

**PENDING LEGISLATION**

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**HEARING**  
BEFORE THE  
**COMMITTEE ON**  
**ENERGY AND NATURAL RESOURCES**  
**UNITED STATES SENATE**  
ONE HUNDRED SEVENTEENTH CONGRESS  
SECOND SESSION  
ON

**S. 2232      S. 3428**  
**S. 2302      S. 3699**  
**S. 2733      H.R. 3119**  
**S. 2896**

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MARCH 1, 2022  
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## PENDING LEGISLATION

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TUESDAY, MARCH 1, 2022

U.S. SENATE,  
COMMITTEE ON ENERGY AND NATURAL RESOURCES,  
*Washington, DC.*

The Committee met, pursuant to notice, at 10:02 a.m. in Room SD-366, Dirksen Senate Office Building, Hon. Joe Manchin III, Chairman of the Committee, presiding.

### **OPENING STATEMENT OF HON. JOE MANCHIN III, U.S. SENATOR FROM WEST VIRGINIA**

The CHAIRMAN. Before we turn to the legislation before us today, I want to take a moment to acknowledge Russia's invasion of Ukraine and how Putin has used energy as a weapon to gain leverage over our European allies. One thing that has not been talked about as much is that during this time of war, the United States is still importing more than a half a million barrels per day of crude oil and other petroleum products from Russia, with imports up over 20 percent in 2021 over 2020. To me, it makes no sense at all for us to rely on energy from a country that is actively engaging in acts of war against a freedom-seeking democracy in Ukraine, when we were blessed with abundant energy resources right here in America. There is no reason why the United States should not be totally energy independent, or at the very least, trading with our allies where we need to. This is the only way to ensure our energy security. It is hypocritical for us to ask others to do what we can do for ourselves—and that is asking the OPEC+, if you will—when it comes to producing energy that we and our allies need.

It is time for the Administration to take strong action to unleash American energy, up to and including banning Russian oil imports at a time when they are attacking our allies. Our oil and gas industry partners also need to come to the table and do the right thing for our country and the consumers that rely on their product. We are going to continue talking about these issues in the coming days and weeks because energy security and energy independence must be top-of-mind for all of us.

But for today, our hearing will focus on seven energy bills, five of which are bipartisan. Our agenda is short today, in large part because we did a lot of good work earlier in this Congress, and many of my colleagues' bills were included in whole or in part in the Bipartisan Infrastructure bill. The bills on the agenda today pertain to advancing the Department of Energy's cutting-edge research and development programs and infrastructure, as well as relating to managing Department of Energy funds, functions, and

authorities. I would like to thank my colleague, Senator Barrasso, for working with me on two of these bills—the DOE Science for the Future Act, together with Senators Durbin and Blackburn, and also the Fission for the Future Act. The DOE Science for the Future Act authorizes fundamental research and development activities performed by scientists at the Department of Energy, the National Labs, universities, and private companies to advance our understanding of the atom, the cell, the Earth system, and the universe. These scientific endeavors involve the most advanced scientific instruments in the world, from the fastest computers to the brightest light sources, and so much more. The Office of Science is a critical piece of the United States' ability to advance human knowledge of the sciences, and in carrying out the mission, it advances a critical and ultimately non-partisan aspect of our society. We also expanded the ways the DOE's Established Program to Stimulate Competitive Research—or EPSCoR for short—can support universities in states like mine, West Virginia, and Wyoming and New Mexico and many others to boost our competitive research capabilities everywhere, not just in elite schools.

West Virginia is one of 24 EPSCoR states, most of which are represented on this Committee, where EPSCoR funds have been critical for advancing fundamental university research, including at our own West Virginia University. The House included their version of an Office of Science authorization in the America COMPETES bill, and we look forward to working out any differences there might be in conference soon so that the China package can get to the President's desk. The House bill also included Senator Luján's bill, which is on our agenda today, to fund deferred maintenance, infrastructure needs, and updates for our National Labs. I appreciate Senator Luján's leadership on the National Labs and his partnership in ensuring they are treated as the crown jewels that they are of our nation's research and innovation ecosystem.

