Public Meeting of the

President's Council of Advisors on Science and Technology (PCAST)

October 18-19, 2021

Meeting Minutes

Meeting Participants

PCAST Members

1. Frances Arnold, Co-Chair
2. Eric Lander, Co-Chair
3. Maria T. Zuber, Co-Chair
4. Marvin Adams
5. Dan E. Arvizu
6. John Banovetz
7. Ash Carter
8. Frances Colón
9. Lisa A. Cooper
10. John O. Dabiri
11. William Dally
12. Sue Desmond-Hellmann
13. Inez Fung
14. Andrea Goldsmith
15. Laura H. Greene
16. Paula Hammond
17. Eric Horvitz
18. Joe Kiani
19. Jon Levin
20. Steve Pacala
21. Saul Perlmutter
22. William Press
23. Penny Pritzker
24. Jennifer Richeson
25. Vicki Sato
26. Lisa Su
27. Kathryn Sullivan
28. Terence Tao
29. Phil Venables
30. Catherine Woteki

PCAST Staff

1. Anne-Marie Mazza, Executive Director
2. Ambika Bumb, Deputy Executive Director
3. Sarah Domnitz, Deputy Executive Director and PCAST Designated Federal Officer

Invited Speakers (in order of presentation)

1. Gina McCarthy, National Climate Advisor, The White House

2. Michael Oppenheimer, Center for Policy Research on Energy and the Environment, Princeton University
3. Jane Lubchenco, Deputy Director for Climate and Environment, The White House Office of Science and Technology Policy
4. Jesse Jenkins, Department of Mechanical and Aerospace Engineering and the Andlinger Center for Energy and Environment, Princeton University
5. Arun Majumdar, Department of Mechanical Engineering and Department of Materials Science and Engineering, Stanford University
6. Richard Hawryluk, Princeton Plasma Physics Laboratory (Department of Energy National Laboratory), and Chair of National Academies Report *Bringing Fusion to the U.S. Grid*
7. Erin Sikorsky, The Center for Climate and Security and The International Military Council on Climate and Security, The Council on Strategic Risks

START DATE AND TIME: Monday October 18, 2021, 12:05 p.m. Eastern Time

LOCATION: Virtual Meeting via Zoom.gov

WELCOME

PCAST Co-Chairs: Frances Arnold, Eric Lander, Maria Zuber

The PCAST co-chairs called the meeting to order – Frances Arnold, California Institute of Technology; Eric Lander, Science Advisor to President Biden and Director of the White House Office of Science and Technology Policy (OSTP); and Maria Zuber, Massachusetts Institute of Technology. Zuber led the introductory remarks by describing the UN Climate Change Conference held in Paris, France in 2015, attended by representatives of 192 nations who arrived at an initial commitment to reduce greenhouse gas emissions. Zuber said those commitments were nonbinding and insufficient to address many of the anticipated negative outcomes from climate change. She added that the policies in place today unfortunately put the world on track for a 3-degree Celsius rise in average temperature, which is much higher than the Intergovernmental Panel on Climate Change's (IPCC's) warning that even a 2-degree Celsius rise is too much. The negative consequences of the temperature increase have been demonstrated in the last year with wildfires in the western United States, serious storms resulting in flooding in the Gulf Coast states and the North East, and winter storms that interrupted power to millions in Texas.

Zuber stated that the public is more aware of the crisis, and President Biden has asked for advice on how science can help alleviate the crisis. She stated that the two-day PCAST meeting will address climate change, and will include presentations on the Biden administration's priorities and planned initiatives, currently available technologies and innovation needed to solve the problem, and climate-related threats to the economy and national security.

SESSION: CLIMATE CHANGE, ENERGY, AND THE ENVIRONMENT

PERSPECTIVE FROM THE BIDEN-HARRIS ADMINISTRATION

Gina McCarthy, National Climate Advisor, The White House

Gina McCarthy commented on science and the future of climate change from two perspectives – what the federal government is doing now and what plans and initiatives are being contemplated for the future. President Biden has said that climate change is a "code red" alert for humanity. The crisis has been underscored by the negative consequences seen in the United States—flooding in the Midwest, superstorms hitting the Gulf Coast and eastern United States, and wildfires, droughts, and heat waves in the western United States.

