Diversity and Inclusion

MEMBERSHIP UNITS

inclusion efforts, provide a space who are involved in diversity and a variety of backgrounds. FDI will in physics, as it will be able to existing efforts by APS and its will both supplement and expand this goal. The formation of FDI will both supplement and expand this goal. The formation of FDI is an integral step to meeting for all those engaged in physics, and coming and inclusive environment approval from the Council.

Inclusion (FDI) received over 1600 signatures needed for the Council's signatures, blowing past the 200 signatures, and consists of four persons, who rotate through one-year terms as Vice President, President-Elect, President, and Past President. These four members all began their new roles on January 1, 2020. For more on APS governance visit aps.org/about/governance

FDI on Diversity and Inclusion

MEMBERSHIP UNITS

APS Launches a New Forum on Diversity and Inclusion

n November 8, the APS Board and Council approved the creation of a new forum dedicated to making physics a community where all people feel welcome and heard. A petition to create the Forum on Diversity and Inclusion (FDI) received over 1600 signatures, blowing past the 200 signatures needed for the Council’s consideration, and the petition received a unanimous vote of approval from the Council.

A key tenet of the APS Strategic Plan: 2019 is serving the physics community by providing a welcoming and inclusive environment for all those engaged in physics, and FDI is an integral step to meeting this goal. The formation of FDI will both supplement and expand existing efforts by APS and its member units to promote a culture of diversity, equity, and inclusion in physics, as it will be able to bring together APS members from a variety of backgrounds. FDI will grow the number of APS members who are involved in diversity and inclusion efforts, provide a space for discussing issues within the science community, and support existing projects.

“The creation of this forum is very timely as the portfolio of APS diversity programs has grown substantially over the last few years,” says Monica Plisch, Director of Programs at APS. “For example, the new APS-IDEA project will network and support physicists working to improve diversity, equity, and inclusion in their physics departments and laboratories, and the Forum is a natural partner in this effort.”

Strategic Plan

Throughout 2018, APS members, leadership, and staff prepared a new Strategic Plan to guide the society and lay out priorities for APS in the years ahead. Strategic planning is an opportunity to set priorities, focus resources, work toward common goals, and assess and adjust the Society’s direction in response to a changing environment.

“I don’t see strategic planning as a tactical exercise but as a process that will lay out options, strategies, and rationales so that APS can remain a strong advocate for physics in a changing environment,” said 2018 APS President Roger Falcone.

This process involved the Strategic Planning Steering Committee, APS Board of Directors, APS Senior Management Team, staff, and volunteer leaders working with a consultant to bring in stakeholders and stay at a consistently high level. Outreach to members included discussions at the APS Leadership Convocation, Town Halls at APS March and April Meetings, Focus Groups at March and April Meetings, presentations at the APS Annual Business Meeting, and an online feedback form.

The result has been a dynamic, nimble plan that is easy for everyone to understand, a document that is an active guide for APS to respond to opportunities and challenges. The APS Strategic Plan 2019 will be used to communicate the organization’s goals, potential actions, and metrics for measuring success and impact, both internally and externally. The plan document can be downloaded at go.aps.org/strategicplan.

“I am very impressed by the efforts of the staff and the Board and all the committees who put in an incredible amount of work and completed the plan on schedule,” said 2019 APS President David Gross. “We want to improve current operations and build on what APS has always been doing and doing well, to do it even better. Given my limited time as President, I have focused on implementing some of the newer initiatives, especially the Innovation Fund and a new annual meeting.”

Added APS CEO Kate Kirby, “APS has a tremendous amount to be proud of in terms of the things the Society does for and with the physics community. It is important for us to continue doing those things but also to explore, experiment, and pilot new ways to move forward.”

Here are some of the important accomplishments thus far: APS Innovation Fund: The APS Innovation Fund was launched in early 2019 to inspire members to develop fresh approaches to serving the physics community in ways aligned with the Strategic Plan. Four projects were selected for funding (see APS News, August/September 2019): improving the APS meeting experience through machine learning; the APS Inclusion, Diversity, and Equity Alliance (APS-IDEA) to create a network of diversity leaders; informing and activating the US physics community to tackle nuclear proliferation issues; and the US-Africa Initiative in Electronic Structure to foster collaborations between African and US physicists. The APS Board and Council voted in November to continue the Innovation Fund in 2020.