I would also like to bring attention to the Fission for the Future Act, which Ranking Member Barrasso and I introduced in December. The bill directs the Secretary to work with communities or with retiring or retired fossil generation facilities to determine the feasibility of constructing advanced nuclear power plants. This bill is an important building block to assist in the economic revitalization of communities providing reliable baseload electricity and opportunities to attract industry to produce advanced materials, hydrogen, and other non-electric applications. Less than a month ago, my home state of West Virginia finally repealed the state ban on nuclear power. I strongly supported this move, in part because of the energy transition that has begun over the last few decades and continues to take place. We must be thinking about how to continue providing baseload power. Nuclear is an obvious choice, especially with the advanced technologies that hold such promise, and for shuttered coal plant sites that are already connected to the grid, it just makes common sense. So I look forward to discussing this bill today.

With that, I am going to turn to my colleague, Senator Barrasso, for his opening remarks.

**OPENING STATEMENT OF HON. JOHN BARRASSO,  
U.S. SENATOR FROM WYOMING**

Senator BARRASSO. Well, thank you very much, Mr. Chairman, and like you, before I turn to the subject of today's hearings, I want to say a few words about Ukraine. I would like to make it clear that this Committee stands with the people in the country of Ukraine. We condemn Russia's invasion in the strongest possible terms. Mr. Chairman, as you said yesterday, the United States can and must ramp up domestic energy production and increase access to our abundant resources and technologies to both protect our energy independence and support our allies around the globe. And we in the minority stand ready to ensure that our NATO allies and Ukraine have access to abundant American energy. We in the minority are ready to support additional exports of liquefied natural gas, of crude oil, of coal, and uranium from the United States. The United States has the energy resources to help our allies reduce their dependence on Russian energy. The United States has the energy resources to empower our allies to take tougher action against Russia. We have the energy resources to improve our economy and reduce inflation here at home. We just need the political wheel here in Washington to make that happen.

Now I will turn to my remarks for the hearing.

Mr. Chairman, today we are going to consider seven bills related to the Department of Energy. I will limit my comments to the three bills which I have introduced and co-sponsored. The first is S. 2302, a bill to ensure that the Assistant Secretary will lead the Department's Office of Cybersecurity, Energy Security, and Emergency Response. In March of last year, I, along with a bipartisan group of Senators on this Committee, wrote to the Secretary urging her to assign an Assistant Secretary to lead the Office of Cybersecurity. We explained that the last administration assigned an Assistant Secretary to head this office. We also explained that the role of the office would be diminished if a Senate-confirmed official did not lead it. Two months later, criminal hackers based in Eastern Europe stole data which led to the shutdown of the Colonial Pipeline. The shutdown caused gasoline and diesel fuel shortages. Prices spiked along the East Coast. More recently, the FBI and the Department of Homeland Security warned Americans to expect cyberattacks from Russian-backed actors. We were warned again—the Senators were—last night by the Chairman of the Department of Homeland Security. Despite these developments, the President has not nominated an Assistant Secretary to lead the Cybersecurity Office. The Department's latest reorganization plan also indicates we will not get such a nominee. My bill, with Senator Risch as co-sponsor, is companion legislation to a bipartisan bill that has already passed the House. There is no good reason for the Secretary to diminish the role of cybersecurity in that office. It is time for the Senate to act.

The second bill is S. 3428, Chairman Manchin's Fission of the Future Act. I am the lead co-sponsor of the bill. It would provide financial assistance to states and other entities seeking to deploy advanced nuclear reactors. A growing number of states recognize that advanced nuclear reactors are a critical part of our energy future. My home State of Wyoming will be home to TerraPower's first Na-

trium reactor. The State of Washington will host X-energy's first advanced reactor. This bill will help states with licensing, developing, and construction of these reactors and related supply chain infrastructure.

I have also co-sponsored S. 3699, Senator Manchin's bill to reauthorize the Department's Office of Science. This bill will significantly expand EPSCoR, which is the Established Program to Stimulate Competitive Research. For decades, the Department has overlooked research at universities in rural states. This bill will help ensure that universities like the University of Wyoming better compete for the Department's research dollars. The bill also establishes new basic research programs on carbon and rare-earth mineral extraction, underground storage of carbon dioxide, as well as nuclear energy. These new programs will help ensure that the Office of Science is conducting research to promote all types of American energy. In addition, the bill will help address our needs and our nation's needs for medical isotopes. Medical isotopes play a critical role in diagnosis and in treating diseases like cancer. For far too long we have been dependent on Russia and other countries for our supply of these isotopes. Sanctions may jeopardize our supply. This bill will boost domestic production of these isotopes and reduce our foreign dependence. Finally, the bill will reduce the risk that adversaries like China will steal research funded by the Office of Science. The bill will impose penalties on funding recipients who knowingly violate the Department's protocols to protect American research.

