This rate ranged from 51.3 percent in Nevada to 89.6 percent in Wisconsin.
- Across all reporting states, the Averaged Freshmen Graduation Rate (AFGR) was highest for Asian/Pacific Islander students (91.4 percent). The rates for other groups of students were 81.0 percent for White students, 64.2 percent for American Indian/Alaska Native students, 63.5 percent for Hispanic students, and 61.5 percent for Black students.
- There were 613,379 dropouts from high school (grades 9 through 12) with an overall event dropout rate of 4.1 percent across all 49 reporting states and the District of Columbia in 2007-08. Indiana and New Jersey were tied for the lowest dropout rate at 1.7 percent while Louisiana had the highest event dropout rate at nearly 7.5 percent.
- Across the 47 states that were able to report high school dropouts by gender, the dropout rate was higher for males than for females at 4.6 percent and 3.5 percent, respectively. The dropout rate was higher among males in every state. The male-female gap ranged from 0.3 percent in Nevada to 2.7 percent in Louisiana.

According to U.S. Education Secretary, Arne Duncan, the "report confirms that our nation faces a dropout crisis. When 25 percent of our students -- and almost 40 percent of our black and Hispanic students -- fail to graduate high

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# RECOMMENDED SCIENCE AND SOCIETY EDUCATIONAL RESOURCES

1. Matthew L. Wald, "What Now for Nuclear Waste?" *Sci. Am.*, **301**(2), 46-53 (Aug 09).

After spent fuel from nuclear reactors is removed from the reactor core, it emits so much heat that immersion in water is the only safe way to cool it. But after a few years, cooling by water is no longer needed, and the spent fuel is then removed from the holding tanks at the reactor site and stored in sealed casks filled with an inert gas, much like the casks originally intended for transport to an underground burial site.

Storing spent fuel above ground at the reactor site for an extended time allows it to cool further. This reduces the amount of heat that must be accommodated by an underground repository. In this respect, delays in developing an underground repository for commercial nuclear waste are not necessarily bad from a scientific point of view, Wald points out. But he notes that the politics of locating this repository have shifted to avoid the home states of congressional leaders, once Texas (Jim Wright) and Washington (Tom Foley) and now Nevada (Harry Reid), though Yucca Mountain is still "on the books" (although its further development has been defunded).

Wald's listing of the contents of spent fuel, apparently based on 4.4% enrichment in uranium-235, is 3.4% fission products, 1% actinides, and 95.6% original uranium. This listing does not distinguish between the fissionable isotope, uranium-235, and the more prevalent uranium-238, which leads to the production of actinides, chiefly plutonium, when it absorbs a neutron. Rather, Wald merely attributes actinide formation merely to failure of a uranium nucleus to fission when it is struck by a neutron and neglects to note that an additional percent of the original uranium is so converted and fissions to produce some of the reactor's energy, resulting in 4.4% fission products, 1% actinides, and 94.6% original uranium.

2. Dickson Despommier, "The Rise of Vertical Farms" *Sci. Am.*, **301**(5), 80-87 (Nov 09).

The land equivalent of South America is used to feed the world's current 6.8 billion inhabitants, and another Brazil will be needed to accommodate the 9.5 billion expected by 2050. There will also be greater demand for water above the 70% presently used for agricultural purposes and fuels above the 20% of gasoline and diesel

presently used on farms. Climate change also threatens the *status quo* of agricultural productivity.

Despommier's answer is vertical urban farms in buildings or sites no longer used for their original purposes, using drip irrigation, aeroponics, and hydroponics. Among the problems eliminated are massive applications of fertilizers and pesticides, agricultural runoff, and machinery to harvest crops and transport them to market. Benefits include reduced fossil fuel use and concomitant carbon dioxide emissions, year-round agricultural production, extraction of energy-producing waste from "black" water (sewage) and use of the resulting "gray" water, and restoration of current agricultural land to become a carbon dioxide sink.

(*Editor's Note:* Dickson Despommier's vertical farms should not be new to *Newsletter* readers. His talk to the Scientific Literacy Seminar at Columbia University about them on 5 December 2006 was reported in our Winter 2007 issue.)