APS Ethics Committee: A new Ethics Committee, which convened for the first time on June 6, 2019, will lead the charge for promoting ethical practices by APS members (see APS News, July 2019). The committee chair for 2019–2020 is Michael Marder (University of Texas at Austin). Among the committee’s many roles will be development and review of ethics policies for APS; procedures for handling complaints and potential revocation of honors; creating materials to educate members in best practices; and organizing...
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EDUCATION

CUWiP Positively Impacts Women in Physics

BY LEAH POFFENBERGER

Each year, around 2,000 undergraduate women in physics make their way to one of the many regional locations for the annual Conferences for Undergraduate Women in Physics (CUWiP). CUWiP began as a grassroots effort launched by the University of Southern California in 2006, growing to six conference sites. In 2012, APS became an institutional home for CUWiP, providing support for a growing number of conference sites: from January 17 to 19 this year, 13 sites across the country will host women seeking undergraduate physics degrees.

CUWiP was founded with the goal of increasing the number of bachelor’s degrees awarded to women. Just over 20 percent of bachelor’s degrees in physics were awarded to women in 2017, compared to almost 35 percent of bachelor’s degrees in all fields. Through a weekend of plenary sessions, workshops, and networking events, CUWiP seeks to provide undergraduate women with a supportive community and tools they need to be successful in physics.

“Almost everyone who has a physics degree and a woman will attend one of our CUWiPs. About 2,000 women each year are pursuing physics degrees and [we have] about 2,000 attendees each year,” says Renee Michelle Goertzen, Senior Program Manager at APS. “We have a national reach.”

CUWiP indeed has a large presence, with 12 sites in the United States and one in Canada, providing geographic ease of access for many of the attendees. These conferences are also remarkably diverse, drawing in undergraduate women from 35 percent of bachelor’s degrees in women in 2017, compared to almost 35 percent of bachelor’s degrees in all fields. Through a weekend of plenary sessions, workshops, and networking events, CUWiP seeks to provide undergraduate women with a supportive community and tools they need to be successful in physics.

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CUWiP continued on Page 6

INTERNATIONAL AFFAIRS

Postcard: Physics in Vietnam

BY MICHAEL SCHRIEBER

In the coast of Vietnam, near the midpoint between north and south, sits Qui Nhon. In this city tucked within rolling hills, the locals go to the beach at the break of dawn before the streets fill up with the honking and puttering of motor scooters. It’s here too where many scientists come to relax and attend meetings on particle physics, cosmology, and biophysics at the International Center for Interdisciplinary Science and Education (ICISE). Bordered by sandy beaches and coconut trees, ICISE hosts roughly 20 conferences per year. In September, I went to ICISE to attend a conference at the 15th Rencontres du Vietnam and to learn about the development of physics research in the country.

Established in 2013, ICISE owes its existence to Vietnamese-born, French-trained physicist Jean Trân Thanh Vân, well known for his work at the International Centre for Theoretical Physics (ICTP). Trân Thanh Vân is currently the director of ICISE.

In the past, physics has been in the shadow of other scientific disciplines. “We have a long tradition here in mathematics,” Trân Thanh Vân explained to me. Well-registered mathematicians have come from Vietnam, including Fields-Medal winner Ngô Bảo Châu, and Vietnamese high school students perform well in international math competitions. By contrast, physics has lagged behind, in part because it’s easier for universities to support a math professor than a physics professor needing experimental facilities.

“According to my memory,” physics began to develop in Vietnam in the year 1956 when the department of physics was established at Hanoi University,” said Nguyễn Văn Hviol, who was the first director of ICISE.

MEETINGS

Putting the Flu in Fluid Dynamics: Tracking the Transmission of Airborne Disease Particles

BY LEAH POFFENBERGER

During the peak of flu season, many people find themselves being wary of their coughing co-workers or sniffling students, but airborne diseases, like cold and flu viruses, can sometimes travel far beyond a sick colleague’s desk.

At the 2019 Division of Fluid Dynamics meeting in November, Sima Asadi from the University of California Davis presented research on tracking what activities cause a sick person to expel the most virus-laden droplets and modeling how these particles can spread in an indoor environment. Asadi’s research, done as part of a partnership between the University of California Davis and the Kahn School of Medicine at Mount Sinai in New York, shows the disease-spreading potential of speaking loudly and the spread of disease-carrying aerosol particles at various distances.