McCarthy said President Biden's Build Back Better agenda has multiple components. She listed several of them: Investing in infrastructure, which includes investing in transportation, such as replacing fossil fuel vehicles with electric vehicles; deploying renewable energy; prioritizing public health and environmental justice, such as eliminating lead pipes from the drinking water delivery system and cleaning up leaking oil and gas wells to reduce pollution from methane emissions. Ambitious goals have been set, for example, to reduce emissions by 50 percent by 2030 and achieve net-zero emissions by 2050. To do this, the United States will need to use 100 percent clean energy by 2035. The White House is working to ensure that the National Climate Task Force brings together cabinet-level leaders in the administration to look at every opportunity to achieve these goals. Twenty federal agencies have already established climate adaptation resilience plans. There also is a focus on restoring confidence in scientific integrity and strengthening partnerships with states and local communities. One of the most important partnerships is the Justice40 Initiative to deliver 40 percent of overall benefits of climate and clean energy investments to disadvantaged communities. Finally, McCarthy mentioned the upcoming UN Climate Change Conference to be held in Glasgow, Scotland in November 2021, during which the White House intends to push for a global methane pledge.

Zuber moderated the Q&A and discussion between PCAST Members and McCarthy.

THE CURRENT STATE OF CLIMATE CHANGE AND WHAT COULD COME NEXT

Michael Oppenheimer, Princeton University

Michael Oppenheimer said that a dangerous gap is widening between the rate of climate change and the learning curve for implementing adaptive measures. There is no coherent federal approach for adapting to the current climate change risk nor to the climate change risk that is growing over time; the United States has placed adaptation "on the back burner," Oppenheimer said.

Oppenheimer said he believed the existing patchwork approach of relying on post-disaster relief is outdated and inadequate to respond to rapid climate change and may have exacerbated—rather than reduced—exposure to climate change risk. He noted five shortcomings: 1) it fails to provide targeted aid to low-income communities; 2) it fails to provide incentives for households to take pre-disaster adaptive actions to minimize household damage; 3) it fails to incentivize municipalities to restrict development in

risk-prone areas; 4) it fails to adequately coordinate policies across agencies in areas such as planned relocation; and 5) it fails to recognize that disaster risks will become less insurable as multiple risks are compounded because of climate change.

Oppenheimer said that the federal government controls the majority of financial resources, but state and local authorities and individuals are mainly responsible for implementation. Federal funding procedures do not encourage adaptation until disaster occurs. Oppenheimer described two examples. The first example was Hurricane Katrina (in 2005), which demonstrated that defenses built based on the experience during Hurricane Betsy, which occurred 40 years earlier, were inadequate. They are not able to withstand the higher water surge that Category 4 and 5 storms deliver, especially if those storms occur more frequently, as is predicted for the future. The second example was Hurricane Sandy (in 2012), which was accompanied by a significant storm surge that made landfall just south of New York City. The bulkhead protecting lower Manhattan—old and in poor condition—was only six feet tall, but the surge reached over 10 feet high. The ensuing flooding affected emergency generators in hospitals and electric power substations, thus requiring evacuation of hospitalized patients. Subways were flooded for three days. Failure of the myopic emergency planning was evidenced by the fact that four out of nine storm surges in the previous 60 years had come within a foot of flooding the subways, but that did not influence city planners. Much of the damage could have been averted by taking advantage of the federal disaster assistance fund of $2 billion to reinforce flood zone infrastructure, taking steps like moving emergency generators out of basements to upper floors, and banning new hospital construction in flood zones. Oppenheimer noted that global warming is expected to increase surges by two to four times by 2050.

Oppenheimer stated that there were lessons learned from these experiences: First, what worked in the past with once-in-a-century high water will not work when high water occurs every year, which is predicted to happen by 2050. Second, taking preventive steps is less costly than risking damage and loss of life, which are likely to occur. Finally, planning must consider demographics. Officials cannot assume that residents can adapt to heat waves by making behavioral adjustments, such as installing home air conditioning or traveling to cooling centers, because systemic racial bias, low incomes, and/or poor health are barriers to these behavioral adjustments. A study of cooling centers in Phoenix, New York, and Chicago revealed that these centers often were inaccessible to those without cars who lived in areas underserved by public transportation. Furthermore, the centers often close at night when heat is most deadly. Another example of inequity in planning was seen during Hurricane Katrina in 2005 when emergency evacuation plans failed because officials assumed that residents could drive out of the evacuation area in their cars, but this was impossible for many because the area was highly populated with low-income residents who did not own cars.