3. Mark Z. Jacobson and Mark A. Delucci, "A Path to Sustainable Energy by 2030" *Sci. Am.*, **301**(5), 58-65 (Nov 09).

With a massive effort akin to retooling factories to build aircraft in World War II or building the Interstate Highway System, the world could accommodate its projected demand of 16.9 TW of power (2.8 TW in the U.S.) with 11.5 TW provided by water, wind, and sun (1.8 TW in the U.S.) by 2030, the lesser amount due to the greater efficiency of using electric power than that produced by fossil fuels. Slightly more than half (51%) would be provided by wind, 40% by solar, and the rest by water. But of the needed generating capacity, no more than 2% of what is needed is already in place, except for the hydroelectric plants. Hydroelectricity, along with plugged-electric cars, is also slated to serve to fill in gaps left by the intermittency of solar and wind (which complement each other in being strongest when the other is not), and geothermal will serve as the baseload electrical energy source.

Wind, geothermal, and hydro are already economically competitive, the authors note, and calculations have shown that the lifetime cost of mass-produced electric vehicles will be comparable to an internal combustion engine vehicle when the price of gasoline is \$2 or more

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per gallon. The only problem they caution about is possible materials shortages: 1) neodymium in turbine gearboxes, but this might be obviated by a trend toward gearless turbines; 2) tellurium, indium, and silver in photovoltaic cells, which could be recycled, and the amount of silver reduced; 3) lithium for batteries, and 4) platinum for fuel cells.

4. David Appell, "Still Hotter Than Ever" *Sci. Am.*, **301**(5), 21-22 (Nov 09).

The basis for challenging global temperature graphs over long periods in the past, such as Muchael Mann's showing the "hockey stick" pattern of current warming, is the multiplicity of proxy data used to extract temperatures – tree rings, coral drilling, and ice cores. A new reconstruction of global temperature over the past 600 years by Martin Tingley, involving the manipulation of 1296x1296 matrices, produces the same "hockey stick" that characterizes Mann's graph.

5. David Biello, "Burying Climate Change" *Sci. Am.*, **301**(5), 23-25 (Nov 09).

Technologies for extracting carbon dioxide from coal-burning power plants include using ammonia to form ammonium carbonate, amine scrubbers, and siphoning off in coal gasification. Once extracted, carbon dioxide can be subjected to 2000 Psi and liquefied, then forced 8000 feet underground to form carbonates.

6. Jesse Hicks, "The Pursuit of Sweet (a history of saccharin)," *Chem. Heritage*, **28**(1), 26-31 (Spring 10).

Since its accidental discovery in 1878, saccharin has interacted with society in various ways. It has served as an alternative sweetener for those needing or wanting to reduce their sugar intake for medical reasons, dietary reasons, and economic reasons (sugar was in short supply during both world wars). It is also interlaced with the history of government regulation of food additives, prompting enactment of the Pure Food and Drug Act in 1906, followed by the Food Additives Amendment, which contained the Delaney clause forbidding carcinogens, in 1958. With the advent of animal testing, the story of saccharin, and that of other sweeteners as well, has also been intertwined with the question of what evidence is needed to establish that a substance is a human carcinogen.

7. Diane Wendt, "The Man With a Fish on His Back," *Chem. Heritage*, **28**(1), 32-36 (Spring 10).

The fish on the man's back was a cod, the oil from whose liver was believed to have positive medicinal effects in days before there was a Food and Drug Administration to test medicines for their purported claims. Yet this article chronologizing the marketing of cod-liver oil around the world shows that its medicinal claims were not completely without foundation: it was found to contain both vitamins A and D and mega-e fatty acids.

8. Arthur Daemmrich and Margo Bresnen, "Plastic's Second Act," *Chem. Heritage*, **28**(1), 38-39 (Spring 10).

The plastic in this article is a butanediol copolymer developed as a compostable polymer to be marketed as Ecoflex by BASF, only to be found to be technologically inseparable from nonbiodegradable plastics. The "Second act" is BASF's revised business model to market Ecoflex as a plastic sheeting to hold moisture in soil and prevent weed growth, also as a wrap for organic produce.