Coughing and sneezing are the two most obvious behaviors that some people think of when it comes to the spread of airborne diseases, since both give off large, easily visible droplets and a large number of microscopic particles—and both can carry the virus. However, simply breathing and speaking can give off tiny particles capable of carrying infectious agents, too. And since breathing and speaking can happen continuously, versus coughing and sneezing which happen more infrequently, it’s possible that these activities have a higher probability of disease transmission. Previous studies of infectious disease transmission have identified talking as a notable particle emission mechanism but did not account for differences in speech volume.

“(Other studies involved) counting from one to 100 and saying ‘okay,’ whereas we’re kind of this much particle, so talking is important,” said Asadi. “But we did a more controlled measurement: we controlled for the loudness of speech.”

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Loud talkers spread more virus.

after establishing volume of speech as a parameter for aerosol emission and disease transmission, the next step for Asadi’s research group was to use this data while examining the role of distance: what is the likelihood that someone in an enclosed space, like a classroom or an airplane, gets others sick through airborne particles?

Classical modeling of disease transmission has made use of what is known as the Wells-Riley model, which assumes all air in a room is perfectly mixed—meaning the aerosol particles are assumed to be part of that mixture. This fails to account for both time and location in the room, which limits the model’s usefulness for short-
n response to APS members’ concerns over climate change, the society recently submitted a public comment (go.aps.org/3plp5e) opposing the EPA’s proposed policy amendments to curtail regulation of greenhouse gas emissions. The amendments would eliminate requirements on oil and gas companies to install technologies to monitor methane leaks in pipelines, wells, and storage facilities. The EPA urged the EPA to instead carry out a rigorous assessment of methane emissions—a major contributor to climate change.

“Public policies related to climate change are top concerns of our members. Recent science is now showing that the environmental impact of methane emissions on global warming is about twice as great as past estimates. We are directly opposing the administration’s proposed rule change relaxing methane emissions, and we are doing so based on the science,” said Philip Buckbaum, 2020 APS President and a physics professor at Stanford University and SLAC National Laboratory.

APS previously encouraged members to submit their own comments on the proposed amendments by EPA’s November 25 deadline.

According to the APS comment, “Current regulations require that calculations of methane’s radiative forcing (RF) had excluded any short wave-length effects. This omission has led to a systematic underestimation of methane’s RF by approximately 15 percent. Additionally, the inclusion of short wavelength effects impacts methane’s 100-year global warming potential (GWP), increasing it by 14 percent above the current value provided by the Intergovernmental Panel on Climate Change.”

Furthermore, the APS comment stated: “With the risks of methane emissions now determined to be higher than previously estimated, this is not the time to be relaxing regulations.”

Interestingly, major oil and gas companies have previously made statements supporting the regulation of methane emissions, including BP America Chairman and President Susan Dío, who outlined the company’s stance in an op-ed in the Houston Chronicle (March 29, 2019). She wrote, “First, it’s the right thing to do. It’s also the business decision.”

But not everyone agrees. The White House has tasked the President’s Council of Advisors on Science and Technology (PCAST) with a new initiative to reduce methane emissions from the oil and gas industry. The White House launched its Sputnik satellite. As the world watches, we must take a new look at methane emissions and the role we must play in reducing them.

The White House has tasked the council with developing a “five-year plan” for accelerating the development of these industries that includes immediate, short-term recommendations. Droegemeier suggested the plan could focus on overcoming obstacles that inhibit collaboration across the academic, industrial, government, and non-profit sectors of the US research enterprise. He characterized such an initiative as “much more than rhetoric.”

A second workstream entails better leveraging federal laboratories to benefit the enterprise. At the meeting, conversation about the industries of the future dovetailed with discussion about how the labs could better advance them.

Speaking to the council, Department of Energy Office of Science Director Chris Fall emphasized that DOE’s national labs have substantial authority to build cross-sector relationships. He added there is already considerable interest in using the labs to build partnerships but noted that new initiatives can tax the capacity of the administrative officers responsible for implementing them.

The third workstream involves bolstering the US STEM workforce. Although the council did not decide how they would approach the issue, they discussed a variety of problems such as recruiting and retaining a diverse community in STEM fields, bolstering the skilled technical workforce, and upskilling workers to adapt to technological and economic change. They also broached the possibility of looking at US visa practices and other issues related to retaining foreign talent in the US.