Oppenheimer said the impediments to effective planning and prevention include the public's short-term memory of disastrous events, the fact that political consequences favor *ex post facto* clean-up (prospective action involves intangible long-term results), and the propensity for individual households to take a single action, like raising a house above current flood water levels, without considering that future floods will likely be higher.

Oppenheimer concluded with the following suggestions:

- The federal government should continue to develop a coherent, whole-of-government, approach to climate adaptation that promotes security and that centers on equity by

reorienting post-disaster response towards a national narrative of advance risk-reduction planning. Steps to do this include restructuring existing disaster programs to include discounts to property risk reduction actions; unlocking more financial resources for states and municipalities; supporting low-income households to enable moving out of high-risk areas and incentivizing local community processes for on-site risk reduction and relocation; and offering resilience-oriented model zoning codes, mandatory risk disclosures, and scientific and educational materials, such as updated hazard risk maps.

- Reduce racial and economic barriers to disaster aid.
- Support transition to safe and secure employment in the green sector by identifying professions and infrastructure particularly vulnerable to climate hazards, conducting inspections, and providing aid for workplace retrofitting.
- Establish a national adaptation plan.
- Continue to mandate that all federal agencies develop a climate adaptation plan and assign a clear lead agency responsible for adaptation.

Zuber moderated the Q&A and discussion between PCAST Members and Oppenheimer.

ACTIVITIES ACROSS THE FEDERAL GOVERNMENT TO COMBAT, MITIGATE, AND ADAPT TO CLIMATE CHANGE
Jane Lubchenco, Deputy Director for Climate and Environment, The White House

Jane Lubchenco discussed the Division of Climate and Energy's focus within OSTP. The division coordinates relevant activities across federal agencies, including interactions with scientists, academia, and the public. She reiterated comments by other speakers about the dire weather effects caused by climate change and discussed efforts within OSTP to understand the basic elements and impact of these effects. She stated that OSTP is focused on sharing this knowledge with federal policy makers and stakeholders.

Lubchenco said the U.S. Global Change Research Program, created in 1990 and overseen by OSTP, is a key federal program that facilitates collaboration between 13 federal agencies to advance understanding of the changing climate. The program coordinates research, oversees U.S. participation in the IPCC, and produces the National Climate Assessment (NCA), which evaluates program findings and analyzes current trends. One working group report from the latest assessment will focus on impacts and adaptation and be released in February 2022; another working group report, anticipated to be released in March 2022, will focus on mitigation. There will be a synthesis report published in the fall of 2022.

Other efforts are also underway, Lubchenco said. For example, early in 2021, President Biden issued Executive Order 14008—section 211D of that order resulted in a report co-led by OSTP, the National Oceanic and Atmospheric Administration (NOAA) and the Federal Emergency Management Agency (FEMA) that provided a roadmap for improved coordination of climate services and highlighted opportunities for public-private partnerships. The report also addressed how climate models are primarily understood by and accessible to only climate scientists who are modelers—they are difficult for everyone else, even for non-climate scientists, to understand. The new Climate Resilience Information System is an effort to make the models more accessible so that non-experts can use the information. Additionally,

President Biden ordered federal agencies to develop climate adaptation and resilience plans, and more than 20 agency plans now exist. Lubchenco also noted that initial focus by the administration was mostly on mitigation, but it is increasingly turning its attention to adaptation.

Zuber moderated the Q&A and discussion between PCAST Members and Lubchenco.

ROADMAP TO NET ZERO 2050: ACCELERATING INNOVATION AND DEPLOYMENT OF CURRENT AND NEW TECHNOLOGIES

Jesse Jenkins, Princeton University

Jesse Jenkins spoke about achieving net-zero greenhouse gas emissions by 2050 and the Net-Zero America Project, a major project by Princeton University that involved a large group of researchers over two years. A final report on the project will be released in time for consideration at the UN Climate Change Conference in Glasgow, Scotland in November 2021. The project proposed five potential pathways to get to net-zero emissions by 2050 (although there are others) and assessed the implications for infrastructure, capital mobilization, labor transitions, air quality and public health benefits, and other challenges and benefits of the transition. The approaches were:

