Science at the Ballot Box

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The Future of Science In America: The Election Issue

Contents

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Science at the Ballot Box – Editors' Note 3

by Aaron F. Mertz, Jylana L. Sheats, Cary Funk, and Corey S. Powell

Advice to the Next President 4

by Aaron F. Mertz

contributions compiled by Aaron F. Mertz and Kyler Zhou

Frances H. Arnold 6
Edward S. Boyden 6
Martin Chalfie 7
H. Robert Horvitz 7
A. James Hudspeth 8
Judith P. Klinman 9
Eve Marder 9
John C. Mather 10
Emmanuel Mignot 11
Susan Solomon 12
Thomas C. Südhof 12
Carl Wieman 13

What's at Stake for Science in the U.S. Presidential Election 14

by Cary Funk

How to Rebuild Trust in Science 21

by Cary Funk and Jylana L. Sheats

Looking Ahead to Combat Climate Change 26

by Kitty Pollack and Greg Gershuny

What AI Can Do for Your Country 31

by Jylana L. Sheats

Science for the People 37

by Michael Akinwumi, Elizabeth Good Christopherson, Anna Dulencin, and Jon Kaye

Preserving America's Place in Global Science 43

by Tobin Smith

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Science at the Ballot Box

Taking stock of the moment for science and science policy.

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The Aspen Institute is delighted to collaborate with *Nautilus* magazine on "Science at the Ballot Box," a special series of articles exploring what is at stake for science and science policy in the upcoming United States election and beyond.

Science informs every aspect of governments' efforts to protect the public and to improve our lives—sometimes in ways that are obvious, sometimes not. The U.S. Food and Drug Administration draws on research studies and clinical trials to regulate the safety of new drugs and medical devices, as well as to evaluate their effectiveness for treating specific

diseases and conditions. The Environmental Protection Agency uses scientific data to shape the standards that ensure the public has clean air and water. America's armed forces depend heavily on science and technology to keep our nation safe with cutting-edge equipment and intelligence-gathering tools.

Even the daily operations of the government (from delivering mail and packages to moving people smoothly through airport checkpoints) benefit from science-rooted innovations. On every level, our lives are touched by choices we make about how to support research and about how to incorporate scientific insights into the law of the land.

In "Science at the Ballot Box," thought leaders from the Aspen Institute and other leading organizations take stock of where we stand today and where promising opportunities lie ahead.

On every level, our lives are touched by choices we make about how to support research and about how to incorporate scientific insights into the law of the land.

The series highlights the voices of people using science to address civic issues in society, locally and nationally; leaders who are developing forward-looking policies to address climate change while making sure we have an abundant, reliable energy supply; scientists and tech developers who are grappling with the far-ranging implications of artificial intelligence in the workplace; and organizations that are building trust in science through personal engagement with the public.

In these articles, we will take a close look at the landscape of public opinion to better understand how Americans' attitudes toward science are influenced by political affiliation, education, race, ethnicity, and age. We will also take a broad perspective to consider where the U.S. stands in global science and how it can continue to compete and to serve as an international leader. Some of the country's most distinguished researchers will share detailed, deeply informed advice they would give the incoming president.

The Aspen Institute is politically neutral about the outcome of the upcoming election. We are nonprofit and nonpartisan, meaning that we don't take sides or stand with one particular party. But we do believe strongly in the value of scientific research and rational decision-making. On the cusp of the 2024 election, we see this moment as an ideal opportunity to think deeply about the future role for science in society—not just over the next election cycle, but for many years to come.

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This editors' note was found originally at Nautilus.

Advice to the Next President

Leading scientists and engineers offer strategies for putting the public good ahead of politics.

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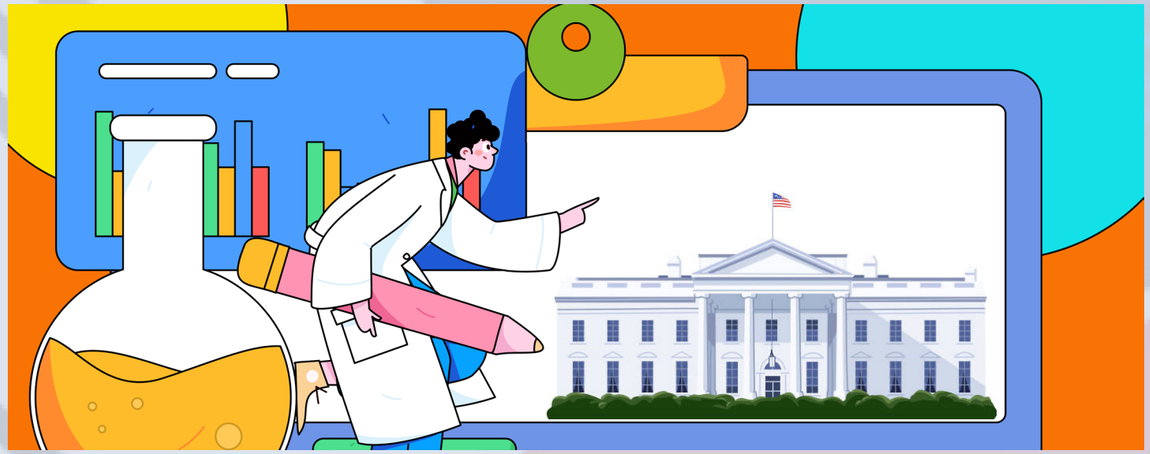
Aaron F. Mertz *is the founder and executive director of the Aspen Institute Science & Society Program.*



Science is the beating heart of progress, yet its critical role often gets drowned out by the clamor of political theater. With a national election looming in the United States, the Aspen Institute Science & Society Program contacted some of the most lauded scientists in this country—including Nobel laureates and holders of the National Medal of Science—and asked them to share their recommendations on how the next President should bolster American science and draw on scientific insights to help address the nation's most pressing problems.

These heavyweights from biomedicine, chemistry, neuroscience, physics, and environmental studies largely converged on the big issues facing the country and the world, even as they offered diverse perspectives on the best ways to tackle those issues.

One recurring theme across the responses is that science is more important than ever in a fractured society. Enormous social challenges like climate change, an aging population, and artificial intelligence are made even more difficult by deep disagreements over how to tackle them. These experts say that science-informed responses offer the best opportunity to break through the polarization. Chemical engineer Frances Arnold, for example, argues that science can bridge divides by offering solutions that transcend political and social boundaries. As she puts it, science is "our one universal language."

Our respondents see the rise of anti-science rhetoric as a dire threat to the future of the U.S. They raise alarm over growing irrationality and political manipulation of scientific facts in American society and around the world. This dangerous trend not only jeopardizes the country's ability to advance knowledge but also undermines the capacity to confront global crises such as public health emergencies.

Many of the experts' responses call for a revamp in the U.S.'s approach to STEM (science, technology, engineering, and mathematics) education, arguing that a changing world requires new ways of teaching and learning. Experts including physicist Carl Wieman advocate for a transformative shift, away from memorization

and toward using science as a creative tool for better decision-making and deeper understanding. Many of the experts also emphasize the importance of an inclusive workforce, highlighting the invaluable contributions of immigrants to U.S. scientific achievements.

Scientific progress has been an integral part of American identity from the start. Article I of the U.S. constitution calls on Congress "To promote the Progress of Science and useful Arts." Since then, the challenges the country faces have changed radically, but the optimal strategy for facing them remains the same: investing in groundbreaking research, nurturing the next generation of scientific minds, and upholding the scientific method as our greatest tool for building a safer, happier, healthier, and more just society.

Contributions compiled by
Aaron F. Mertz and Kyler Zhou.

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Frances H. Arnold
Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry
California Institute of Technology
2018 Nobel Prize in Chemistry

It is time to heal divides by remembering what we share—a deep love for our children, our nation, and our jewel of a planet. We also share science, our one universal language. Science is an expression of our deepest curiosity and desire to understand where we came from, where we are, and where we are going. It is also a powerful tool for making difficult choices on where to invest and where to stand back. Without science, we lose the opportunity to guide the future.

Science does not take sides. Science provides understanding, and it provides the fuel for innovation and prosperity. Science can help unite the country and guide us into the future we want to see. Please move to support and replenish the science and technology workforce in the federal government, and make use of the voices outside the federal government that love our nation as much as you do. Here you can lead by example.

We are a great nation, with but a small fraction of the world's population. Most of the smartest and most creative people are born outside our borders. Let us continue to welcome them here, where they will push the frontiers of science, inspire us, and create wealth and opportunities.

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Edward S. Boyden
Professor in Neurotechnology
Massachusetts Institute of Technology
2016 Breakthrough Prize in Life Sciences

Twentieth-century science yielded many inventions that revolutionized everyday life: the airplane, the computer, the cell phone. We even landed on the moon, the iconic demonstration of scientific achievement. In contrast, the problems we're trying to solve in the 21st century—curing brain disorders, addressing climate change, confronting aging-related diseases—can seem enduringly daunting. What should we do?

Scientific fields often undergo revolutions when they achieve a "ground truth" level of understanding, a description of the fundamental building blocks of the system being studied along with how they interact with each other. For example, airplanes, computers, cell phones, and moon rockets all build on the scientific field of physics. In the early 20th century, physicists began to achieve a "ground truth" understanding of physics, sufficient to explain a wide variety of phenomena. This understanding galvanized countless innovations, like those named above. The scientific risk associated with inventing something new was reduced to the point where engineering and design could proceed predictably and robustly.

Why are 21st-century problems so hard? Physics involves a small number of building blocks, and a small number of ways they interact. In contrast, brain science, climate change, aging, and many other 21st-century problems involve far greater numbers of building blocks and interactions. Addressing such problems requires technologies to see and control the relevant building blocks, as well as their interactions, to reach "ground truth" understanding. To generate such tools will require scientific institutions, funding, and culture that welcome serendipity, because "ground truth"-oriented tools often emerge, in part, through luck. (For instance, CRISPR was discovered in yogurt; PCR was enabled by microbes from hot springs.) But luck can be engineered. Systematic approaches—such as trying to think of every way to solve a problem, or examining partially failed solutions to see how they could be rebooted towards success, or creating new kinds of collaboration between problem-experts and solution-providers—could enable us to augment our serendipity.

Such tools will need to be systematically applied to the complex systems in question, so that "ground truth" data can be acquired, new principles discovered and models made, and new eras of engineering and design opened up. The low-science-risk field of physics continues to bear fruit; based upon the revolution launched by the computer, one can drop out of college and start a company like Apple, Microsoft, or Facebook. Perhaps someday a college dropout will cure a brain disease or solve another big 21st-century problem. Then we will know we have succeeded.

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Martin Chalfie
Professor of Biological Sciences
Columbia University
2008 Nobel Prize in Chemistry

In my essay four years ago, I made three major requests of the incoming president: 1) "increase support for both fundamental and applied research"; 2) "put more resources into educating future scientists [and] provide opportunities to increase diversity within the sciences"; and 3) "ensure that governmental decisions and administrative policies are based on strong scientific consensus." These requests were long-term goals, so no one would have expected them to have been achieved in a single presidential term. I believe that the past four years have seen increased support for them. Nonetheless, these goals remain aspirations for the future.

Unfortunately, the need for decisive action in support of science and science education remains high. As I write this piece, New York City is seeing once again a surge in COVID-19 cases, and concern is growing in the U.S. about bird flu being transmitted to people. Additionally, the world has just experienced the hottest summer ever recorded.

Addressing problems of health, climate, food security, and many other issues requires a multifaceted approach. To implement what I outlined above and in my previous essay, the next four years should see both immediate support and long-range support. We need immediate financial support to enable research that can cope with the issues we are facing and to rejuvenate and invigorate STEM education to produce the workforce that will make the next series of breakthroughs. In addition, we need to realize that we simply do not have enough of the basic scientific knowledge that will allow us to address these global challenges.

Increasing our knowledge base should be a top priority. In my opinion, the discussions by politicians and in the news media about using science to address societal problems are often couched in terms that make the efforts seem like engineering problems. We talk about scientific endeavors being "moonshots," based on the incredible effort that landed Neil Armstrong and Buzz Aldrin on the moon in 1969. For example, much of the discussion on how to solve our current climate disaster seems to revolve around attempts at lowering carbon emissions, switching from fossil fuels to "clean energy," and sequestering CO_2 and other greenhouse gasses. And advocates for disease research, al-

beit acting from the very real pain and suffering of loved ones, focus on projects to find immediate treatments or cures.

We need immediate financial support to enable research that can cope with the issues we are facing and to rejuvenate and invigorate STEM education to produce the workforce that will make the next series of breakthroughs.

These approaches should be pursued, but talking about the problems in terms of applying existing knowledge neglects the enormous gaps in that knowledge. For example, Manu Prakash at Stanford University, in a talk to the annual meeting of the American Society for Cell Biology, pointed out that oceans are major repositories of greenhouse gasses, but our knowledge of their capacity and the processes involved is minimal. With regard to human biology, we have tools and knowledge that were unimagined 25 years ago, but we have much more to learn. We still do not understand the functions of most of the genes in the human genome.

The argument for increased support for basic research is that it has repeatedly provided new insights and approaches to address the problem that we all want to solve. Improvements in imaging have given us unprecedented ways of studying biological processes, and gene-editing techniques have provided novel ways of correcting processes gone awry in human disease. We are currently in a golden age of scientific discovery, and we must continue to expand this work.