9. Vince Beiser, "Desperately Seeking Landmines," *Miller-McCune*, **3**(2), 18-21 (Mar-Apr 10).

More than 70 countries are plagued with underground explosive mines, which were a lot easier to emplace than they are to identify and remove. Clearing land from mines is more significant than opening it up to safe travel; it also opens the land to agricultural use. A host of mine-detection technologies – some physical, some biological – fills a 226-page catalog, but the only one that appears to be cost effective or acceptable is ground-penetrating radar, which one expert characterizes as "the main breakthrough in mine clearance since 1940."

10. Caren Chesler, "Bananas Aweigh," *Miller-McCune*, **3**(2), 22-23 (Mar-Apr 10).

Extending the shelf life of fresh produce is essential to naval mess hall morale, and this article describes ways to reduce the respiration of fresh produce: lowering its storage temperature, modifying the percentage of oxygen and carbon dioxide in the storage environment, and controlling the ratio of oxygen to carbon dioxide moving in and out of the storage packaging. Another approach is decomposing ethylene gas emitted by ripening produce which, in turn, causes other produce to ripen.

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11. Michael Haederle, "Trouble in Mind: Will the new neuroscience undermine our legal system?" *Miller-McCune*, 3(2), 70-79 (Mar-Apr 10).

Given the "core tenet of the new neuroscience that there is no single place inside our brain where free will is exercised and a kernel of 'self' resides," this article address the question: "If all our mental states can ultimately be reduced to neuro-physiological brain states, and there is really no such thing as free will, how can people be held accountable for criminal behavior?" It profiles the work of neuroscientist Ken Kiehl, who has made functional MRI scans of a thousand inmates' brains. From this he has learned that such a scan remains constant throughout a person's life, and he "believes it will one day be accorded the same respect as DNA evidence, which is now considered to be the scientifically irrefutable god standard of forensics."

12. Paul Krugman, "Building a Green Economy," *New York Times Magazine* (11 April 2010).

This Nobel economics laureate begins his "brief survey of the economics of . . . lessening climate change" by arguing that "we should have policies to discourage activities that generate negative externalities ['costs that economic actors impose on others without paying a price for their actions'] and that it is generally best to rely on a market-based approach." But he is very concerned about the planet's warming, which he clearly regards as the cause of a negative externality. The planet is warming now, he notes, and models have predicted it far in advance. Doing nothing about it now will cause greater climate changes in the future.

Of the two most likely ways to pay for the negative externality caused by global warming – "cap and trade" and a pollution tax – Krugman has the following to say: "If the government imposes a pollution tax, polluters know what price they will have to pay, but the government does not know how much pollution they will generate. If the government imposes a cap, it knows the amount of pollution, but polluters do not know what the price of emissions will be." Krugman finds no reason that one would be better than the other but sees "no reason to believe that a broad-based emissions tax would make it through Congress." Therefore, he rests content with the cap and trade provision of the Waxman-Markey climate change bill that has been narrowly passed by the House of Representatives. But he does not rest content with those who would introduce a cap and trade system

only gradually. "Current projections of global warming in the absence of action are just too close to the kinds of numbers associated with doomsday scenarios. It would be irresponsible . . . not to step back from what could all too easily turn out to be the edge of a cliff." "Climate change will lower gross world product by 5 percent, stopping it will cost 2 percent," he writes, "so let's go ahead."

13. Christie Anschwandten, "Evidence Is Only Part of the Story," *Miller-McCune*, 3(3), 32-37 (May-Jun 10).

"My mind is made up. Don't confuse me with facts!" The principal of Missouri Military Academy had these words framed in his office in the late 1950s to ward off closed-mindedness in students. Today those words would apply to expressions of disbelief that human activity is endangering the climate of our planet or belief that intelligent design trumps Darwin's theory of natural selection.