Droegemeier suggested that, to elevate attention to issues affecting younger people, this version of PCAST will include for the first time a subcommittee comprising 20 individuals at the student, postdoc, and early-career levels. PCAST has tentatively scheduled its next in-person meeting for February 2020.

The author is the Senior Science Policy Analyst at FYI.

FYI: Science Policy News from AIP

White House Revives Science and Technology Council

William Thomas

The President’s Council of Advisors on Science and Technology (PCAST) had stood dormant for more than 33 months when President Trump signed an executive order reconstituting it on October 22. Comprising eminent outside experts, the role of the council is to provide independent advice to the president and White House policymakers.

Every president has stood up their own version of the council since George H.W. Bush first established his in 1980. Before that, most other presidents employed analogues bodies, dating back to Dwight Eisenhower’s creation of the President’s Science Advisory Committee in 1957 after the Soviet Union launched its Sputnik satellite.

So far, Trump has named nine of an anticipated 16 members. Of them, three are academics, including Birgitta Whaley, director of the Quantum Information and Computation Center at the University of California Berkeley. Council members from industry include Dario Gil, the director of IBM Research, and A.N. Sreeram, head of R&D at the Dow chemical company.

PCAST will be chaired solely by Kevin Droegemeier, director of the White House Office of Science and Technology Policy and the council’s 17th member. Past iterations of the council have also drawn a co-chair from among its ordinary members, but that does not appear to be in the plans for the current version.

At PCAST’s first meeting on November 18, Droegemeier emphasized that, with only about a year remaining in the current presidential term, time is of the essence. He said the council will not produce detailed reports, as previous presidents’ councils have, but rather will focus on making more immediately “actionable” recommendations. He also said its efforts will focus on what he referred to as three “priority workstreams.”

The first workstream revolves around five “industries of the future” that OSTP identified earlier this year as priority R&D areas: artificial intelligence, quantum information science, 5G telecommunication satellites, advanced manufacturing, and synthetic biology.

The White House has tasked the council with developing a “five-year plan” for accelerating the development of these industries that includes immediate, short-term recommendations. Droegemeier suggested the plan could focus on overcoming obstacles that inhibit collaboration across the academic, industrial, government, and non-profit sectors of the US research enterprise. He characterized such an initiative as “much more than rhetoric; it actually is an experiment at scale.”

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Closely with Brown and Plisch on organizing FDI, the committee worked going slowly enough to make sure before the by-laws, the mission and time to go through and get the first says Simmons. “It took us a long

any given meeting to listen to what know one another’s unique view-

to Simmons, this was a long process, able to spread the workload, build for a larger membership group to be

Best Practices guide for department as LGBTQ, so I was interested first edition of its Best Practices

in a variety of high-tech equipment, at VAST, with 250 staff members, (IMS), today the biggest institute emphasis on applied physics, such condensed matter, quantum optics,

The Nobel Lectures in Physics and Chemistry: The View from Stockholm

ABIGAIL DOVE

n a cold December day in Stockholm, Sweden, the Nobel Lectures in Physics and Chemistry—among them three APS members—delivered the leadership of FDI will continue to give voices to people from varied backgrounds and minority groups within physics.

An important question was how the (by-laws) could ensure that the leadership of FDI will continue to give voices to people from varied backgrounds and minority groups within physics.

A key issue for the FDI organi-

growth. IOP is the modern-looking building

However, in 1969, the Vietnamese government established the IOP—a national laboratory in the spirit of US national labs. “The quality of the research, IOP is the modern looking building, the IOP's olive-colored building in

Vietnam continued from page 3

Vietnam's Institute of Physics (IOP). He told me that the government of Vietnam used to send many physics students abroad to learn and other socialists. When they came back, their main task was educating teachers, so these physicists had little time to do research.

In 2009, the physics program at the IOP was re-established and is the physics faculty at Vietnam National University (formally known as Hanoi University), where I spent an

The IOP is one of two dozen insti-

tutes in the Vietnam Academy of Science and Technology (VAST), which has a large campus in the middle of Hanoi. I paid a visit to the IOP, which is a corner of the VAST campus and met with its director Dinh Van Trung. He said that the Institute’s $1 million budget supports 150 staff members, around a third with PhDs in theoretical research, collectively publishing around 100 papers per year in national and international journals.