Finally, I want to add two new priorities. First, although not a new problem, we are seeing an increase in attacks on scientists and health professionals. Protective measures, including new legislation, are needed to ensure scientists, doctors, and nurses are safe from attacks and intimidation. Second, we must invigorate and enlarge the public-health infrastructure in the U.S. To many of us, the COVID-19 pandemic revealed how much more a strong, scientifically based public health system could have saved lives and kept people safe. Making people healthy is not only the work of researchers.

I have enormous respect for the scientists, engineers, and health professionals who work daily to improve our health and wellbeing. Supporting and encouraging them should be a major priority in the next four years.

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H. Robert Horvitz
David H. Koch Professor of Biology
Massachusetts Institute of Technology
2002 Nobel Prize in Physiology or Medicine

By leading our country over the next four years, you will have the opportunity to impact the policies and practices that support novel biomedical research and technologies and that promote and govern their application in human health and disease. A sound science-based policy agenda will profoundly improve the safety, health, and lives of all Americans for generations.

Past federal investment in biomedical research has been extraordinarily productive. Largely through research conducted or supported by the National Institutes of Health, the U.S. has pioneered the development of crucial diagnostic procedures, novel treatments, life-changing cures, and new prevention strategies for a broad variety of disorders, including cancer and heart disease. Innovative advances in areas like gene therapy and gene editing have been developed based on discoveries from basic research, directed not toward curing any specific disease but rather toward the exploration of new areas of biology.

Nonetheless, the biomedical research community faces serious challenges. With the aging of our population, threats of epidemics, and dangers of bioterrorism, bold investment in and strategic priorities at the NIH will be crucial to protect our citizens.

That is why I helped prepare a recent report, *Beyond 2020: A Vision and Pathway for NIH*. I recommend this report to you as you begin your new term and look to seize opportunities to propel 21st-century biomedicine. The report emphasizes three recommendations: 1) The NIH should ensure that its research portfolio prioritizes funding fundamental investigations; 2) the NIH should develop new grant mechanisms that emphasize novel ideas and support highly creative scientists; and 3) the NIH should develop a new peer-review process that identifies and rewards bold innovative ideas and foundational approaches.

In addition, it is crucial to develop mechanisms to ensure a robust pipeline of young scientists, not only in the field of biomedicine but also more generally in other areas of STEM. As newly trained young people become leaders in academia, industry, and government, their understanding of science will help them shape public policy in the increasingly complex and challenging world in which we live.

A national commitment to scientific research is essential to unlock our enormous potential for revolutionary breakthroughs and to maintain U.S. world-wise leadership in science and technology. You are uniquely positioned to seize this moment to address today's challenges and ensure a strong future for science and innovation in the U.S. and in the world.

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A. James Hudspeth
Director of the F.M. Kirby Center for Sensory Neuroscience
Rockefeller University
2018 Kavli Prize in Neuroscience

What worries me the most is the undercurrent not just of anti-intellectualism, but more deeply of irrationality. When logic, cause-and-effect, and the primacy of demonstrated truths lose their societal power, we are in grave trouble indeed. This must be how a Dark Age starts.

I take the point that we scientists and humanists have brought on some of the problems ourselves. I think that our scientific generation, or at least those such as myself, has been blindsided by the power of nescience. Through the activities of big tobacco, then big petroleum, then-President George W. Bush's "let's study it further" response to global warming, it has only gradually become clear how great are the numbers of interests, and how great are the amounts of money, that have been mustered precisely to deflect, defer, and ultimately defeat science.

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Judith P. Klinman
Professor of the Graduate School of Chemistry
University of California, Berkeley
2014 National Medal of Science

I write as a deeply concerned scientist, woman, mother, and grandmother in a time of uncertainty. Science holds tremendous promise to benefit and stabilize society. That said, the success of future ventures will be closely tied to the wisdom, vision, and integrity of the next administration.

We have just experienced the hottest summer on record across the country, highlighting (again) the disruptive impact of climate change on humans and other species. The rapid shift of

science toward new catalysts, energy sources, carbon capture, and bioremediation is impressive. But time is fast running out to moderate the extreme damages from climate change. Immediate changes in behavior could have a big impact, for example:

Increase governmental incentives and rebates (for restructuring homes, offices and means of transport) to accelerate awareness and action at the individual level.

Eliminate non-essential governmental air travel. Airplane flights have been shown to be the largest contributor to personal carbon budgets. Governmental change could lead to similar change within the private sector.

Invest in advanced remote technologies that can rival the best qualities of in-person venues.

The low level of scientific literacy in the U.S. remains a divisive political issue, differentiating rich states and communities from poor ones. This rift calls for a focus on enhancing scientific literacy within the least educated states and regions. It will be important to identify local educational leaders who would be interested in summer enrichment programs for their communities. At the same time, we should recruit a "literacy corps" of advanced high school and college students (and possibly retired faculty) from regions of established scientific excellence. Create small grants to cover summer living expenses and stipends for the selected students and local administrative costs.

The low level of scientific literacy in the U.S. remains a divisive political issue, differentiating rich states and communities from poor ones.

Throughout the rapid process of ongoing change, we must not lose sight of basic research. Science is a discipline built on conceptual and fundamental breakthroughs. Many young people are deeply curious and drawn to this inherent quality of science. We need to retain and encourage such people within the scientific establishment. They are the bedrock for future technological advances.

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Eve Marder
Victor and Gwendolyn Beinfield Professor of Neuroscience and Biology
Brandeis University
2023 National Medal of Science

As a teenager, I remember lying on my bed on a summer's morning, watching tree leaves softly move in the breeze, trying to reconcile their apparent calm with my nascent knowledge of the miraculous complexity of the biochemical mechanisms found in each of their cells. Even after a full lifetime studying neurons and the circuits they form in the brain, I still find biological systems infinitely fascinating and full of mystery. Today, I study the relative robustness of the nervous systems of North Atlantic crabs and lobsters as they face warming ocean waters. We try to understand the mechanisms that confer biological resilience to animals facing extreme temperatures and altered environments.

Sadly, the relevance of our work on marine animals is all too applicable to humans who are today suffering from a myriad of neurological conditions, such as seizures and stroke, that are exacerbated by extreme temperatures. The science of the future must continue to combine study of fundamental biological mechanisms with societal-level changes that will protect all life into the future. We face new challenges in science education as students have access to enormous amounts of knowledge, but must still remember what they have learned in order to think creatively and innovatively. At this moment, science and science education are needed more than ever to provide society with the essential tools to cope with the problems of today and tomorrow.

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John C. Mather
Senior Astrophysicist
The National Aeronautics and Space Administration (NASA)
2006 Nobel Prize in Physics

What has science done for us lately? Well, how about electric everything, from cars to buses to trains to ships to airplanes? How about a drug that stops people from getting HIV? Or vaccines against COVID-19? We've got them. We need more of all that, and you as President have a lot to do with it. The government sets policy, makes laws about who profits, and develops and buys the latest technology, after all. You, as President, can lead with the future in mind, making sure we have what we need in a changing world.

We can protect the environment, protect the people, provide for the common welfare, and maintain peace. Science and engineering and math and technology give us the joy of finding out things, and the joy of knowing that we're providing for our kids and grandkids. Every big problem you face in leading the nation and the world has a basis in something technical. Just ask!

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Emmanuel Mignot
Director of the Stanford Center for Narcolepsy
Stanford University
2023 Breakthrough Prize in Life Sciences

Our epoch will be remembered as the golden age of biology. Today, we can visualize molecules with microscopes, study thousands of genes and proteins at once, and visualize whole-body physiology in real time. Combined with analytics and artificial intelligence, this capability is leading to exponential progress, with the potential to cure many diseases and improve life. The problem nowadays is not trying to make something work but having to decide what to study first. We don't have enough people and money to do all the good science we could do. Yet we need to renew our commitment in unbiased science, or we will be left behind.

One danger is political. I hope that you, our next President, will only appoint the best people, independent of politics. Technical jobs must be filled based on experience and expertise, not opinions. The reason is that scientific truth always wins over opinion. We must put the best people in charge and simply let the best research happen. Many impactful discoveries have been made in basic science areas where applications were not obvious. Consequences can be difficult to predict, too. Who would have thought that inventing the atomic bomb would have ushered one of the longest eras of world peace?

We must also invest a lot more in research and training. Science is not valued enough. Researchers are not well paid. Funding is insufficient. Physicians, exhausted by decades of studies, don't want to do research. Medical costs are absurdly expensive, many times higher than they are in Europe, for an inferior result. In the disease I study, narcolepsy, treating one patient costs about $250,000 per year in medication alone. Yet I am in heaven when I receive an NIH research grant of $400,000 a year; and for this I must write hundreds of pages, submit multiple times, and when funded, report and justify constantly.

Finally, I see regulatory and administrative overreach. We constantly must take useless mandatory training courses and sign paperwork online. Research or clinical trials take years to get off the ground. Visas that used to take three weeks now take six months. Collaborating with Germany on a federal grant requires a review by the State Department. It is so complicated to do international research, that some of my willing patients have died before they could contribute their sample. Privacy regula-

tions are excessive. Patients don't realize the cost involved in trying to prevent—unsuccessfully, I may add—any small breach of private information. I compare this to how we protect our home. It is easy to pick a lock, yet we don't use security doors everywhere. Billions could be saved.

We have the opportunity to become the leading country in biological sciences and medicine in the next four years. This could be vastly profitable. For this, knowledgeable scientists and doctors with a vision must be in charge, politics and excessive regulation must be avoided, and investment plus training must be increased.

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Susan Solomon
Lee and Geraldine Martin Professor of Environmental Studies
Massachusetts Institute of Technology
1999 National Medal of Science

Science provides a cornucopia of benefits to humanity. These benefits include fertilizer to increase our output of foodstuffs, modern transportation to whisk us around, and the polymers that are molded into forms ranging from lightweight plastic bags to artificial hands. But these and other miraculous advances have often displayed a darker side—those of damage to nature as well as to ourselves. Every scientist, and indeed every non-scientist as well, can now perceive for themselves the dangerous and personal risks of climate change, air pollution, unbridled waste, ecological destruction, and more. A forward-looking nation that wishes to remain competitive in today's global marketplace will need to foster science that leads to practical innovations and will need to ensure that we understand and safely deal with known environmental risks as well as novel ones.

Fantastic new discoveries that would continue to lift up society and increase American competitiveness are undoubtedly just around the corner, waiting to be revealed. Your presidency will shine if it augments the funds for our national scientific enterprise, because in this 21st century we need science more than ever. We need it to lead us not just to more prosperity, but also to a more sustainable future. Fruition of new discoveries depends just as much on the influx of young bright minds as it does on the provision of adequate funds, and the federal government that you lead plays an outsized role in the future health of both factors.

Our universities today are the envy of the world, and we attract young scientists from all over the world. To continue to excel, we must welcome these people, avoiding an insular approach to university student and researcher entry and residence visas. And we must also do better at stimulating our own younger students in every community across America to flourish in STEM subjects, starting with first grade and continuing through high school, with a nationwide renewal of STEM curricula and teaching methods that are both more inclusive and more appealing to our diverse national population.

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Thomas C. Südhof
Professor of Molecular & Cellular Physiology and of Neurosurgery
Stanford Medical School
2013 Nobel Prize in Physiology or Medicine

Science is a pervasive presence in everyone's life, but most people don't realize how much science they use. The essence of science is that it is independent of a person's beliefs, religious or otherwise. Science is never a prescription for action. It informs society about choices for actions, but doesn't decide such actions. For the future—not only of our country but of humanity as a whole—it is imperative that we isolate science and science education from non-scientific intrusions, because otherwise scientists cannot provide useful recommendations for action.

Moreover, it is essential that we take scientific conclusions seriously, because of their implications for the future. For example, as scientists we can state only that human activity is making the Earth become warmer rapidly, and that this warming is a cause of natural disasters. The decision whether economic sacrifices are justified to slow down this warming is a political one. As another example, it is well established that vaccinations against infections such as measles or rubella serve population health as a whole. Again, the decision whether to require vaccinations is a political one that science cannot make.

There appears to be an increasing tendency to ignore science because science is inherently apolitical and thus has no power. My sincere recommendation would be to act against this tendency, which poses a long-term threat to health and prosperity on Earth.

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Carl Wieman
Professor Emeritus of Physics and of the Graduate School of Education
Stanford University
2001 Nobel Prize in Physics

In 2020, I shared my advice to the next president of the U.S. Four years later, my concerns and recommendations remain much the same, because the underlying issues we face extend far beyond any one policy or any one administration.

Science and its associated technologies dominate modern society. Scientific advances are vital for the health of the economy and for the personal health of the citizens. Preserving this health requires ongoing investment in both scientific research and the development of future scientists. However, what is more important today is better science education for all students. That is what is needed for non-scientist citizens to thrive in the modern economy and to make wise public policy decisions about critical challenges society faces, including: climate change, the rapid advance of artificial intelligence, choice of energy sources, individual and public health actions, etc. These all have underlying technical aspects that must be understood to make sound decisions.

Responding productively to today's big challenges requires a new type of science education, not the traditional memorization of facts and procedures. Students need to learn science as a process for arriving at better decisions and explanations and learn how to use science to make decisions. Research shows that such an education requires activities that give learners practice in making and critiquing relevant decisions.