1. E+: High electrification
2. E-: Less electrification
3. E- B+: Less electrification, high biomass
4. E+ RE-: High electrification, constrained renewable energy
5. E+ RE+: High electrification, all renewable energy by 2050

The E+ and E- pathways refer to very high versus lower levels, respectively, of electrification of vehicles and buildings. The E- pathway would delay adoption of electrification by about 10 years. The E- B+ pathway includes a factor for using biomass to offset reduced electrification; the U.S. Department of Agriculture has estimated that about one billion tons of dry biomass would be needed per year. The two other pathways (E+ RE- and E+ RE+) involve a push and pull on renewable energy and may encounter barriers to adoption, such as opposition to land use or bottlenecks to transmission buildout. The E+ RE- pathway constrains the growth of wind and solar energy while relying more on nuclear and natural gas energy; the E+ RE+ pathway uses 100 percent renewable energy and phases out fossil fuels by 2050. Jenkins said each pathway is transformative to some degree, and each is affordable. In the last 50 years, the United States has spent between 5 percent and 8 percent of gross domestic product (GDP) on energy services during prosperous times, with two temporary spikes between 10 percent and 14 percent caused by oil price shocks and a global financial crisis. Estimates for each of the five pathways project that GDP spent on energy services would remain below six percent through 2050.

Jenkins emphasized that the Net-Zero America Project only focused on technologies that were already proven at the pilot stage or commercially demonstrated at full scale. And the project relied on the four key building blocks of a net-zero emissions economy: 1) energy efficiency and switching as much demand as possible to electricity; 2) clean electricity supplies by decarbonizing the emissions that come from

electricity and expanding use of electricity to supply the needs of transportation, heating and industry, and to produce hydrogen as a zero-carbon fuel; 3) using net-zero carbon fuels to power things that cannot be electrified; and 4) carbon capture, use, and storage.

Looking at the challenges, Jenkins said about a third of current energy demand can be absorbed with zero carbon energy carriers—mainly electricity—but also hydrogen, steam, and biomass. The other two-thirds of energy demand require liquid and gaseous hydrocarbon fuels, and this demand far exceeds the supply of biofuels and the ability to offset with negative emissions, so demand will need to be reduced by making changes such as switching from boilers to heat pumps and replacing internal combustion cars with electric vehicles. The next step is to increase the use of clean electricity and build a net-zero emissions economy. This means that over the next decade, the United States must more than double its supply of carbon-free electricity, which would be a four-fold increase in wind and solar energy capacity to fill the gap through 2030.

Jenkins said the good news is that the cost of energy from renewable sources (wind, solar) and fast-burst technologies that can supply energy for a few hours at time (lithium-ion batteries) have plummeted over the last decade. These technologies can help balance some of the supply and demand. Unfortunately, a critical third category of technologies—"firm" low-carbon technologies, such as advanced geothermal and nuclear energy, nuclear fusion, power plants with carbon capture, and net-zero carbon source gas power plants—are still immature. Jenkins said the United States must focus on developing these technologies over the next decade to get to net-zero by 2050.

Arun Majumdar, Stanford University

Arun Majumdar said that achieving 100 percent carbon-free electricity by 2035 would require that the United States achieve at least 80 percent clean electricity by 2030. Greenhouse gases (GHG) are most often carbon dioxide, methane, ozone, nitrous oxide and chlorofluorocarbons, and their negative effect is to raise ambient temperature. Unconventional gas has replaced much of coal-based energy, but it still produces GHG. Renewable electricity is one of the cheapest ways to produce electricity, and advances in lithium-ion battery technology have lowered the cost of that energy source. The cost is approaching $100 per kilowatt hour, which will make electric cars economically competitive with gas-powered cars.

Majumdar said that in spite of these positive developments, addressing climate change will require much more work. Future goals include: multi-day grid-scale storage at a cost of about $10 per kilowatt hour; sustaining the 95 nuclear plants in the United States and reducing the cost of small modular nuclear plants; development of refrigerants with zero global warming potential, which will phase out current refrigerants; developing zero net energy buildings; decarbonizing industrial heat processes in the manufacture of steel, cement, and petrochemicals; decarbonizing the food and agricultural industry; and launching a major effort to manage global carbon dioxide because once it is in the atmosphere, it lasts for hundreds of years.