One of the positive signs for the IOP and other physics institutions in the government’s Program of Development in the Field of Physics by 2025. This program (and a similar one in chemistry) aims to improve research sectors that can help accelerate the economic development of the country, said Nguyen Van Hoi. With input from the physics community, the program has targeted top research priorities in theoretical and experimental physics, condensed matter, quantum optics, and nuclear physics.

In Vietnam, the government places an emphasis on applied physics, such as materials science. Not far from IOP is one of the new centers to promote diversity and inclusion.

Over the longer term, I hope that the FDI can be a place where we can have meaningful conversations about the barriers many physicists encounter. We should name the things that worry us and try to be better colleagues to one another,” says Simmons.

rlence, science, nuclear physics, and particle physics.

The opportunities for gradu-

and Diversity and Inclusion Manager. “I think there was a need for a larger membership group to be able to spread the workload, build for a larger membership group to be

The doors to the lecture hall mercifully opened just as an icy mix of rain and snow was beginning to fall, and there were barely any empty seats to be found when APS Fellow James Peters (Vanderbilt) kicked off the Nobel Lectures in Physics. Peebles is credited with developing the theo-

continues from page 1

Committee on Minorities in Physics and the Committee on the Status of Women in Physics, have laid in order to tackle larger issues. Committees comprise smaller groups of appointed APS members who oversee and support particular efforts on a variety of fronts while forums are larger membership-ship units that any APS member can join and contribute to in ways like the Division of Nuclear Physics, also have initiatives for diversity and inclusion. “It made me appreciate a more centralized mechanism of promoting these aspects of physics. [APS] has shown a lot of diversity work for APS, but they are smaller groups: for example, the APS committees have just nine people. There’s only so much that they have the capacity to do,” says Erika Brown, APS Education and Diversity Programs Manager. “I think there was a need for a larger membership group to be able to spread the workload, build for a larger membership group to be

The author is a Corresponding Editor for Physics based in Lyon, France.
METHANE CONTINUED FROM PAGE 4

and equipment, the more we can make a case for doing this. Simply, the challenge of producing more energy on Earth is less than that of reducing atmospheric methane.

It has a shorter lifetime in the atmosphere than carbon dioxide (CO2), so reducing methane is a more immediate and effective way to tackle climate change. This is why some people, including the Intergovernmental Panel on Climate Change (IPCC), have highlighted methane as a key issue.

“Here, we have something we can actually do something about,” says Goertzen. “The other half of this year’s conference will be focused on methane.”

The meetings will include sessions on the causes and solutions of methane, as well as discussions on how to engage the public and policymakers on this issue.

“Networking has always been one of the largest changes to CUWiP,” says Goertzen. “I want [undergraduate students] to have that opportunity to network with others, to talk about physics, to learn about the importance of networking time.”

This was just a brief introduction to what physics students can expect to learn and experience at the upcoming APS meeting. The conference will include a variety of talks, workshops, and networking opportunities, all focused on promoting diversity and inclusion in physics.

Next year, the APS will be holding its annual meeting in Denver, Colorado. This meeting will include a special focus on climate change, highlighting the urgent need for action on this issue.

“Physics is critical to solving the climate crisis,” says Goertzen. “The science and technology we develop today will shape the future of our planet.”

Do we have what it takes to make a difference? Yes, we do. The APS is committed to promoting diversity and inclusion in physics, and we encourage all students to attend the upcoming meeting to learn more and engage with the community.
vortex below. Using high resolution imaging and computer analysis, Marcus and his team were able to measure what’s happening in the vortex underneath the cloud layer.

“We determined the actual boundary of the underlying vortex, which is the machine that drives the red spot and it’s not completely correlated with the clouds,” said Marcus in a press conference. “It’s not at all clear that the shrinking of one has to do with the shrinking of the other. You can’t just conclude that if the cloud is getting smaller that the underlying vortex is getting smaller.”

The mismatch of clouds and vortex is possibly what started the worry about the Great Red Spot in the first place: the small vortices that interacted with the red spot don’t always have their own clouds, allowing them to attract less attention from astronomers as they move across the planet, until they moved too close to the Great Red Spot. The spot is a high-pressure system that turns in the opposite direction of the planet, making it an invisible force creating invisible clouds and storms that are also anti-cyclones, but low-pressure cyclones that turn in the direction of the planet also exist—they just don’t reliably produce clouds announcing their presence. The existence of invisible non-cloud producing cyclones can be inferred when they come close to an anti-cyclone, causing the visible anti-cyclone to act differently.