Although such an education is far beyond what our schools are currently providing, it is far from impossible. Research in teaching and learning has provided new insights on how to cultivate this kind of thinking. Turning this research into widespread practice will require fundamental changes in how we think about teaching. Much as researchers have established medical expertise as a set of complex knowledge and practices that a doctor needs to know and apply to achieve good patient outcomes, we need to think about the teaching of science in the same way. This will require professionalization of the science teaching profession, with much more rigorous training in "teaching expertise." The result will be the educational equivalent of switching from bloodletting to antibiotics.

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This article and this compilation were found originally at Nautilus.

What's at Stake for Science in the U.S. Presidential Election

Polls capture shifting, conflicted public views about science.

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***Cary Funk** is the senior advisor for public engagement with science at the Aspen Institute Science & Society Program. She is the former director of research on science and society at Pew Research Center and the founding director of the VCU Life Sciences Surveys at Virginia Commonwealth University.*

After a summer of political drama in the United States—including two assassination attempts on former President Donald Trump and President Joe Biden's surprise decision to end his re-election bid—it may seem unlikely that there's any aspect of the upcoming election that has not been thoroughly picked over in news coverage and social media chatter. But in politics, as in so many aspects of life, the things that people talk about do not tell the full story.

On the surface, this year's presidential election is focused heavily on inflation, border security, and reproductive rights. Dig more deeply, though, and many critical issues for science and technology policy are also at stake. Those issues may not make headlines, but they have a tremendous impact on the future direction of the economy, the environment, national security, and the overall state of public health and well-being. Today's science policy decisions will lay the groundwork for the world we live in 10, 20, and even 50 years in the future.

As a pollster, I have spent the better part of my career looking at the factors driving voters' choices at the ballot box and, simultaneously, at the factors influencing people's views of science. The polls my colleagues and I have conducted help us see the patterns in what the public, as a whole, cares about and how they see the choices ahead. Our work also points to emerging changes that could have lasting consequences for science in the U.S.

Attitudes toward science and politics used to be easy to regard as separate threads in the American psyche, but in recent years I have noticed the two become intertwined. The polling I see from my former colleagues at Pew Research Center and from other organizations also turns up important differences in science attitudes among groups in society. Those divergences could become increasingly consequential for the place of science in society. Political party affiliation is one major factor, but education, race and ethnicity, and generational cohort are also important.

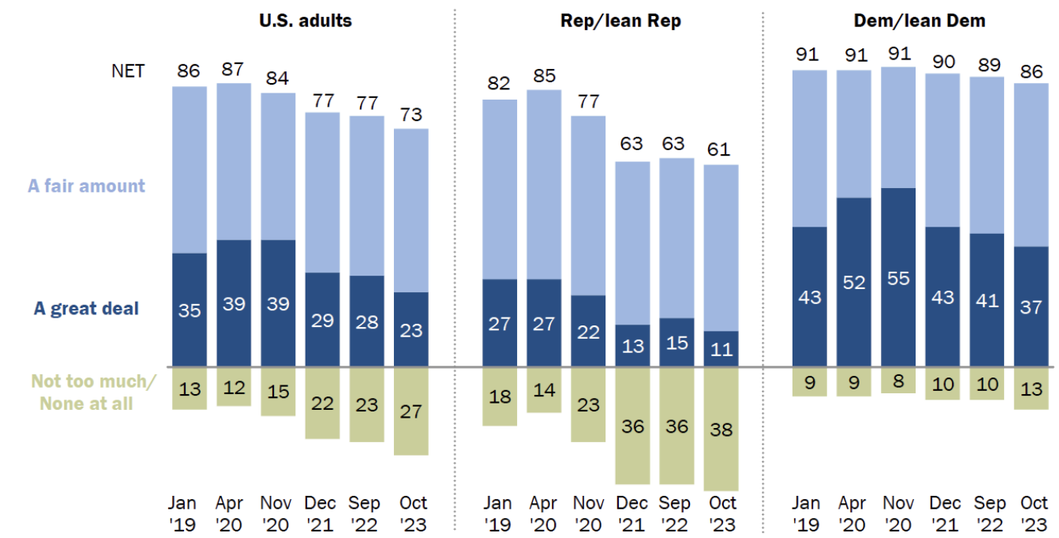
What I see in recent polls provides a different perspective on what is at stake in this election and on what kind of future the public might choose—or inherit.

The COVID-19 pandemic catapulted science and scientists to the forefront of public attention in 2020 and set the stage for Biden's election over Trump that fall. But controversy over the government's handling of the outbreak quickly triggered sharp and lasting political divisions.

In recent years, my colleagues and I have documented a widening division of opinion between political groups over how much to trust scientists. Pew Research Center surveys find the share of Republicans and Republican-leaning independents who have a negative view of scientists—saying they have "not too much" or "no confidence" in scientists to act in the public's best interests—doubled, from 18 percent in January 2019 to 38 percent in October of 2023. There has been a corresponding drop in the share of Republicans and leaning Republicans with strong trust in scientists, though 61 percent of them hold at least softly positive views of scientists in the 2023 survey. In contrast, the vast majority of Democrats and leaning Democrats (86 percent as of October 2023) express at least softly positive levels of confidence in scientists, and the share with the strongest level of trust has returned to pre-pandemic levels.

Declining levels of public trust in scientists

*% of U.S. adults who have ___ of confidence in **scientists** to act in the best interests of the public*



Note: Respondents who did not give an answer are not shown.
Source: Survey of U.S. adults conducted Sept. 25-Oct 1, 2023.
"Americans' Trust in Scientists, Positive Views of Science Continue to Decline"

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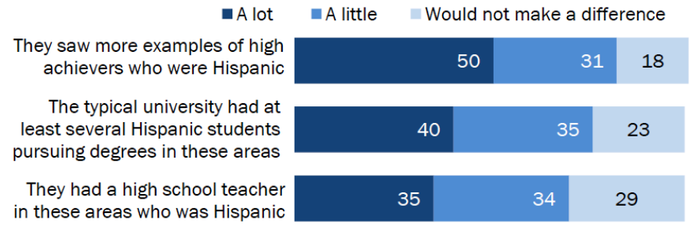
Half of Hispanic adults think having more Hispanic high achievers in STEM would help a lot to attract more to these degree programs

% of Hispanic adults who say young Hispanic people would be ___ more likely to pursue college degrees in STEM if ...



Note: Respondents who did not give an answer are not shown.
Source: Survey conducted Nov. 30-Dec. 12, 2021.
"Hispanic Americans' Trust in and Engagement With Science"

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These polling data capture a growing segment of the public that tends to regard science with a skeptical eye and that is correspondingly inclined to challenge findings and recommendations from scientists. Such skeptical sentiments could play out in a myriad of ways. They may lend support to proposals, touted in the "Project 2025" plan that incorporates advice from former advisers to former President Trump, to replace many of government's career civil servants with political appointees. The influence of science advisors and science-based policymaking is already being diminished by a U.S. Supreme Court ruling that ended a decades-old precedent of legal deference to a federal agency's interpretation of statutes, known as the Chevron deference doctrine. That 2024 ruling restricts the role of government scientists in guiding how policies can best protect public health and safety.

Political divisions over climate policy, which have been ongoing since the 1970s, suggest that once political divisions over science emerge, they tend to get wider and more hardened over time unless there is a concerted effort to address the sources of these divides. Widened divisions then can obstruct civic discourse and constructive action. Of course, different viewpoints are necessary in civic discourse to at least some degree. An open discussion of scientific evidence and science-related policy recommendations is valuable regardless of one's views toward specific rules and regulations.

A key question this November will be how well Trump and other GOP candidates do at holding onto support among working-class voters. Once considered a stronghold for the Democratic Party, working-class voters (defined in simple terms as those who haven't earned a four-year college degree), particularly white working class, helped deliver Trump's win in 2016 and have become an important part of the GOP coalition heading into 2024.

A less frequently discussed shift started years earlier, when voters with a college degree, especially those with a postgraduate education, started lining up squarely with the Democratic Party. Exit polls conducted for the National Election Pool of media organizations found that postgraduates were split about evenly between the Democratic and Republican presidential candidates back in 1988. As of 2004, voters with a postgraduate education were upward of 10 percentage points more likely to vote for the Democratic presidential candidate. In 2016, that advantage grew to more than 20 points. Americans today are increasingly divided by the way that their educational experiences tie with their political identities and perspectives.

Education is also strongly related to people's views toward science. Across Pew Research Center surveys collected since 2016, my former colleagues and I routinely found a strong correlation between education and confidence in scientists to act in the public's interests, in support for federal funding of scientific research, and in holding the view that science's impact on society has been largely positive. As of October 2023, about 8-in-10 U.S. adults with a postgraduate education said the effect of science on society has been mostly positive (79 percent) compared with 42 percent of those who had a high school degree or less schooling. In a 2020 analysis on behalf of the National Science Foundation, John Besley of Michigan State University, and Derek Hill of the National Center for Science and Engineering Statistics concluded that "overall, the best predictor of positive views about S&T [science and technology] in the United States is education."

Education-based differences over the value of science and scientists in society are poised to widen further and remain part of the public opinion landscape for years to come.

People across all education levels can and do engage with science in everyday life. Astronomy enthusiasts and bird watchers do not need years of higher education to appreciate the wonders of the world. Many professions—such as electricians, car mechanics, and medical technicians—require a strong mastery of principles in science acquired through training or self-study. Nevertheless, U.S. adults with a college degree or higher are more likely to be exposed to science-related experiences such as taking part in a community science project or going to a museum.

It's concerning that the people who most strongly support and engage with science increasingly draw from the portion of the population with a college or higher degree. That pattern reinforces an exclusionary image for those with no such degree that science is not for "people like me." Education-based differences over the value of science and scientists in society are poised to widen further and remain part of the public opinion landscape for years to come.

Hispanic adults make up a growing share of the American electorate, and they account for a sizable share of the electorate in several battleground states, including more than 1-in-5 eligible voters in Arizona and Nevada. Polling data show that views toward science and politics are changing rapidly within this large and diverse population. Those changes are often obscured within polling data that look only at the country's population as a whole.

Prior to 2020, polls have shown a roughly 2-to-1 advantage for Democratic candidates among Hispanic voters nationally. Recent surveys suggest a softening of support for the Democratic Party among this group. There has been a 10 percentage-point drop in the share of Hispanic adults who consider themselves Democrats or independents who lean to the Democratic Party between 2020 and 2023, according to Gallup surveys. It is not clear what is driving the shift in political allegiances or whether it is occurring across all segments of this diverse group.

According to survey data, Hispanic Americans' views of science have also been changing. A 2023 Pew Research Center survey found 49 percent of Hispanic adults saying that the effect of science on society was mostly positive, while 44 percent said it was an equal mix of positive and negative effects, and 7 percent said the effect was mostly negative. The share of Hispanic

adults saying the effect of science on society was mostly positive dropped by double digits from 63 percent in February 2021 and 66 percent in January of 2019. This shift highlights a need for more attention to the factors influencing Hispanic-Americans' views of and experiences with science.

In a survey and focus groups with Hispanic-Americans by Pew Research Center in 2021, Mark Hugo Lopez and I found that the lack of representation in science and allied fields significantly influenced how people saw and experienced science. A majority of Hispanic-Americans (68 percent) describe themselves as being at least somewhat interested in following science news. But just 26 percent of Hispanic adults rated scientists as a professional group as "very welcoming" of Hispanic people in these roles; 29 percent said they are not too welcoming or are not at all welcoming of Hispanic people and another 42 percent said that scientists are somewhat welcoming of Hispanic people in these jobs. Most Hispanic adults said that seeing more high-achieving Hispanics in science, technology, engineering, and mathematics (STEM) would help a lot (50 percent) or a little (31 percent) in attracting more Hispanic people to pursue college degrees in STEM fields.

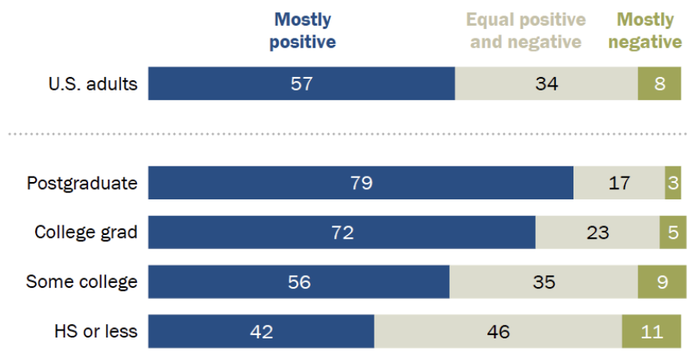
Evidence to date suggests that younger adults offer an important opportunity to deepen engagement with science in the U.S., with the potential to influence civic discourse for decades to come.

In a 2024 survey conducted by Gallup and the Walton Family Foundation, members of Generation Z (covering ages 12 to 27) stood out for their relatively high levels of trust in scientists, as they also did in 2023. Like the U.S. population in general, this group expressed low levels of trust in Congress and in the news media. But 73 percent of Gen Z adults ages 18 to 27, and 65 percent of Gen Z youth, said they had a great deal or quite a lot of trust in science. The share of Gen Z with the strongest level of trust—34 percent with "a great deal of trust" in scientists—was far above that for any other groups and institutions rated. Just 13 percent of Gen Z expressed the same level of trust about the military.