Majumdar suggested three approaches that should be pursued to achieve net-zero emissions. The first is long-duration grid-scale storage of renewable energy—this will be necessary to have high uptake of renewable energy in the energy grid. This is because the more renewable energy in the grid, the more storage will be needed and the cheaper that storage will need to be. For example, for 80 percent of energy

to come from renewable sources, about 100 hours of continuous storage would be required. The storage may only be needed five to ten times a year, however, so the cost of storage would need to be low to make the investment worthwhile. In contrast, if 40 percent of energy comes from renewable sources, only three to four hours of storage may be required and lithium-ion batteries would be sufficient.

Majumdar said the second approach to pursue is to develop GHG-free hydrogen as a clean fuel for long-haul transportation, maritime shipping, and aviation, as well as manufacture of ammonia and fertilizers. Secretary of Energy Jennifer Granholm announced an "Energy Earthshots Initiative," the first of which is to produce GHG-free hydrogen. The third approach to pursue is carbon capture, but the cost will need to be reduced by an order of magnitude for this to be employed.

Majumdar said his key recommendations for achieving a net-zero emissions economy are: 1) deploy current technologies but ensure that the United States does not get locked into current technologies that could become obsolete; 2) employ innovations and breakthroughs in energy technologies to reach net-zero emissions for U.S. and global economies; 3) include use-inspired, sustained research and development efforts; and 4) to achieve economy-wide scale with urgency, implement policies that reduce the barriers and risks along the innovation value chain.

Arnold moderated the Q&A and discussion between PCAST Members, Jenkins, and Majumdar.

MEETING ADJOURNED: 4:05 p.m. Eastern Time

MEETING RESUMED: Tuesday, October 19, 2021, 12:05 p.m. Eastern Time

LOCATION: Virtual Meeting via Zoom.gov

THE POTENTIAL FOR INTEGRATING FUSION INTO THE U.S. ENERGY GRID

Richard Hawryluk, Princeton Physics Laboratory, and Chair of the National Academies Report, *Bringing Fusion to the U.S. Grid*

Richard Hawryluk began his presentation by discussing the two key recommendations that came out of the National Academies of Sciences, Engineering, and Medicine (NASEM) study he chaired on bringing fusion to the U.S. energy grid: 1) the United States should be a leader in fusion that will impact the transition to a low-carbon emission electrical system by 2050; 2) the Department of Energy should foster creation of national teams, including public-private partnerships, to develop pilot plant designs and roadmaps that will lead to an engineering design for a pilot plant to bring fusion to commercial viability.

Hawryluk stated that energy utilities foresee a transition to low-carbon electrical generation by 2050, but this transition needs to be accelerated. Relying solely on renewables is a good start, but there is a risk of increased costs that must be neutralized by incorporating firm low-carbon technologies to reduce costs and improve grid stability. Therefore, pilot plants must provide technical economic information, such as construction and operating costs. Hawryluk said the NASEM study committee to developed a set of goals for the fusion pilot plant plans. These included that the pilot plant must produce energy sufficient to meet the needs of the market (greater than 50 megawatts of electrical power), cost less than $6 billion to build,

and provide enough reliability information to support making a decision about whether to build by 2045. Important issues are reliability, availability, and environmental safety. There is also a need for a regulatory framework.

Hawryluk noted that to have a viable design by 2028 with initial plant operation by 2035 to 2040, innovations in fusion confinement and technology to extract fusion power and close the fusion fuel cycle should be developed in parallel. Computer simulations have been an important part of the development of the tokamak program and the magnetic fusion program. Technical innovation research is needed in high temperature superconducting magnets, development of structural and functional materials with an assessment of neutron degradation, high-heat plasma heating systems, high efficiency fusion cycle for tritium processing, and development of a breeding blanket.

Hawryluk said that to produce a pilot power plant, the public-private partnerships must include diverse participation among governments, private industry, national labs, and universities. The Department of Energy should develop a framework for those partnerships. The NASA Commercial Orbital Transportation Services program could be a model. Hawryluk suggested that three or four teams be established to look at different concepts that exist, some of which are somewhat developed, while others are still in early stages of development. The objective is to develop a good schedule and cost design by 2028. Hawryluk noted that the United Kingdom and China have both stated that they would like to be the first to put fusion on the grid.

Arnold moderated the Q&A and discussion between PCAST Members and Hawryluk.