According to Marcus, the observation of the Great Red Spot flaking was simply a result of the strong anti-cyclone to act differently. When two anti-cyclones interact, the smaller of the two will be absorbed by the other, but the merger isn’t instantaneous; a visible bulge in the boundary of the anti-cyclone’s clouds can be seen until it is fully absorbed. In the case of anti-cyclones and cyclones, as the outer boundaries of their vortices interact, it creates what’s called a stagnation point. Typically this causes an anti-cyclone to be observed as slightly altered. When these two are mixed, one or more cyclones are created, and if the cyclones are large enough, they might be observed as a single entity. The digested anti-cyclone was thrown into a visible bulge in the boundary of the anti-cyclone’s clouds.

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A round 1975 our government and industry all said that the energy needed to make a dollar of gross domestic product (GDP) could never drop. A year later, I heretically suggested it could drop 72 percent in 50 years (7). So far, it’s dropped 58 percent in 43 years, but just the innovations already added by 2030 can save another threefold, or twice what I originally thought, a third of the cost. Today, that looks conservative because optimizing buildings, vehicles, and factories as whole systems—no parts of parts—can often make very large energy savings cost less than small or no savings, turning diminishing returns into increasing returns.

Depleting only stupidity

Economists know that a mineral’s reserves—the identified deposits profitably extractable with current technology—are only a small part of the resource base. Most energy analysts also narrowly define reserves of energy efficiency like mineral resources, but the actual energy efficiency reserves are several-fold larger than those now typically recognized and captured.

The “missing majority” is hiding in plain view and is exploitable by integrative design, as I will describe. But this geological analog breaks down on cost: orthodoxies are finite assemblages of ideas. While such ideas are essentially inexhaustible, they are not necessarily infinite in number, i.e., inexhaustible assemblages of ideas. Exploiting ideas depletes only stupidity, a very abundant resource. All of this is documented in a peer-reviewed paper [2] called “How Big is the Energy Efficiency Resource?”

An example—my house

I’d never built a house before, so I didn’t know what was possible. My wife Judy and I live near Aspen, Colorado, at 20 meters elevation. Temperatures there used to dip to as low as minus 44 degrees Celsius. We saw up to 39 days of continuous midwinter chill, but our house uses no combustion. (That’s so 20th century.) Instead, we use superinsulation, ventilation, heat recovery, and superinsulated windows that insultate like 16 or even 22 sheets of glass but look like two and cost less than three, making the house 99 percent passive solar heated and 1 percent active solar.

Eliminating the heating system more than paid up front for the efficiency that displaced the heating system, slightly reducing total construction costs and then saving also 90 percent of electricity and 99 percent of the water heating.

It was all paid back in 20 months with 1983 technologies, which are not nearly as good or cheap as those we have now.

Our house helped inspire more than 160,000 European buildings, vehicles, and factories as whole systems—no parts of parts—more artfully chosen, combined, and timed and sequenced.

Integrative design in the author’s residence in Colorado means that no combustion energy sources are needed for heating and cooling. (IMAGE: ROCKY MOUNTAIN INSTITUTE)

The big picture

What can integrative design do for a big economy? Well, seven years ago our business and design synthesis, Reinventing Fire [1], rigorously showed how to triple US energy efficiency and quintuple renewables by 2050 needing no oil or coal or nuclear energy and at least a third less natural gas, while saving 5 trillion, growing the economy 2.6-fold, strengthening national security and cutting fossil carbon emissions 82 to 86 percent. This needed no new inventions nor Acts of Congress, but instead, with smart city and state policies, could be led by business for profit. The first eight years of this 40-year journey are nicely on track, because the private sector smelts the 5 trillion on the table.

That’s exactly what should be happening. I hope these examples will encourage you to rethink paying back in less than a year and at a third less cost—because it’s a technology; it’s a design method. And most people don’t yet think of design as a scaling vector—a way to make things big, fast.

And the methods are simple—it’s just physics. What do such savings mean for the motors that use over half the world’s electricity? From the fuel burned in the power plant to the end use, there are so many compounding losses that only a tenth of the fuel energy comes out the pipe as flow. But every unit of lower friction you save at the pipe leverages back to 10 units of fuel cost, emissions, and global warming saved at the power plant and as you go back upstream, the components get smaller and cheaper, so the total capital cost goes down. If you know an engineering textbook that mentions this “start downstream” principle, I would love to see it.