Younger adults have been tilting toward the Democratic party in recent years. There's no guarantee that those voters will make a difference in the election outcome, however. Historically, younger adults are the least likely

Large educational differences in views of the effect of science on society

% of U.S. adults who say science has had a(n) ___ effect on society



Note: Respondents who did not give an answer are not shown. "Some college" includes those with an associate degree and those who attended college and did not obtain a degree.
Source: Survey of U.S. adults conducted Sept. 25-Oct. 1, 2023.
"Americans' Trust in Scientists, Positive Views of Science Continue to Decline"

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age group to register and submit a ballot. One X factor this election is whether Taylor Swift's endorsement of Vice President Kamala Harris will help persuade the eligible voters among Swift's more than 240 million Instagram followers to submit a ballot. The New York Times reported that within 24 hours of her post on X, some 405,999 people followed her link to Vote.gov, which helps people register and check their voter registration status.

There's an overlooked opportunity to find common goals in areas of science that connect to our daily lives, even if voters disagree over specific policy approaches for achieving those goals.

Younger adults are often highly motivated to engage with issues related to pressing problems in their communities. One survey of voters under age 34 in November of 2023 highlighted gun violence prevention (26 percent), addressing climate change (26 percent), and expanding access to abortion (19 percent) as the top issue priorities behind the economy. A separate analysis from a New York Times/Siena College poll found that reproductive rights has "overtaken the economy as the single most important issue to their vote" among women younger than 45.

Members of Gen Z also express high levels of interest in science-related jobs. Three-quarters of these individuals, surveyed by Gallup and the Walton Family Foundation in 2023, expressed at least some interest in a future career related to a STEM field, offering an opportunity for more engagement. Girls Who Code and programs like it are helping to increase diversity in technology and other STEM careers. Efforts such as the Aspen Institute's Our Future is Science mentorship program help youth connect scientific work with social justice. But for the more than 30 million U.S. adults under age 24, turning science interest into a lifelong vocation will require this diverse generation to see STEM careers as offering accessible and rewarding career opportunities.

Partisan attitudes tell only part of the story. There's an overlooked opportunity to find common goals in areas of science that connect to our daily lives, even if voters disagree over specific policy approaches for achieving those goals.

The wide differences along political lines in public views about climate, energy, and the environment often stand out. But when my Pew Research Center colleagues and I interviewed people in the U.S. who voiced little urgency to address climate change, we heard support for the principles of biodiversity and caring for the planet, even among people who expressed reservations about government policies in these areas. In the words of one man in his 20s, "I think it's very important to not overdevelop so there's still space for natural habitats." A man in his 50s said, "Let's not litter. Let's have good clean water. Let's not do anything that's going to hurt our planet."

Similarly, we find a sense of collective interest in advancing quality and affordable health care. A June 2023 Pew Research Center survey found a majority of both Democrats and Republicans (64 percent of Americans, overall) said the affordability of healthcare is a "very big problem" in the country today. A survey by Harvard T.H. Chan School of Public Health in November 2023 found that four health care issues garnered strong support across all segments of the public: preventing chronic diseases (83 percent), preventing and addressing mental ill-

ness (80 percent), reducing infant mortality (79 percent), and preventing and addressing opioid and other substance addiction (72 percent).

Concerns over the rapid emergence of artificial intelligence, such as ChatGPT, also cut across traditional divisions in society. The share of Americans describing themselves as "more concerned than excited" about the increased use of artificial intelligence in daily life went from 38 percent in 2022 to 52 percent in 2023 according to Pew Research Center surveys. These surveys highlight a collective anxiety about a future dominated by AI. My colleagues and I have seen that refrain again and again in public responses to emerging tech. The response reflects a widely shared belief in holding human agency over scientific and technological developments.

...congressional members who have bipartisan co-sponsors are more effective at advancing legislative proposals.

Given these underlying commonalities—value for a clean and healthy environment, support for affordable healthcare, and concerns over AI—it makes sense that reaching for common ground pays off for legislative leaders. Researchers with the Center for Effective Lawmaking analyzed the factors behind legislative success, scoring legislators based on 15 metrics such as how many bills the lawmakers introduce, how far they advance toward becoming law, and how impactful they are. The researchers' key finding was that congressional members who have bipartisan co-sponsors are more effective at advancing legislative proposals. Even members in the majority party are more likely to succeed when they put forward bills with bipartisan co-sponsors.

There is an opportunity here, too, for civic organizations to encourage public discussions that highlight shared values and goals, and that showcase science not as a prod for dictating policy but as a tool for distinguishing helpful actions from ineffective or counterproductive ones. Such an approach might help counter the worrisome trend, seen in recent polling, of U.S. attitudes about science diverging along political party, educational, racial, and ethnic group lines. A more broad-based sense of trust in science could help break through political logjams and change the course of this country.

★ ★ ★

This article was found originally at Nautilus.

How to Rebuild Trust in Science

Earning trust is hard; winning it back is even harder. Here's how to do it.

★ ★ ★

Cary Funk *is the senior advisor for public engagement with science at the Aspen Institute Science & Society Program.*

Jylana L. Sheats *is a clinical associate professor of social, behavioral, and population sciences in the Tulane University Celia Scott Weatherhead School of Public Health and Tropical Medicine and the associate director at the Aspen Institute Science & Society Program.*

Change moves at the speed of trust." So says businessman and author Stephen Covey in his book, The Speed of Trust. Those of us who seek solutions to complex social problems reflect on that phrase a lot. As a society, we cannot realize the fruits of the scientific enterprise without a basic level of public trust in scientists and their research.

Trust in science is especially crucial during moments of crisis. People who reject scientific findings often ignore actions and advice that could vastly improve their lives—and sometimes even save them. At least five of those killed in Hurricane Helene in September stayed put because they didn't believe official warnings about the deadliness of the storm, according to Florida officials. In the first 15 months of the COVID-19 pandemic, one study estimates, at least 232,000 people in the United States died because they did not get vaccinated.

The Aspen Institute's Science & Society Program has brought together experts from a

wide array of fields and institutions to discuss tactics for strengthening trust—specifically, for fostering broad-based agreement that scientific research contributes valuable evidence and understanding that are relevant to society's needs. The advice that has emerged from those discussions is often framed around three broad concepts: involve local leaders, know your community, and improve the information ecosystem.

These worthy principles are difficult ones to put into action. Trust is easy to lose and difficult to gain or to win back. Building trust requires a continuous process of establishing and maintaining relationships between experts and the people who are being asked to rely on them. But we are excited to see a growing number of people and organizations putting in the hard work to build trust in science, especially the science around public health, and making change really happen.

Last spring, we convened a diverse group of researchers, science communicators, journalists, and policy analysts to dig into the details of how to build public trust in science. We summarized our findings in an Aspen report, Tactics for Trust. Our aim was to move beyond analyzing the obstacles to trust and to focus intently on how to go about achieving it. Doing so includes listening closely to what people really care about and to why they often feel that the scientific enterprise is irrelevant or even contrary to their needs.

Let's start with the goal of involving local leaders. We have watched many well-intentioned efforts go awry, as organizations hold events intended to reach a general audience but end up talking mostly to themselves. There is some value simply to making information about science-related issues available to the public. But trust-building is much more powerful when it is designed around collaborative projects that draw in members of the local community, giving them meaningful roles and fostering lasting relationships.

Lisa Goldman Rosas, faculty director of the office of community engagement in Stanford University's School of Medicine, is taking that approach with her office's Health Equity Ambassadors Program. It solicits and funds partners from local nonprofits to spend nine months working with university researchers on community-engaged research projects, so that everyone learns together. This past year, "our program participants developed climate change and health equity projects that truly reflected what mattered to their communities," Rosas says.

One of these projects, led by Maya Paulo of the California-based nonprofit Climate Resilient Communities, surveyed residents of East Palo Alto to help identify conditions that put them at risk of serious harm from extreme weather. The project focused on hazards at home, work, and all through this low-income community. Paulo and her colleagues then held public information sessions about extreme-weather risks and provided local residents with resources to help them prepare for future conditions. Afterward, 8 in 10 homeowners in the area (responding to an English-language survey) said they had taken action to upgrade their roofing.

Ultimately, the Health Equity Ambassadors Program aims to create a network of local leaders who can act as its namesake "ambassadors" between Stanford and partnering organizations. Those ambassadors help design and perform research to understand the needs of the community and to translate their findings into programs and policies that promote health equity.

"We know that building trust takes time and that no one strategy works for all communities," Rosas says. "One way that we do this is by recognizing the expertise of our community partners through funding, support for featuring their work in ways that are meaningful to them, and ensuring that our research projects provide results directly to participants and communities involved in the research."

Brittney Doyle, who founded the nonprofit consulting organization Wise Health SF in 2015, also speaks about the importance of building trust with local leaders. Wise Health SF creates health programs tailored to the needs of vulnerable populations in the San Francisco Bay Area. They partner with community groups, government agencies, and nonprofits and offer services such as health-education workshops and community health "pop-up" events. The organization also hosts focus groups to make sure that their efforts are genuinely useful in connecting high-need communities with public health and healthcare resources.

Instead of barging in with a pre-defined approach, Wise Health SF works together with the community to identify pressing local health issues and develop tailored solutions. "Building trust should be the first thing that happens," Doyle says. "Whenever you're planning programming, there should at least be 90 days set in place strictly for getting to know the players."

Trust in science is especially crucial during moments of crisis.

Among Wise Health SF's partners is the San Francisco Department of Public Health. They collaborated to develop wellLINK, a program that provides HIV education and treatment for people experiencing homelessness. The program also distributes items such as nutritious meals-to-go and personal supplies (soap, toothbrush, socks, sleeping bags, etc.), and shares onsite-referrals to shelters and other housing solutions. The need is acute: Over the course of a year, more than 20,000 people in San Francisco seek homeless services.

Before starting wellLINK, Doyle took her own advice on building trust. She made sure that Wise Health SF employees and volunteers had a consistent presence at the wellLINK program site well ahead of the launch of the project. "It's important that I am collaborating with partners that are already doing the work and are recognized in the community. That just makes it easier to reach communities experiencing homelessness," she says.

Leaders in science communication and outreach frequently stress how important it is to know your community so that initiatives can tailor their engagement efforts to the cultural world of the people they are trying to reach. One of us, Jylana Sheats, knows firsthand how difficult that kind of focus can be in practice.

Early in her position at Tulane University's Celia Scott Weatherhead School of Public Health and Tropical Medicine, Sheats received funding to conduct a culturally informed project aimed at improving eating behaviors among middle-aged and older Black people in New Orleans. Her plan was to develop a text-message system that could encourage healthier food choices, such as fruits and vegetables, and limit common sugary drinks such as soda and juice.

Sheats conducted focus groups to learn what "healthy eating" meant to people in the community, and what beliefs and barriers shaped their eating habits. She quickly realized that her identity as a Black woman didn't automatically translate to understanding the cultural nuances of older Black residents in New Orleans, so she added a small community advisory board to provide input on text message content. One seemingly small but crucial lesson sticks in her memory. Sheats was sharing a healthier recipe for mac & cheese, and learned that "in New Orleans, a dish of macaroni and cheese is typically made with spaghetti noodles, not elbow macaroni," she says. "This detail allowed us to create a video cooking demonstration that was authentic to local preference."

Local connections merge with global connections at Ciencia Puerto Rico (CienciaPR), a network that promotes science education and science careers for Puerto Rican communities around the world. Mónica Feliú Mójer, who directs public engagement with science at CienciaPR, explains that successful community engagement requires commitment as well as empathy. "We invest so much energy to make sure our relationships are lasting and resilient—meaning that our relationships are able to withstand differences, challenges, and misunderstandings," she says.

Andrea Isabel López, who worked with CienciaPR on public communication and out-

reach, emphasizes a concept called reflexivity: "an examination of our identities, beliefs, assumptions, privileges, prejudices, practices, and motives and how they influence what we do or think in a situation." She identifies reflexivity as an important reason for CienciaPR's success at boosting vaccination rates in Puerto Rico during the early stages of the Covid pandemic, as discussed in another article in this series.

"Being honest about our identity as an organization is vital for establishing trust, especially given the potential harms these partners may have previously experienced from scientists or academics," López says.

Efforts to "improve the information ecosystem" are especially urgent for public health organizations that are seeking to share potentially life-saving guidance in a style and format that people can easily relate to. In today's reality, that means sharing information through videos, social media, and other media that mix education with entertainment. "They offer powerful tools to bridge the gap between complex health information and the communities that need it most," says Tambra Stevenson. She is the founder and CEO of WANDA (Women Advancing Nutrition Dietetics and Agriculture), a nonprofit dedicated to providing Black women and girls with better access to healthy, culturally relevant foods.

Trust-building is much more powerful when it is designed to draw in members of the local community.

Stevenson shares her favorite example from these efforts: the creation of "Little WANDA," a character for a bilingual children's book series and an associated doll, shared on social media as #IamWanda. The story of Little WANDA educates children of African descent about nutrition, agriculture, and health in a relatable way. "We are on a mission to reclaim our food traditions, restore our health, and return to our roots," Stevenson says. "We've seen increased interest in health and nutrition topics among the children and families we serve."