This article brings the same words to mind in relating how medical evidence is unable to shake longstanding contrary beliefs – long-distance runners believe that ibuprofen reduces inflammation, while the large doses taken expose them to gastrointestinal risks with no corresponding benefit; and increasing the threshold recommended age and reducing the recommended frequency for mammograms caused many women to believe that their protection against breast cancer was being minimized. The key to overcoming reluctance to accept new evidence, the author suggests, is to frame the new evidence in a way to give people a greater basis for hope.

14. Thomas Hayden and Malcolm Potts, "Make Birth Control, Not War," *Miller-McCune*, 3(3), 48-57 (May-Jun 10).

In this article, taken from their book, *Sex and War: How Biology Explains Warfare and Terrorism and Offers a Path to a Safer World*, these authors blame warfare on testosterone in young males, then argue that "if testosterone is the ultimate weapon of mass destruction, then the birth control pill may be the ultimate prescription for peace." ". . . to work for greater health and longer life . . . without also giving people the ability to determine family size is to condemn them to an increased likelihood of overpopulation, poverty and environmental degradation, as well as a dramatic and quantifiable increase in the likelihood of bloody conflict," they write. They also argue that "decreased family size is actually a *prerequisite* for economic growth and social stability."

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15. Jim Morrison, "Hurricanes Over the Horizon," *Miller-McCune*, 3(3), 58-67 (May-Jun 10).

In recent years earthquakes in the U.S. have caused only a fraction of the economic losses brought about by hurricanes, and Congress has now called for a "national hurricane initiative similar to the one that exists for earthquakes." The most promising results seem to be being able to predict the number of hurricanes and their frequency, which are found from sediment cores to correlate with the El Niño/La Niña cycle in the Pacific Ocean, pe-

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warmed the atmosphere further, which caused further releases, and so forth in a vicious circle. The planet has generally cooled during the last 50 My, and new methane ices have had ample opportunity to spread over the ocean floor.

CO<sub>2</sub> and temperatures are again increasing. We're putting ourselves in danger of another PETM-like event. But unlike 55 Mya, Greenland and West Antarctica today hold huge ice sheets that would eventually melt under a massive methane release, causing catastrophic ocean rise. Hansen's long-term perspective demonstrates the enormous rate of change that humans are imposing on the natural world. The warming 59 to 50 Mya was caused by an increase in atmospheric CO<sub>2</sub> concentrations that averaged only one "part per million" (ppm, meaning one CO<sub>2</sub> molecule for every million atmospheric molecules) every 10,000 years. By comparison, today's CO<sub>2</sub> concentrations have increased by over 100 ppm in just two centuries! Wherever this is taking us, it's taking us mighty fast. Today's CO<sub>2</sub> concentration is nearly 390 ppm, 40 percent higher than it's been during at least the past 800,000 years. This CO<sub>2</sub> spike occurred just since the beginning of the industrial age around 1800.

As Hansen explains, this 390 ppm level is not sustainable: Marine species are suffering multiple stresses from warmer oceans; tropical regions are expanding, bringing spreading drought, deserts, and fires; the Greenland and West Antarctic ice sheets are losing mass at unacceptable rates; mountain glaciers are disappearing; and Arctic summer sea ice will soon vanish. It's "difficult to imagine how the Greenland ice sheet could survive if Arctic sea ice is lost entirely in the warm season." Policy makers have talked for years about stabilizing the climate at 450 ppm, but in light of the trends noted by Hansen even 390 ppm is too high. What's the maximum safe level?

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school on time, we know that too many of our schools are failing to offer their students a world-class education." The full 26-page report is available online at <<http://nces.ed.gov/pubs2010/2010341.pdf>>.

(Editor's Note: The preceding item was excerpted from the *Triangle Coalition Electronic Bulletin* for 10 June 2010 and reprinted with permission.)

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riods of higher or lower hurricane activity, and Atlantic Ocean temperatures.

Hansen is a proficient calculator of such problems. He calculates that a reduction from 390 to 350 ppm will restore planetary energy balance and stabilize the dangerous trends noted above. This won't happen overnight, and we'll be living dangerously until we get back to 350 ppm.