I want to thank the Chairman for his leadership and his willingness to work with me on two of these important bills, and I hope he can also join me in supporting the third. I also want to thank our witness, Dr. Richmond. I look forward to your testimony.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Barrasso.

And now we are going to turn to our witness for today's hearing, the Honorable Dr. Geri Richmond, Under Secretary for Science and Innovation at the Department of Energy, and we want to welcome you back.

You may start.

**STATEMENT OF HON. GERALDINE RICHMOND, UNDER SECRETARY FOR SCIENCE AND INNOVATION, U.S. DEPARTMENT OF ENERGY**

Dr. RICHMOND. Thank you very much, and can I also say thank you for your vote of confidence in confirming me for this position, too. So I think I am thanking you.

The CHAIRMAN. Now you have to prove your value.

Dr. RICHMOND. Oh, I know. Now the hard stuff starts.

[Laughter.]

Dr. RICHMOND. Well, thank you also for letting me be here today. Distinguished members of the Committee, Chairman Manchin, Ranking Member Barrasso, it is with great pleasure that I join you today to represent the Department of Energy at this hearing, and particularly the Office of Science. As members of this Committee know, the DOE Office of Science is the cornerstone of the research enterprise in the United States. Through basic and use-inspired re-

search, and the development and operation of cutting-edge tools, the Office of Science enables advances in areas of science and technology of critical importance to our economic and national security, including a just and equitable clean energy and climate change transition.

S. 3699, to be referred to as the Department of Energy Science for the Future Act of 2022, recognizes and reinforces the importance of the Office of Science and the community of researchers it supports, both at DOE's National Laboratories and at U.S. colleges and universities, to advance all the DOE missions, including energy, security, and environmental management. At the same time, the Committee, through this legislation, has clearly stated the importance of the Office of Science in addressing a much broader range of science and technology challenges. These challenges include addressing the ongoing COVID-19 pandemic and ensuring the security of the Office of Science-supported research, both of which require close coordination with other federal departments and agencies. This is an ambitious bill, and I commend the Committee for its vision.

S. 2232, to be referred to as the Restore and Modernize our National Laboratories Act of 2021, is, along with the parallel provisions of the DOE Science for the Future Act, a recognition of the foundational importance that the DOE's 17 incredible National Laboratories play in sustaining U.S. leadership in science and technology, and for tackling the most pressing problems of our time today. The National Laboratories are known internationally as powerhouses of innovation, and are a host to many of the world's leading capabilities for scientific discovery and technology development. As Secretary Granholm describes them, they are the nation's "solutions factories." This complex of 17 laboratories has its origins in the Manhattan Project, with some of the labs entering their eighth decade of operation. DOE recognizes that significant investment is required to ensure that the DOE's laboratories are positioned to continue their long history of groundbreaking discoveries.

I am also here today to speak to several additional bills of significance to the DOE. Bill S. 3428, to be referred to as the Fission of the Future Act of 2022, is a strong statement of support to the Department for continued public-private partnerships to advance demonstration and deployment of next-generation nuclear power concepts. At the same time, the bill aligns with the Department of Energy's justice efforts with consideration for helping disadvantaged communities as we transition toward a carbon-free power sector in the decades to come.

Bill number S. 2733, to be referred to as the U.S. Enrichment Corporation Fund Termination and Transfer Act, rescinds the authorization of the U.S. Enrichment Corporation—or USEC fund—and moves the funds still in its coffers to the general fund of the Treasury. We look forward to working with Congress on this further.

And finally, House bill 3119, to be referred to as the Energy Emergency Leadership Act, and S. 2302, would assign the Department's responsibilities in energy sector security and in responding to energy sector emergencies to an assistant secretary at the Department. Disruptions to the energy system in the U.S. could have

a devastating consequence, and the Department's Office of Cybersecurity, Energy Security, and Emergency Response plays an essential role in mitigating the risk of disruptions and responding rapidly when disruptions occur. Executing on this mission requires a team of professionals with unique training and experience needed to understand and mitigate the risks and respond rapidly when crises do occur.

I look forward to discussing the legislation in more depth. Thank you for the opportunity to let me meet with you today.