Stevenson is taking a long-term approach by starting with materials tailored to elementary-school-age girls and then building on that engagement as the girls age into adulthood. The #IamWanda campaign veers far from old, institutional strategies for trust-building, because studies and anecdotal experiences have repeatedly shown that direct appeals to "trust science" have little effect. A storybook character who looks like her intended audience and lives in a world that resembles their own is much more likely to encourage participation and to inspire the desired actions.

"By integrating culturally relevant narratives and engaging educational tools, we build a foundation of trust within the communities we serve," Stevenson says.

Hip Hop Public Health is another effort to present health information in ways that reflect the culture and interests of its intended audience. The project was established in 2011 by Olajide Williams, a neurologist at Columbia University, and Doug E. Fresh, a Barbadian-American artist and rapper. They merged their talents, creating lyrics for rap music that explains fitness, vaccines, hypertension, stroke, and other health topics in a quick, catchy way. They are reaching out to a range of underserved communities, where traditional attempts at health communication have proven ineffective. Since its founding, Hip Hop Public Health has produced more than 200 songs and videos—combining music with performance or animation—which collectively have been streamed more than 500 million times.

There are as many approaches to developing relatable health information as there are communities that need it. CareMessage, founded by former Stanford classmates Vineet Singal and Cecilia Corral in 2012, works with health care organizations to engage with patients using personalized, culturally tailored text messages. They aim to get those patients to be more responsive to appointment reminders or to completing a prescribed treatment regimen. CareMessage also shares information about preventive care, disease management, and behavior change.

Singal and Corral are targeting health care among low-income populations who have historically faced a variety of health care inequities. They focus specifically on access to care, clinical outcomes, and social drivers of health. CareMessage has generated more than 70 million interactions with patients. Measuring the impact of those messages is difficult, but Corral reports that the organization's internal evaluations found a 50 percent success rate at bringing diabetes patients back into medical care after a gap in treatment.

Some of the organizations deploying novel approaches to building trust in science are reaching out to audiences beyond the U.S., which adds another layer of social complexity. John Cook, a senior research fellow at the Melbourne Center for Behavior Change, designed the Cranky Uncle game to help people strengthen their critical thinking skills in a fun and widely relatable way, integrating humor and playful cartoons while teaching users to spot misinformation. "Understanding how science works is an important step toward building trust in science," he says.

Cook conducted an eye-tracking study, which revealed the kinds of details that cause people's eyes to linger and influenced his approach. He argues that "humorous, visual science communication grabs people's attention longer than more conventional science communication, and it's through the greater attention that the messages have an effect." Cook's first version of Cranky Uncle, focused on climate-related misinformation, was released in 2020 for Apple and Android users, and is available in 12 languages. This year he released a second version focused on misinformation about vaccines, initially tailored to users in several nations in Africa.

One of the few efforts specifically designed to increase trust on a global scale is the nonprofit Global Listening Project, co-founded by Heidi Larson, an anthropologist, health researcher, and expert on vaccine hesitancy. She and her colleagues started the global organization in response to the Covid pandemic and the ruptures it showed in public trust. They are running a long-term effort to document people's experiences during the pandemic and to bring those voices to the notice of policy makers.

Larson and her team have already completed a series of focus groups around the world and conducted a 70-country survey. They hope that their results will help policymakers design strategies and public messages that foster more social cohesion and trust in science, medicine, and other social institutions. At the same time, the Global Listening Project is also sharing information about the ways that science and health leaders pay attention to public experiences and concerns. Societies need to bolster trust and social cohesion, Larson argues, so that they can respond more rapidly and effectively when the next health crisis occurs.

Although building trust in science on a global scale can seem daunting, the necessary steps we see are largely the same as those we see working well locally: learn about your community, cultivate relationships with leaders in that community, and demonstrate that you are trustworthy. Above all, communicate with people in ways that relate to their own cultures and perspectives—and maybe even to the things they do for fun.

★ ★ ★

This article was found originally at Nautilus.

Looking Ahead to Combat Climate Change

Environmental leaders need to pursue a vision of the future, not just address mistakes of the past.

★ ★ ★

Kitty Pollack *is the senior advisor at the Aspen Institute Energy & Environment Program and an expert in policy collaboration and innovative program design.*

Greg Gershuny *is the vice president and executive director of the Aspen Institute Energy and Environment Program (EEP) and co-director of Aspen Ideas: Climate, a public forum focused on climate solutions.*

Climate policy is too often designed around how the world operates today, rather than how the world will operate tomorrow—or how, in our wildest dreams, it could operate. Climate scientist Katharine Hayhoe of Texas Tech University likened this conventional approach to "driving down the road into the future looking in the rearview mirror."

This backward-oriented approach to climate policies and solutions means that limited, near-term ideas often crowd out more visionary ones. For instance, engineers have developed a process called enhanced oil recovery, in which they inject pressurized carbon dioxide deep underground to extract more petroleum from depleted wells. Some portion of the injected carbon dioxide then remains sequestered beneath the Earth. Industry groups have hailed this approach as a way to tap more oil reserves while also capturing carbon using existing fossil-fuel infrastructure. But many climate activists have raised concerns that this strategy could prolong the life of industries that should instead be making a complete shift to clean energy technologies.

Another example of go-with-the-status-quo thinking can be heard in the growing hum of energy-inefficient air conditioners, which are being installed around the world in response to the increasingly frequent and intense heat waves. In their rush to keep up the pace of development and to respond to the urgent health risks associated with extreme heat, policymakers have broadly ignored longer-term strategies to promote passive cooling techniques (relying on shading and natural airflow, for instance) that consume less energy and that, by extension, generate less greenhouse emissions. Efforts to expand access to air conditioning have also in many cases silenced broader discussions around where and how communities should be developed, and whether these plans are sustainable on a changing planet.

Both enhanced oil recovery and the installation of air conditioners, in their own ways, address pressing needs of the moment using existing immediately available technologies and approaches, but as such they are fundamentally built on the past. The challenge for the next generation of leaders is to balance the rapid deployment of today's best climate solutions, while cultivating a visionary mindset that allows them to consider fresh ideas and approaches. In other words, we need to accelerate rapidly while looking forward.

Limited, near-term ideas often crowd out more visionary ones.

Forward thinking is essential for tackling environmental challenges that are vastly bigger and more complex than any we have confronted before. In the 1960s and 1970s, when DDT was poisoning the environment and smog was filling the skies, environmentalists were laser-focused on fixing the errors of the past, primarily through chemical bans and regulation of polluting industries. But the problems we face now are of a totally different magnitude. In 1972, when DDT was banned, the amount of carbon dioxide was 329 parts per million (ppm). Today it is 426 ppm, representing decades of emissions from every part of the world. Reigning in past mistakes with bans and regulations will not be enough this time.

Moreover, bans and regulations have intensified the political polarization around climate action in the United States. Many voters still view "climate" as a partisan issue, with only 23 percent of Republicans viewing climate change as a major threat (versus 78 percent of Democrats), according to a 2023 study. That split represents a failure on the part of leaders to overcome the negative framing of climate action as taking things away rather than adding new technologies like quiet and powerful EVs or emission-free solar panels for the home. Technological innovations and clean energy industries will be a major source of jobs and economic growth; the Inflation Reduction Act, passed in 2022, has ushered in a large wave of this potential growth.

If leaders were to better articulate the big opportunities that lie in the clean energy transition and other environmental policies, they could increase the number of voters who count climate action as a priority. To do so, government agencies, environmental groups, and industry partners must be willing to break from the status quo, envision a planet that can benefit everyone—and be willing to implement the forward-looking policies necessary to create that future.

Thinking about the future of the planet can feel overwhelming to researchers, politicians, and the public alike. That apprehension encourages band-aid fixes even when the problems are right before our eyes. For example, many states and communities are implementing more rigorous building codes in areas where sea level rise is predicted to overtake the coastal community, rather than exploring ways to move communities out of those flood zones. By merely tinkering with past systems, policymakers are missing the chance to articulate a bold new vision designed to address the realities that await.

We already have a lot of data about what our future world could be like. The Rhodium Group, an environmentally focused think tank, predicts that by century's end, global temperature will increase between 2.3 and 3.4 degrees Celsius above pre-industrial levels. The analysts forecast that carbon emissions from electricity generation and transportation will drop significantly toward the middle of the century, due to the adoption of more green energy and electric vehicles. Cutting carbon emissions from heavy industry (including from the production of iron, steel, and cement, along with the ongoing production of oil and gas) will be much more challenging.

China, the U.S., and other high-emitting countries are predicted to lower their emis-

sions by mid-century, but emissions in India and many other countries in Asia, the Middle East, and Africa are expected to increase as those countries' economies grow. Overall, the Rhodium Group forecasts that global fossil fuel consumption will continue to increase through 2060, peaking at more than 60 percent above today's levels.

The forecast is not set in stone, however. Investing in mature clean-energy technologies in rapidly developing countries like India could head off that continued expansion of fossil fuels by driving down the costs of clean energy, for instance. The scale of the necessary investment is immense, and would require a correspondingly immense response. According to a report from the International Energy Agency, clean energy investment in emerging economies will have to reach more than $1 trillion a year by 2030 in order to meet 2050 goals of net-zero emissions: no longer contributing to the overall amount of carbon in the environment. Public funding cannot support this transition alone—but it can be used to mobilize private capital by making clean-energy infrastructure projects more appealing and less risky to investors. Such financing strategies could help prevent the predicted rise in fossil-fuel use while presenting significant economic opportunities for developing nations.

Reigning in past mistakes with bans and regulations will not be enough this time.

At a closed-door Aspen seminar for climate and energy leaders in the winter of 2023, we asked participants to draw pictures of the future, envisioning the world of 2050. The resulting sketches were largely optimistic, depicting abundant clean electricity from solar panels, wind turbines, and nuclear reactors, along with zero-emission flying electric vehicles. But these blue-sky imaginings were mixed with touches of pessimism. Some of the illustrations depicted burning forests, fighting people, a gravestone for the United Nations, and carbon-capture facilities dotting the skylines while oil companies continue pumping out fossil fuels.

We often hear similarly conflicted perspectives in policy conversations among leading climate and energy experts, who are steeped in the everyday push for short-term fixes amidst calls for urgent action and rarely are given the chance to step back and re-examine the bigger picture. The pace of their work makes it difficult for even optimistic policymakers to consider and to confer on what a new path forward could look like.

How, then, can we switch to a truly future-focused approach to climate change? The leadup to the U.S. presidential election is a great moment to pause and consider that question carefully. The incoming administration could have an opportunity to enact big new climate legislation, if we build political consensus across the aisle. Both major parties have a strong interest in creating jobs, building infrastructure, and improving American industrial competitiveness.

As laid out by the Biden-Harris White House in a report envisioning its path toward eliminating net-carbon emissions around the world by 2050, the next round of infrastructure-oriented climate legislation could include virtual power plants, additional electricity transmission, grid interconnection, permitting reform, increased incentives for industrial heat production, more efficient buildings, and investment to make vulnerable communities more resilient to climate disasters. Artificial intelligence, powered by clean energy, could also play a big role: guiding climate-smart farming, monitoring the energy grid in real time, and helping to accelerate the pace of battery development, to name just a few possibilities.

Beyond the specific policies, the institutions responsible for promoting and implementing those policies must also themselves adopt nimble new strategies. Across the democratic world, nations have seen environmental backlashes and sharp political shifts over the past decades, reinforcing the importance of framing climate action in bipartisan and economic-focused terms to ensure the strength of policies to withstand changes in political winds. Government agencies and industry and community groups should also seek to collaborate more efficiently so that bureaucratic hurdles don't inhibit necessary climate action.

These sweeping ambitions become clearer when explored in terms of specific problems and solutions. Maritime shipping, for example, is the backbone of our global economy, but it is notoriously dirty and difficult to reform. Between 80 percent and 90 percent of all goods transported in the world today are moved on a ship. Today nearly all the vessels on the water run on "bunker fuel," also known as heavy fuel oil. Collectively, global shipping emits nearly 1 billion tons of CO_2 per year.

Can we switch to a truly future-focused approach to climate change?

In one effort to tackle this enormous source of greenhouse emissions, our program at the Aspen Institute has worked for the past three years with leaders in private shipping to develop plans to decarbonize global ocean trade. As part of this process, we have brought together leaders across industries to talk candidly with each other about the policies, economic models, and technologies needed to achieve zero-emission shipping. In 2023, in collaboration with Amazon, outdoors-supply company Patagonia, and German coffee retailer Tchibo, we launched a first-of-its-kind buyers' group within the shipping industry, the Zero Emissions Maritime Buyers Alliance (ZEMBA). Starting in early 2025, ZEMBA will run a second campaign to enlist even more companies, which will help drive down costs and expand the market for zero-emission shipping.

ZEMBA was conceived to spur a market-driven transition to cleaner shipping fuels. In the near term, ZEMBA is focused on switching container ships to cleaner fuels, such as hydrogen-derived methanol and ammonia. In the long run, the goal is to make it easy for any business customer around the world to purchase economical, zero-emission shipping services for their freight. Seventeen global companies have already committed to buying services on ships fueled by waste-derived biomethane in 2025 and 2026; these ships reduce greenhouse gas emissions by 90 percent compared to their fossil-fuel powered counterparts.