In my opinion Hansen is absolutely right. Hansen doesn't shrink from entering the policy debate. He advocates a moratorium on coal until coal's CO<sub>2</sub> emissions can be captured and stored underground. This is essential and needs to begin today, but corporate interests prevent it. Hansen opposes the much-discussed cap-and-trade solution because it's complex and thus subject to corporate abuse. He instead supports a gradually increasing direct tax on carbon in order to reduce carbon's use, with the tax income rebated back to the public. The total amount collected each month would be divided equally among all legal adult residents, with half shares for children. For example, when the tax reaches \$115 per ton of CO<sub>2</sub>, every family of four would receive a rebate of \$8000 to \$9000 per year.

All economists seem to agree that tax-and-rebate is the simplest, cheapest, and most effective plan. Nevertheless, I disagree with Hansen's opposition to cap-and-trade, because it's the only plan that's been widely accepted, and most Americans will not support a carbon tax. Environmentalists should support both cap-and-trade and tax-and-rebate. Check out Hansen's web site at <[www.columbia.edu/~jeh1/](http://www.columbia.edu/~jeh1/)>. Under "recent presentations," see his 10 December 2009 video interview on David Letterman's Late Night show. If you don't see this listed, try clicking on "older presentations." Whether or not you agree with Hansen, do read his book.

- Art Hobson

(Editor's Note: This review is reprinted, with permission, from *Physics and Society*, newsletter of the American Physical Society's Forum on Physics and Society.)

## REVIEWS OF SCIENCE AND SOCIETY EDUCATIONAL RESOURCES

James Hansen, *Storms Of My Grandchildren: The truth about the coming climate catastrophe and our last chance to save humanity* (Bloombury USA, New York, 2009). 304 pp. \$25 (hardcover). ISBN 978-1-60819-200-7.

James Hansen is concerned about the world that his grandchildren, Sophie age nine and Conner age four, will inherit. He's written a blockbuster that will be widely discussed.

During the past two decades there has been a deluge of books, most of them good, about global warming. This is the most important of the lot. Hansen is an accomplished scientist. He came to national attention in the 1980s when he testified before Congress and made a series of accurate predictions regarding the severity of global warming. He directs NASA's Goddard Institute for Space Studies, and is adjunct professor at Columbia University's Department of Earth and Environmental Sciences. Congress frequently calls him to testify on climate issues. He has authored and co-authored an impressive number and variety of scholarly papers centering around climate change, papers that are unusual for their depth of analysis and breadth of focus.

Hansen is also unusual among climate scientists in drawing conclusions predominantly from empirical data rather than from computer simulations. Computer models can be valuable, but it's always difficult to know whether all relevant variables are included in the model, and some variables (such as clouds) are nearly impossible

to compute. Empirical data come from mother nature, she includes all the variables, and she can do all the calculations. For example, one of Hansen's figures graphs 65 million years of temperature history. The graph draws on evidence found in deep-ocean sediment "cores" (a long vertical pipe full of sediment inserted into the ocean bottom and then pulled up) and reported in 2001 by other scientists. Such a core contains evidence of the temperature and date of deposit at each position along the core. Hansen draws several lessons from this graph and related evidence. One is that a long-term 9-degree (Fahrenheit) warming, during 59 to 50 million years ago (Mya), was caused by natural releases of carbon dioxide (CO<sub>2</sub>) into the atmosphere.

As you probably know, CO<sub>2</sub> is a major "greenhouse gas" that absorbs Earth's radiated energy and thus warms the planet, much as a blanket on your bed absorbs your radiated energy and thus warms your body. An important lesson comes from the "Paleocene-Eocene thermal maximum" (PETM), a sudden 8-degree temperature spike 55 Mya. Hansen convincingly locates the cause. Rising ocean temperatures caused deposits of "methane ice" (a frozen mix of methane and water that gathers on the ocean floor) to melt and release large amounts of methane (a potent greenhouse gas) into the water, and the methane bubbled up to the atmosphere. Once methane release began, it necessarily continued until essentially all the methane ice was melted, because the initial release

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