NATIONAL SECURITY RISKS POSED BY CLIMATE CHANGE

Erin Sikorsky, The Center for Climate and Security and the International Military Council on Climate and Security, The Council on Strategic Risks

Erin Sikorsky described three areas of climate security risk and their effects on national security: critical infrastructure and military readiness, state fragility and conflict risk, and competition within and between nation-states.

Sikorsky said climate change poses a direct risk to military readiness and infrastructure. Examples include the hurricane damage to Tyndall Air Force Base (located on the Gulf Coast of Florida), which interfered with military operations; flooding damage at Offutt Air Force Base (located in Nebraska); and the need to plan for troops encountering increasingly austere and extreme environments abroad. All of these risks to readiness and infrastructure are manageable by the Department of Defense, Sikorsky said. Addressing the second and third areas of climate risk are less manageable, however.

Sikorsky said state fragility and conflict risk are double burdens, especially for countries that are exposed to damaging climate effects and that lack the ability to adequately respond to such shocks, thus making them even more vulnerable to humanitarian crises and political instability. This double burden can be seen in Iraq, Lebanon and Iran—countries on the Fund for Peace Fragile States Index. They each faced street protests after record temperatures and drought caused water shortages and energy crises. Although climate change was partly responsible, there was also mismanagement and poor governance in those countries. And in some cases, there was a failure to accept responsibility. Algeria and Turkey, which

are considered less fragile countries but still at elevated risk, both blamed their opponents in attempts to deflect responsibility for their poor performance in fighting climate change-induced wildfires.

Sikorsky said the third area of climate security risk occurs when there is spillover within states and between states where geo-political competition influences politics. Climate change that induces mass migration, diminishes food and water security, and increases resource competition will affect power dynamics within and between states. She noted that the climate change-induced discontinuities and shocks that lie ahead are even more concerning because humans are entering a warmer world in which they have no prior experience; there is only limited understanding of how extreme weather will affect person-to-person interactions. Sikorsky said she thinks the behavior of U.S. competitors and adversaries will be altered by climate change, as will the ability of American allies and partners to step up when needed. If the United States' approach to national security does not take this into account, behaviors will be misunderstood, and important information could be missed.

Sikorsky identified Basra, Iraq, a city of four million people, as an example of state fragility and conflict risk. By 2050, significant sea level rise is expected for Basra, which is already challenged by poor governance that has resulted in diminished water flow in the local river, saltwater intrusion which negatively impacts agriculture and fish farming, and a lack of clean water that has resulted in outbreaks of waterborne diseases. There have been anti-government protests, and 15,000 people have been displaced because of water shortages as of 2019.

Sikorsky said China and India are a larger geopolitical example that have a competitive, adversarial relationship exacerbated by the fact that both are nuclear-armed countries. Climate change may influence the relationship between these two countries given that rivers originate in the Tibetan plateau and then flow through India. There is an opportunity, however, to apply a climate lens and engender cooperation around data and science to bring an improved perspective that could lead to bilateral cooperation and improved national security. A 2021 survey of the Association of Southeast Asian Nations (ASEAN) showed that the threat of climate change was 10 points greater for many of those countries than the threat of a military conflict.

Sikorsky said migration also is increasing rapidly. The Red Cross responded to 25 climate-related disasters in the Indo-Pacific region. The World Bank estimated that, without mitigation, climate change will displace 40 million people in South Asia alone.

Sikorsky recommended building strong partnerships between national security agencies and scientific agencies. Congress has provided some tools to do this, establishing a Climate Security Advisory Council to bring the federal scientific agencies and the intelligence community together to develop a common language to enable data and information sharing, but more engagement is needed. In closing, Sikorsky noted that excellent predictive capabilities exist for climate change and the national security community should take advantage of them.

Zuber moderated the Q&A and discussion between PCAST Members and Sikorsky.

PUBLIC COMMENT

No public comments were presented.

CLOSING COMMENTS

Zuber closed the meeting by saying that the United States and the world community should be more strategic and proactive in response to climate change and less reactive.

MEETING ADJOURNED: 2:00 p.m. Eastern Time

I hereby certify that, to the best of my knowledge, the foregoing minutes are accurate and complete.

Frances Arnold, Ph.D.
Co-Chair
President's Council of Advisors on Science and Technology

Eric Lander, Ph.D.
Co-Chair
President's Council of Advisors on Science and Technology

Maria Zuber, Ph.D.
Co-Chair
President's Council of Advisors on Science and Technology