By driving change in container shipping—an industry widely regarded as resistant to environmental transformation—ZEMBA demonstrates what can be achieved through high-ambition, collective action.

We and our colleagues have been working to instill a similar, forward-looking culture across the climate-policy community through a variety of meetings and workshops. For example, we convened three roundtable conversations that yielded Building Cleaner, Faster, a 2021 report advising the U.S. Congress and the executive branch on ways to streamline approval for clean energy projects and to reduce bureaucratic hurdles to reducing carbon emissions throughout the economy. In particular, we proposed reforms of the federal environmental review and permitting processes, seeking to accelerate and expand the development of solar and wind power along with other green-energy projects.

We also recognize that politicians cannot implement forward-looking climate policies without the support and understanding of the voters. To that end, we launched This is Planet Ed, a climate-action initiative aimed at the 73 million youth under 18 and the nearly 19 million students enrolled in higher education institutions—together, about 25 percent of the

total U.S. population. This is Planet Ed provides roadmaps, resources, and videos designed to prepare students with knowledge about climate change and the tools to take action. We have also helped mobilize school districts to consider their own environmental impacts—for example, to upgrade America's 480,000 K-12 public-school buses to electric power, as is underway in New York City. Through these programs, we hope to empower the next generation of climate leaders.

Katharine Hayhoe, a climate researcher who has worked extensively to communicate across political lines, spoke about the magnitude of the challenges we face at a recent Aspen Ideas event. "Today we're on a curve larger than any we've ever negotiated in the history of human civilization," she observed.

With an impending change in U.S. leadership, and with the many elections across the globe happening this year, scientists, engineers, policymakers, industry leaders, activists, and the public as a whole have a remarkable opportunity to rethink how we are navigating this curve. If we work together—with vision, ambition, and a shared sense of optimism—we can implement the forward-looking policies necessary to accelerate toward a better climate future.

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This article was found originally at Nautilus.

What AI Can Do for Your Country

Artificial intelligence could transform how the government works—but it'll be a daunting transition.

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Jylana L. Sheats *is a clinical associate professor of social, behavioral, and population sciences in the Tulane University Celia Scott Weatherhead School of Public Health and Tropical Medicine and the associate director at the Aspen Institute Science & Society Program.*

What would happen if an extreme heat wave hit your city, making life difficult or dangerous for everyone there—especially for people with limited incomes, few ways to stay cool, or limited access to food and resources? It's not hard to imagine. The northern hemisphere just experienced its hottest summer on record, and the world is on track to keep warming for decades. But artificial intelligence could reduce the impact. The National Oceanic and Atmospheric Administration is experimenting with AI tools to identify at-risk neighborhoods and to develop better ways to protect residents from extreme weather.

Although most discussions of artificial intelligence focus on its impacts on business and research, AI is also poised to transform government in the United States and beyond. AI-guided disaster response is just one piece of the picture. The U.S. Department of Health and Human Services has an experimental AI program to diagnose COVID-19 and flu cases by analyzing the sound of patients coughing into their smartphones. The Department of Justice uses AI algorithms to help prioritize which tips in the FBI's Threat Intake Processing System to act on first. Other proposals, still at the concept stage, aim to extend the applications of AI to improve the efficiency and effectiveness of nearly every aspect of public services.

The early applications illustrate the potential for AI to make government operations more effective and responsive. They illustrate the looming challenges, too. The federal government will have to recruit, train, and retain skilled workers capable of managing the new technology, competing with the private sector for top talent. The government also faces a daunting task ensuring the ethical and equitable use of AI. Relying on algorithms to direct disaster relief or to flag high-priority crimes raises immediate concerns: What if biases built into the AI overlook some of the groups that most need assistance, or unfairly target certain populations? As AI becomes embedded into more government operations, the opportunities for misuse and unintended consequences will only expand.

Rachel Gillum, who is vice president of ethical technology at the software company Salesforce and who advised the U.S. Chamber of Commerce on AI, is optimistic that artificial intelligence will, on balance, be a huge benefit. "AI can deliver better, faster constituent services that will transform the way governments serve our communities in really exciting and meaningful ways," she says. "AI allows government employees, who are often resource-constrained, to focus their time on the high-touch work that is needed most."

Automation may eliminate some of today's jobs while creating novel opportunities.

Integrating AI into government operations will require major changes in the federal workforce of nearly 3 million employees. It will also require anticipating the future direction of a fast-changing technology, a kind of flexibility that even Silicon Valley has been struggling with. "AI is horizontal, and it will influence everything—including transformative innovations yet to come, like quantum computing," says Michelle Lopes Maldonado, a member of the Virginia House of Delegates who sits on the AI subcommittee of the U.S. Joint Commission on Technology & Science.

In 2023, the Biden-Harris Administration issued an Executive Order that established a new AI and Tech Talent Task Force. From January to March of 2024, the number of government AI job applications doubled compared to the year before. By April, more than 150 individuals were hired for AI-related federal positions. Alejandro Mayorkas, Secretary of the U.S. Department of Homeland Security, recently announced a new AI Corps, which is hiring workers with AI skills to counter major challenges—including fentanyl trafficking, child sexual exploitation and abuses, and cybersecurity—and to help secure travel and protect critical infrastructure. Homeland Security received more than 3,000 applicants for 50 available positions within a few months.

The National AI Talent Surge, a hiring effort created as part of that same Executive Order, aims to build on these promising results by recruiting more AI professionals all across the federal government. That effort focuses on data scientists, legal experts, social scientists, economists, and engineers—individuals who will not only improve the government's AI capabilities but also help shape regulations for its safe and ethical use. Maldonado is particularly excited about AI.gov/apply, an online portal created by the AI Talent Surge team to streamline the often-daunting federal job application process.

Recruitment alone isn't enough, however. The federal government must also be able to retain AI-skilled individuals to keep its projects running smoothly. Betsy Cooper, founding director of the Aspen Tech Policy Hub, points out that salary discrepancies between government and private sector jobs make it challenging for the federal government to attract and hold on to top AI professionals. But government jobs could draw workers with other benefits. Experts have noted that private-sector salaries often come with unstable or stressful work environments. Data from the 2022 Culture 500 project, which studies primarily for-profit companies, indicate that toxic workplace culture is 10 times more likely to influence turnover rates than compensation. Cultivating an office culture that prioritizes worker well-being, satisfaction, and job security could make government jobs more attractive.

Mutale Nkonde, CEO of the nonprofit communications agency AI for the People, adds that the government has an obligation to provide equitable access to AI jobs, particularly for marginalized groups. She warns that gentrification is pushing Black people out of the urban centers where many AI-related jobs are located, which could reduce their opportunities for both public and private-sector work. "You can't take part. You can't contribute," Nkonde says. "So how can the federal government invest in some of these other areas and create housing or other strategies to ensure that the entire U.S. population can afford to live where the jobs will be?"

AI could eventually improve a wide range of government transactions, from Medicare to social security to taxes.

In parallel with a push to bring in new talent, Nkonde calls out the importance of developing AI skills among existing federal employees. Several new initiatives offer training or professional development opportunities for federal employees, including the AI Federal Workforce Initiative and the Office of Personnel Management's AI Training Initiatives. Shalin Jyotishi, a policy strategist at the think tank New America, advocates for job-development programs along the lines of the Workforce Innovation and Opportunity Act, which helped workers get access to education and training and helped connect employers to the right talent.

Matthew P. Shaw, a lawyer and legal professor at Vanderbilt University, notes that AI is already reshaping job roles and transforming what "work" looks like, both inside and outside the government. At some level, much of the existing federal workforce will need to adapt to the era of AI. Yet Cooper cautions that managers planning job-training programs need to recognize that "the vast majority of federal government workers are not going to have experience with AI or related technologies."

Many workers will require training in the basics of artificial intelligence, "often for positions that don't exist yet," Shaw says. Automation may eliminate some of today's jobs while creating novel opportunities—especially in areas like regulation and compliance, where building and maintaining AI systems will be crucial. The Department of Defense and the Department of Homeland Security are actively launching training programs to develop worker AI skills. Still, a lot more targeted efforts will be required to build AI technical proficiency across the federal government.

Looking further ahead, Jyotishi highlights the need for an education system that provides the expertise that workers will need for the AI-driven jobs of tomorrow. He advocates for investments in AI education in community colleges, calling them an "underestimated vehicle for workforce transition in the AI era." The National Science Foundation's AI Education Act of 2024 supports those efforts. Jyotishi sees great potential in AI workforce partnerships, such as those between labor unions and community colleges, "to ensure vulnerable and marginalized communities aren't left behind."

Maldonado stresses the importance of the earlier stages of education as well. In 2023, the Biden-Harris Administration announced $277 million in grants to achieve "educational equity and innovation," with $90.3 million going toward STEM. This builds on the federal YOU

Belong in STEM initiative, designed to "help implement and scale equitable, high-quality STEM education for all students from Pre-K to higher education—regardless of background." At the state level, Maldonado highlights GO TEC, an initiative in her home state of Virginia that prepares middle school students for jobs in IT, advanced manufacturing, and other STEM fields. "We currently have robotics and other tech initiatives that are often considered extracurricular activities. These should be part of the regular curriculum," she says.

AI education programs also offer an opportunity to draw in groups that are often underrepresented in STEM. With a background in sociology, Nkonde has spoken with students from high school to graduate levels about algorithmic bias and biased tech design. A social justice approach to STEM education, such as Aspen's Our Future is Science program, allows future science leaders to grasp the societal impacts of their work, Nkonde notes: A workforce that blends technical skills with ethical awareness will help ensure AI serves the public good.

AI teams need members of varied educational, cultural, racial, and gender identities.

Artificial Intelligence is already making noticeable improvements in the way the government works. Salesforce's Gillum reports that AI tools have helped the Transportation Security Administration "reduce response time and enrich security efficiency," taming some of the frustrations of the more than 2 million people who pass through U.S. airports daily. AI could eventually improve a wide range of government transactions, she notes, from Medicare to social security to taxes. But that scenario requires more than the right employees. It also requires the right systems and applications.

The sprawling, fragmented nature of the federal government makes it impractical to implement a unified set of AI policies and practices. On the other hand, AI itself could be effective at breaking down institutional barriers. Maldonado, who was a tech lawyer before she entered politics, asserts that "AI can absolutely bridge gaps between federal agencies, but we need to move past the 'fiefdom' mentality, where each agency is territorial about its work. To fully leverage AI, we need to foster a mindset of collaboration and co-creation, which is already more common in the private sector."

The National Artificial Intelligence Research Resource is a pilot program by the National Science Foundation, begun in January 2024, to foster collaboration across 13 federal agencies in conjunction with more than two dozen private, nonprofit, and philanthropic partners. Its goal is to expand access to AI tools for researchers and students, focusing on work that addresses major societal challenges. The two-year program will assess the feasibility and value of such large-scale collaborations.

Such efforts have their work cut out for them. "It's no secret the federal government lags significantly in digital transformation," Jyotishi says. "Government websites, grants management systems, and reporting processes are woefully outdated." Current college students have experienced those lapses firsthand with the recent implosion of the Department of Education's Free Application for Federal Student Aid (FAFSA) system, which helps students apply for higher-education financial aid. The system ran on antiquated technology, and the department's ambitious effort to overhaul the system rendered it largely inoperable. Schools were unable to process financial aid applications for weeks to months this past year, leaving students unsure if they could afford to enroll.

The FAFSA fiasco is a cautionary tale of the need for multi-level solutions to prevent disruptions in vital federal systems. Maldonado suggests that the government needs to create centralized protocols and guidelines that establish best-practice standards (including technological infrastructure and workforce training), which can then be used to guide AI implementation in various agencies. She suggests creating a federal agency or office focused on AI and emerging tech to lead these efforts. "This way, not everyone will have their own AI czar or a separate set of processes," she says.

Federal agencies also need to adopt long-term AI strategies, which will require reducing their dependence on external contractors and suppliers, according to B Cavello, a former AI developer at IBM and TechCongress fellow. Their experience is a case in point. The TechCongress program was created in 2016 to provide the federal government with emerging tech experts. Since then, it has brought 109 scientists, engineers, and technologists into Congress in temporary advisory positions.

"Rapid advancements in science and technology demand dedicated expertise," says Michael Akinwumi, Chief AI Officer at the National Fair Housing Alliance. "Unlike temporary roles, permanent positions provide institutional knowledge, foster long-term relationships, and promote proactive policy development."

Amazon's experience with its experimental talent recruitment tool showcases one of the great challenges with expanding the role of artificial intelligence: Bias can easily infiltrate allegedly neutral technologies, distorting or subverting their intended goals. A decade ago, Amazon began developing machine-learning algorithms to automate its hiring process. Company officials abandoned the project in 2018, after an internal review revealed that the system disproportionately favored men. The problem was that the AI system was trained on data reflecting the company's early, male-dominated workforce.

The issue is not unique to gender or to hiring, Nkonde notes. Other automated recruitment tools have been found to discriminate against candidates with "African-sounding names." Similar biases have emerged in software systems for criminal justice, immigration, and housing. The scale of the federal government, combined with its mandate to serve all the people, give it a unique obligation to root out such damaging potential impacts of AI.

Akinwumi's work at the National Fair Housing Alliance is an example of how AI can be applied the other way, to counteract systemic biases. He developed a system that identifies discriminatory patterns in housing and fair-lending loans and that enables the NFHA to design appropriate legal responses. His goal is "to promote responsible AI use, ensuring fairness, transparency, and public trust." Similar AI techniques could be used to analyze and reform outdated zoning codes, to streamline permitting, and to optimize construction that improves housing affordability and accessibility.

Nkonde argues that software engineers should pursue well-defined principles of ethics and equity in each phase of AI development. The National Institute of Standards and Technology is attempting to institutionalize such principles by requiring that the agency's projects all adhere to a list of federal "AI Commitments." But enforcing such standards requires significant effort.

Cooper, who served as the founding executive director of the University of California, Berkeley's Center for Long-Term Cybersecurity, says that "AI's reliability remains questionable, and every AI-generated output still requires human vetting." One way to ensure that AI systems have been carefully evaluated is to require government impact assessments. Nkonde, an AI policy advisor, has pushed this approach as the lead supporter of the proposed Algorithmic Accountability Act, introduced by Representative Yvette Clarke from New York City. This legislation would require assessments to confirm that machine learning technologies adhere to non-discrimination laws before public rollout. Although the Act has not passed, its principles have been integrated into all major privacy proposals from the U.S. House Energy and Commerce Committee.

"If an AI system fails to meet this standard, it should not be procured or used—not because it's the ethical thing to do, but because it's

required by law," Nkonde says. Gillum agrees, noting that "the risks governments face implementing AI are not all that different from those companies face—though in some cases, the stakes are even higher." For instance, AI will very likely be incorporated into government services and benefits that directly impact people's livelihoods.

Weeding out bias requires diligent, ongoing effort, as evidenced by Google's recent missteps with their experimental Gemini AI tool. Image requests generated through Gemini inaccurately depicted historical figures, representing Black men as Nazi-era German soldiers, the Pope as an Asian woman, Native Americans as Vikings, and President George Washington as a Black man. Google apologized and launched a new version of Gemini in August 2024. Some critics saw the historical misrepresentations as a failed attempt to address previous biases that suppressed images of minorities—but the effort backfired and just ended up creating new stereotypes.

Ultimately, AI will be useful in government only if it improves how government serves the people—all of the people.

"If you only have technologists at the table, you're going to have multiple blind spots. If you only have policymakers at the table, you'll also have multiple blind spots," Maldonado observes. AI teams need members of varied educational, cultural, racial, and gender identities, she notes, because otherwise "we may not recognize certain gaps because of our life experiences." Nkonde also recommends incorporating social scientists into AI development. "Without the involvement of social scientists," she says, "we risk creating AI systems that are technically advanced but socially disconnected."

Ultimately, AI will be useful in government only if it improves how government serves the people—all of the people. Reflecting on that high-level goal, Cavello, who now directs Emerging Technologies at Aspen Digital, pushes back on a common complaint that assessing the ethics of AI systems slows the pace of innovation. "Innovation is rushing toward the hard problems," they say. "To me, working on protecting civil rights and privacy … that is innovation."

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This article was found originally at Nautilus.

Science for the People

A growing movement connects scientists with policymakers and the public to shape a better ssdfasdfasdfasdfasdfasdfasdfasdfociety.

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Michael Akinwumi *is an Eagleton Civic Science Fellow who is using large language models to help state legislators evaluate AI-related bills. He has served as the chief AI officer of the National Fair Housing Alliance; he also has a background in financial technology, insurance, and retail banking.*

Elizabeth Good Christopherson *is president and CEO of the Rita Allen Foundation, a venture philanthropy organization that invests early-career leaders in biomedicine and civic engagement. The foundation co-launched the Civic Science Fellows program in 2020.*

Anna Dulencin *is the director of the Eagleton Science and Politics Program at Rutgers University.*

Jon Kaye *is a program director at the Gordon and Betty Moore Foundation. He leads grantmaking initiatives in the life sciences and helps guide the foundation's evidence-informed decision making portfolio.*

As a Ph.D. student at Princeton University, Celia Smits probed the mysteries of fruit fly development, searching for the secrets of how life organizes itself. Yet, as she imagined her future, she yearned for a way to see her research have a more immediate impact on the people

around her. Her desire to connect her work with the needs of the community led her on an unexpected detour—into a staff position in the New Jersey Senate as an Eagleton Science and Politics Fellow, advising legislators on science policy.

The opportunity has given Smits new insights into how science matters to society—and where future research might contribute the most. "One of the difficult things about being a scientist is coming up with something new that no one has thought about before," she says. "Being in this space opens up a lot of questions. You really see the limits of where we know things and where we don't know things."

Smits encountered one of those areas of uncertainty when she started working on legislation to regulate a group of synthetic chemicals known as PFAS (perfluoroalkyl and polyfluoroalkyl substances). PFAS are used in a breathtaking variety of modern products, from cosmetics and nonstick cookware to heart stents, firefighting foam, and lithium-ion batteries for cell phones and electric cars. But these long-lasting substances—often dubbed "forever chemicals"—are also now recognized as potentially hazardous, inspiring efforts to limit their use and to further investigate their health effects.

The overlap between scientific research and social concerns has given rise to a movement known as "civic science."

Since their introduction in the 1940s, PFAS have accumulated in the environment, in the food chain, and in the human body, where some forms have been linked with health risks including cancers, elevated cholesterol, and a reduced response to vaccines. With more than 12,000 types of PFAS created so far, much is still unknown about them. Which forms are most harmful? How much exposure causes health effects? What are the practical alternatives to PFAS? And how should we weigh the cost of cleanup and replacement versus the cost and risk of leaving things as they are? These are questions that scientists can't answer alone, and that policymakers can't answer alone, either. Policymakers need scientists working with them to help assess evolving evidence and competing analyses.

Even determining which chemicals qualify as PFAS is contentious. Smits found that legislators and staff in the New Jersey Senate were eager to engage with the scientific evidence about these chemicals, but they didn't always have the resources to evaluate it. "People can present evidence that says whatever opinion they want to present," she notes. "It's very important to be able to discern what is the most important or the most relevant piece." Drawing on her expertise in chemistry and biochemistry, Smits helped legislators assess the consequences of potential definitions of PFAS in a bill to phase out the use of those chemicals in certain consumer products. That bill is now under consideration in the State Senate and Assembly.

Just as today's scientific research increasingly relies on drawing together ideas from diverse disciplines, untangling complex science policy issues like PFAS regulation requires broad collaboration. Solutions require input not only from scientists, but also from nonprofits, community members, and philanthropic groups.

Such broad-based collaborations are proving especially fruitful at the state level, because states are often able to experiment with new policies in emerging areas of science and technology even while consensus remains elusive at the federal level. With the input of scientists like Smits, states are becoming increasingly valuable laboratories for developing policy solutions that draw on the best available evidence, applying it to yield maximum public benefit.

The overlap between scientific research and social concerns has given rise to a growing, collaborative movement known as "civic science." It is an umbrella term for current efforts to develop programs and interdisciplinary scholarship related to the societal aspects of science; to foster connections between science and democratic decision-making; and to build networks of people—in scientific institutions and outside of them—working to ensure that science reaches its full potential to serve the public good. Civic science is about breaking down institutional and systemic barriers, so that people across diverse communities can participate in the scientific process and use scientific insights to address their most important priorities.

Policy makers need scientists working with them to help assess evolving evidence and competing analyses.

Many scientists, like Smits, are eager to connect their work in a laboratory, in the field, or behind a desk to serving humanity as a whole. At the same time, many people outside of research institutions—in museums, public policy, philanthropy, journalism—are building bridges between science and other parts of society, pulling together the kind of wide-ranging expertise needed to solve complex social problems. Civic science enhances the value to society of basic research while exploring other ways scientists and engineers can use their knowledge to improve people's lives, whether through policy, engaging with their local communities, or making science more welcoming and accessible.

States and territories are critical sites for these exchanges in the United States, because they hold the authority to navigate consequential science and technology issues while operating on a smaller, more nimble scale than the federal government. State-level policies are now addressing pressing problems in public health, artificial intelligence, and climate change. These issues are developing too rapidly to await national-level solutions. Civic science and novel science policies in state governments can draw from policy ideas and innovations happening at the local level. Such experiments can also inform efforts in other states and inform legislation at the federal level. The impact of state-level policy can be substantial: the California Air Resources Board, which sets pollution standards for the state, has influenced automotive emissions policy and industry standards globally.

The recent Supreme Court decision overturning Chevron v. Natural Resources Defense Council further amplified the urgency and opportunity of developing state-level science and technology policies. For the past 40 years, "Chevron deference" allowed federal agencies to interpret ambiguous areas of federal regulations by drawing on the specialized scientific training of their professional staff. The 2024 Supreme Court ruling means that, going forward, more of those ambiguities will be resolved through judicial processes. In the future, states will have more opportunities and obligation to provide stronger leadership in developing evidence-informed policies that are guided by the best available scientific knowledge and expertise.

Only 4 percent of state legislators nationwide have a background in science, technology, engineering, or healthcare. As states face increasingly complex scientific and technological issues, many organizations within and outside of government are developing programs to ensure that state legislatures have access to relevant scientific expertise. The National Conference of State Legislatures is helping to coordinate similar science-access efforts nationally.

The Eagleton Science and Politics Fellowship in New Jersey follows one increasingly com-

mon approach: placing scientists and engineers from a range of disciplines in advisory positions to support state legislatures. Some of these programs are administered through universities, as is the Eagleton program based at Rutgers University, others through a state scientific council or an independent nonprofit. In Missouri, a group of graduate students created a fellowship program and a nonprofit organization to administer it, the Missouri Science and Technology Policy Initiative, as a means to provide nonpartisan science policy research for members of the Missouri General Assembly. Six states—California, Connecticut, Idaho, and New York, in addition to Missouri and New Jersey—have launched year-long, Ph.D.-level science advising fellowship programs in a similar manner.

These science policy fellowship programs have received support from coalitions of philanthropic funders, led nationally by the Gordon and Betty Moore Foundation. In a vote of confidence, California allocated $31.5 million between 2019–2023 to operate, endow, and secure the future of its state legislature science policy fellowship program managed by the California Council on Science and Technology. The California Legislature has frequently acknowledged the value of the program. In New Jersey, Matt Peterson, the associate executive director of the New Jersey Senate Majority Office, says that in just six years, Eagleton Science Policy Fellows have become "an indispensable resource."

Civic science is demonstrating its value as states confront complex, fast-moving challenges. The regulation of artificial intelligence is a prominent example. While Congress is slowly debating bills to set guardrails for AI tools, state lawmakers are passing them. To date, more than 60 state AI bills have been enacted out of 762 proposed AI bills in 45 states compared to just 114 proposed AI bills in Congress according to MultiState, a government affairs firm. In May, Colorado became the first state to pass a broad AI consumer-protection law. The Utah legislature recently approved the Artificial Intelligence Policy Act and created a new state Office of Artificial Intelligence Policy. Other states are joining Utah in considering the creation of "regulatory sandboxes," collaborative projects that bring together researchers and legislators to explore the advantages and drawbacks of specific policies regarding AI and other technology.

In response to generative AI technologies such as ChatGPT and Gemini, 13 states enacted laws this year to address AI-generated deepfakes in elections. Another Eagleton Science and Politics Fellow, Erin K. Reagan, arranged a hearing that influenced proposed New Jersey legislation to regulate deepfakes—deceptive images, audio, or video created using AI tools. The hearing included a variety of experts, including a computer scientist, a communications scholar studying "cheap fakes" (deceptive images easily created with low-tech editing tools), an expert in First Amendment issues, and a researcher studying intimate partner violence. Based on that expert input, the bill was revised to close potential loopholes—for instance, specifying different forms that the solicitation of deepfakes might take. Several scholars noted that, without Reagan's invitation, it would not have occurred to them to share their expertise with policymakers.

One of the authors of this article, Michael Akinwumi, is an applied mathematical scientist with firsthand experience in civic science. He has worked on responsible AI systems, designed to protect privacy and promote equity; he is now developing guidelines for AI regulation that can inform state legislatures across the country. Akinwumi has observed that well-informed engagement from state regulators can stimulate AI innovation rather than stifling it. For example, efforts to ensure fairness, accuracy, safety, and reliability in AI systems that make crucial recommendations—such as who gets approved for a bank loan—have driven advances in theoretical computer science. These efforts have inspired research in explainability (summarizing the process of AI so humans can understand it) and interpretability (revealing the internal steps AI uses to arrive at answers).

In addition to AI legislation, civic science is helping shape policies addressing COVID-19 and future pandemics, climate change, environmental toxins, and gene editing. Crafting effective approaches to these complex areas requires more than scientific and technical knowledge. It also requires sensitivity to public values, and to issues of inequality, polarization, and trust.

The Civic Science Fellows program, which brought together the authors of this article, was created in 2020 to improve the ways that institutions, including state governments, draw on different kinds of expertise to address emerging problems. It connects bench and social scientists with journalists, community groups, content creators, public-interest organizations, and funders. Through the fellows program, organizations confronting science-related challenges (ranging from research institutions to museums and community-based nonprofits) receive grants to hire fellows from a wide spectrum of disciplines and backgrounds. Fellows aim to learn from other experts, develop creative solutions, advance knowledge about what works in civic science, and build trusted relationships that form a foundation for ongoing collaborations.

Civic science is helping shape policies addressing future pandemics, climate change, environmental toxins, and more.

Some of the fellows work with policymakers; others work with scientific organizations to help them grapple with ethics, public outreach, and social implications in fields ranging from neuroscience to quantum computing, from clinical algorithms to synthetic biology. Other fellows approach civic science issues from a community perspective by engaging with people who have not traditionally been included in science so that they, too, can have a voice in shaping policy, using science to address their priorities, and influencing how researchers ask questions and apply their results. Akinwumi is a civic science fellow; his work to support state-level efforts to assure that AI is implemented in safe and equitable ways is one example of how fellows projects weave together different kinds of expertise.

A goal of many civic science efforts is providing ways for local insights and concerns to migrate up to the state and territory level. Civic science fellows Andrea Isabel López, a public health researcher, and Angélica Valdés Valderrama, a social scientist, are studying the efforts of Ciencia Puerto Rico, a nonprofit science-advocacy group working to build relationships between the scientific community and community leaders in Puerto Rico. Ciencia Puerto Rico played an influential role early in the COVID-19 pandemic when the group developed local, culturally relevant communication strategies about the value and safety of vaccination. Their strategies were later adopted by the Puerto Rican House of Representatives. These evidence-based approaches reached more than 200,000 people, including the territory's most vulnerable populations, contributing to Puerto Rico having some of the highest vaccination rates in the U.S. by fall 2021.

In another example spotlighting the value of local engagement, civic science fellow Elyse Aurbach, a neuroscientist and science communicator, worked with the Association of Public and Land-Grant Universities to explore ways state universities and other higher-education institutions can communicate more effectively with local communities. She highlighted examples from university extension offices, which are often funded by state legislatures with the specific goal of bringing the benefits of research findings into communities. Several years ago, the University of Missouri's Office of Extension and Engagement conducted listening tours across Missouri. Community input then led the

university to refocus its extension programming around the areas of economic opportunity, educational excellence, and health and well-being.

The University of Missouri's focus on engagement proved crucial during the early days of the COVID-19 pandemic. County engagement specialists with the university drew on existing relationships to give personalized health information to rural small businesses and to help initiate volunteer efforts to make deliveries from food pantries and grocery stores.

People working in civic science often describe themselves as "boundary spanners" who speak the languages of science and policy, and also of the specific communities they come from. Andrew George is one example, and he is committed to supporting other boundary spanners. His efforts began a decade ago while he was studying molecular biology at Duke University, where he helped create a fellowship for graduate students in North Carolina to contribute to public policy. Then as a civic science fellow, he worked with Sigma Xi, an international scientific honor society, to create an online platform for scientists to find opportunities to participate in state-level policymaking while also engaging with the public.

Since his fellowship ended last year, George has been working with the North Carolina Biotechnology Center, a public-private coalition founded by the North Carolina General Assembly. There, he has created a community ambassador program to draw people from varied socioeconomic backgrounds and provide training and job-placement for work in creating vaccines and medications. The program also supports medical-related education and apprenticeships for college students, high schoolers, and underserved local populations.

Although civic science takes on many forms, its core mission is always the same. "When you add the word 'civic' to 'science' you put in the missing piece for science as it serves the public," said Mariette DiChristina, dean of Boston University's College of Communications and an advisor to the Civic Science Fellows, at a recent discussion at the British Library. "There are challenging, multidisciplinary, strident issues of the day, from climate change to public health to how to incorporate AI, where the answers aren't always what the science says," DiChristina continues. "The answers are often what we decide to do as a community. That's where the civic comes in."

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Preserving America's Place in Global Science

The United States can remain an international leader in science by embracing openness and collaboration.

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Tobin Smith *is senior vice president for government relations and public policy at the Association of American Universities, an organization composed of 71 leading public and private research universities. At AAU, he oversees activities relating to science, innovation, and higher education policy.*

In the summer of 1862, at the height of the Civil War, President Abraham Lincoln signed the Morrill Act, which set aside federal land for new colleges to "promote the liberal and practical education of the industrial classes." Two months earlier, President Lincoln created the United States Department of Agriculture. Less than a year later, while Union and Confederate forces were still fighting fiercely, he signed legislation establishing the National Academies of Science.

Even during the most difficult political and fiscal times, the U.S. government has found ways to advance the creation and dissemination of knowledge. That commitment to science and engineering helped the allies win World War II and forged an enduring partnership between the federal government and universities. Public support for science in the U.S. really took off post-war, with the creation of the National Science Foundation (NSF) and NASA, along with increased defense research and development funding and a vast expansion of the National Institutes of Health. Lofted by that investment,

the U.S. led international science by almost every metric during the second half of the 20th century.

Now America's scientific standing is being put through a series of wrenching tests. Whoever wins the upcoming presidential election will have to make tough decisions about how to maintain scientific leadership in an increasingly competitive global environment. Tight budgets and visa restrictions have been further eroding the U.S. position. In addition, the next president will face intense pressure to protect domestic research and development against foreign competition—even as some of those competitors, especially China, have been significantly boosting their investments in science.

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Although the U.S. might never return to the kind of scientific preeminence it had during the Cold War, we need not slide into full decline or self-destructive isolation. With the right leadership, we can chart a smart course of international engagement, openness, immigration, and strategic research funding that will expand our knowledge, enrich our economy, and ensure our national defense. If we can break through partisan blocks and us-versus-them formulations that hold us back, the U.S. has an inspiring future as a beacon of global innovation.

Federal budget limits will seriously restrict the next administration's ability to make critical investment in U.S. scientific research and development. Despite considerable discussion from Congress about the need to increase federal support for R&D, the final 2024 funding agreement actually cut $800 million from the NSF's budget, one of the largest single-year reductions in the agency's history. As a share of gross domestic product, federal funding provided by the NSF, Department of Energy's Office of Science, and National Institute of Standards and Technology, have fallen to their lowest levels since 1997. And the spending caps set by Congress under the Fiscal Responsibility Act leave little room to increase science investment in 2025.

One of the most urgent areas of need is funding to keep up with rapid advances in the development and application of artificial intelligence. AI's potential to be used for both positive and negative ends echoes the breakthroughs in nuclear physics that occurred during World War II. The wartime research enabled nuclear weapons, nuclear power, nuclear medicine, and other associated technologies, all of which required significant government support and regulation. AI is likely to have similarly unpredictable and transformative societal impacts.

A major task for the new administration and the next Congress will be finding ways to invest in such critical research areas even within political gridlock and budgetary constraints. Competing nations, including China, have announced major increases in funding to fuel their scientific research. Now is not the time for the U.S. to take its pedal off the gas.

Simply expanding federal funding for R&D will not be enough; the government needs to ensure that fundamental research is not held back by excessive and unnecessary security requirements. Congress has repeatedly passed such requirements, driven by increasing concerns about intellectual property theft, national security, and strategic competition, particularly with China. However, the policies surrounding these security efforts are often drafted without differentiating between fundamental advances in scientific knowledge from applied technologies that have clear military applications.

Security policies intended to prevent research from falling into the hands of our adversaries should be evaluated by experts who understand in detail the technical nature of national security risks and who can assess the benefits of secrecy versus its costs. These policies should also be applied consistently across federal agencies so researchers and universities can comply with the requirements while minimizing the administrative burdens they impose. This is an area in which presidential guidance could make a big difference. The Trump and Biden administrations already made some progress with a presidential memorandum directing federal agencies to "standardize disclosure processes, definitions, and forms." The White House's Office of Science can help the next president ensure that security policies are efficiently addressing genuine risks.

These days, large research problems can rarely be tackled by an individual researcher or even an individual lab.

In addition to bolstering domestic research, the next president would be wise to increase scientific collaboration with allied nations—both to support research in emerging technologies and to build international STEM talent pipelines, including with India and developing countries in Africa and South America. Horizon Europe, a multilateral funding program that supports research across the 27 nations of the European Union, offers a useful model for how such a project might operate. The U.S. could take inspiration, too, from the way China has been forging global scientific ties as a part of its Belt and Road Initiative, which has supported the creation of dozens of collaborative labs and universities abroad.

Many of today's most dangerous challenges—with climate change and the threat of future pandemics at the top of the list—will require the coordinated efforts of scientists around the world. Yet politicians in the U.S. (and in many other nations) increasingly question the value of international scientific collaboration. In recent years, geopolitical tensions have interfered with life-saving international disease monitoring, as well as with international collaboration and data sharing on global environmental challenges such as climate change. Concerns about national security, travel and visa restrictions, data access, and privacy keep getting in the way of the work needed to address these existential threats.

In the face of growing isolationist sentiment, the next president should be aware that many of the most consequential scientific initiatives of the post-Cold War era, including the International Space Station and the Human Genome Project, would have been impossible without the robust participation of governments and researchers from around the world. Many of the recent U.S. advancements in mRNA research, which enabled the rapid development of a COVID-19 vaccine and likely saved millions of lives, were driven by immigrant researchers and by open global scientific collaboration.

It is unclear if the U.S. still has the will and ability to lead grand, globe-spanning scientific endeavors. Forging international agreements and securing funding for research happening outside American borders will require vigorous presidential leadership. There is no valid alternative, however. These days, large research problems can rarely be tackled by an individual researcher or even an individual lab or department. More and more, science is conducted internationally. It needs to be funded, coordinated, and regulated internationally as well. Climate agreements, digital privacy protection, disease monitoring and control, and ethical standards for gene editing and artificial intelligence—all of these require international engagement.

Being a leader in global science requires a

commitment to the free and open exchange of information. President Reagan may be best remembered for his anti-Soviet stances, but he also recognized the importance of scientific openness. In 1985, he issued a national security directive that established clear boundaries between classified and fundamental research, protecting the latter from intrusive government controls. He understood that hiding away scientific results while their applications are still unclear will only prevent other scientists from reproducing, replicating, and testing the results for accuracy, impeding the advancement of knowledge.

Many politicians seem to believe that international controls, such as domestic security rules, will give American scientists an advantage. The assumption underlying "scientific protectionism" is that the U.S. has the lead across a wide array of critical technologies and research fields. That is no longer generally true across many areas of computer science, chemistry, and mathematics, and the trend lines show foreign nations advancing in many other fields as well. Even in areas where the U.S. still leads the international community significantly (as in some fields of biological and health sciences), restricting the sharing of information is unlikely to serve our interests; if anything, protectionism is more likely to cause harm.

Immigrants have founded or co-founded almost two-thirds of the top U.S. AI companies.

Before anyone threatens restrictions on scientific collaborations with nations they view as adversarial in sensitive areas like AI or quantum computing, they should assess who has more to gain from scientific openness: the U.S. or our potential adversaries. Building walls around research hinders the ability of U.S.-based scientists to learn from ideas and discoveries by their counterparts in other parts of the world. Without such awareness, domestic scientists don't know what they don't know and may miss out on important developments. The U.S. fell behind China in the development of 5G technology partially due to a failure to engage in international partnerships, which created a blind spot to how far China had advanced in its development of next-generation telecommunications technology.

Immigration has been one of the most contentious issues in this year's U.S. presidential campaign. Unfortunately, immigration is also a key issue that this country needs to resolve to stay ahead in science and technology. Today, every country is engaged in an international competition for top STEM talent. Other nations, such as China, clearly understand this reality. They not only have been investing heavily in domestic scientific research, they also have been developing recruitment strategies to attract and retain outstanding researchers and engineers from around the world.

In 1990, China produced less than 2 percent of the global total in scientific publications. In 2023, that number had risen to 25 percent. China now leads the world in the total share of highly cited, openly published scientific papers underpinning key areas of science in physics, mathematics, engineering, and computer science—including artificial intelligence.

Meanwhile, the U.S. has not developed a global strategy for drawing and retaining top scientific talent, relying mainly on its historical leadership role. Attracting such people from around the world has been, and will continue to be, essential to advancing U.S. national security and economic interests. According to one analysis, immigrants founded or co-founded almost two-thirds of the top U.S. AI companies, with many of these founders having first come to study at U.S. universities while on student visas.

This lack of national talent strategy has been magnified by the adoption of outright harmful policies, such as the China Initiative—a Department of Justice program launched in 2018 that investigated Chinese-American academics—and the 2017 Muslim Travel Ban—which prohibited travel to the U.S. from seven predominantly Muslim countries. These actions have harmed the reputation of the U.S. as being a welcoming place for immigrant scientists.

If the U.S. is to maintain its role as a global leader in science and technology, it will need to develop policies that encourage talented immigrants to study, work, and stay here. One productive step would be to enact legislation aimed at retaining high-skill science and technology talent, such as the Keep STEM Talent Act of 2023 introduced last year by senators Dick Durbin (a democrat) and Mike Rounds (a republican). This bill aims to ensure that foreign STEM Ph.D. students studying at American universities can continue working in the U.S. after completing their degree. Although such legislation enjoys bipartisan support, Congress refused to consider the bill because of the fierce political fights over immigration and border security.

None of these changes will be easy. Many of the actions needed to secure America's place in international science run directly against the political headwinds here at home. But that is the job of a leader: to recognize what needs to happen, and then to summon the will to make it happen.

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This article was found originally at Nautilus.

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