[The prepared statement of Dr. Richmond follows:]

**Testimony of Dr. Geraldine Richmond**  
**Under Secretary for Science and Innovation**  
**U.S. Department of Energy**  
**Before the Committee on Energy and Natural Resources**  
**U.S. Senate**  
**March 1, 2022**

*Opening Statement*

Thank you, Chairman Manchin, Ranking Member Barrasso, and distinguished Members of the Committee. It is with great pleasure that I join you today to represent the Department of Energy (DOE or the Department) at this hearing. As members of this Committee know, the DOE Office of Science (SC) is a cornerstone of the research ecosystem in the United States (U.S.). Through basic and use-inspired research and the development and operation of cutting-edge tools, SC enables advances in areas of science and technology of critical importance to our economic and national security, including a just and equitable clean energy and climate change transition. S.3699, to be referred to as the *Department of Energy Science for the Future Act of 2022*, recognizes and reinforces the importance of SC and the community of researchers it supports, both at DOE's National Laboratories and at U.S. colleges and universities, to advance all of the DOE missions, including energy, security, and environmental management. At the same time, the Committee, through this legislation, has clearly stated the importance of SC in addressing a much broader range of science and technology challenges. These challenges include addressing the ongoing COVID-19 pandemic and ensuring the security of SC-supported research, both of which require close coordination with other Federal departments and agencies. This is an ambitious bill, and I commend the Committee for its vision.

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to many of the world's leading capabilities for scientific discovery and technology development. As Secretary Granholm describes them, they're the Nation's "solutions factories." This complex of 17 laboratories has its origins in the Manhattan Project, with some of the labs entering their eighth decade of operation. DOE recognizes that significant investment is required to ensure that DOE's Laboratories are positioned to continue their long history of groundbreaking discovery.

Finally, H.R.3119, to be referred to as the *Energy Emergency Leadership Act*, and S.2302 would assign the Department's responsibilities in energy sector security and in responding to energy sector emergencies to an Assistant Secretary at the Department. Disruptions to the energy system in the U.S. can have devastating consequences, and the Department's Office of Cybersecurity, Energy Security, and Emergency Response plays an essential role in mitigating the risk of disruptions and responding rapidly when disruptions occur. Executing on this mission requires a team of professionals with the unique training and experience needed to understand and mitigate the risks and respond rapidly when crises do occur.

I look forward to discussing the legislation more in depth.

*S.3699*

#### **Introduction**

The Office of Science's (SC) core mission is to deliver both the scientific discoveries and major scientific tools that will transform our understanding of nature and advance the energy, economic, and national security goals of the U.S. It is the largest Federal sponsor of basic research in the physical sciences and the lead in supporting fundamental scientific research for our energy future. Over decades, the investments and accomplishments in basic research and enabling research capabilities we've made have provided the foundation for countless new technologies that have benefited large and small businesses and launched new industries. These investments have contributed immensely to our Nation's economy, national security, and quality of life.

SC continues this work today.

The core science programs in SC—Advanced Scientific Computing Research (ASCR), Biological and Environmental Research (BER), Basic Energy Sciences (BES), Fusion Energy Sciences (FES), High Energy Physics (HEP), and Nuclear Physics (NP)—along with the Offices of Isotope R&D and Production (IRDP) and Accelerator R&D and Production (ARDP) support research conducted at hundreds of universities and all 17 of DOE's National Laboratories, including the 10 for which SC has direct stewardship responsibility. SC supports different types of research programs—from single investigators and small teams to large, multi-disciplinary, multi-institutional collaborations. These programs probe fundamental questions to address nature's most compelling mysteries—from fundamental subatomic particles, atoms, and molecules that form the building blocks of our universe, to highly complex and dynamic systems, such as energy storage processes, microbial cells, and carbon cycling in the environment. The knowledge gleaned from this research provides the foundation for new discoveries and innovations that are essential to fulfilling the Department's missions.

Many of the transformative scientific discoveries made by our research community are enabled by our stewardship of 28 scientific user facilities, which are available to all researchers based on

the scientific merit of their proposed research. These tools include the world's most powerful computers, brightest X-ray light sources, most intense neutron sources, fastest information network, and specialized capabilities, such as nanofabrication and multiple modes of imaging, within centers for nanoscience and bio-characterization. The Department continues to invest in the development of the next generation of scientific tools to maintain U.S. leadership in scientific discovery and technology development to support our Nation's economic competitiveness and national security.

Science is undergoing a rapid evolution, and the *DOE Science for the Future Act* would support the Department in facilitating this transition. It is becoming more data-centric and more democratic. Multiple scientists in different locations can increasingly produce, share, and analyze the output of research conducted at cutting-edge facilities and apply advanced artificial intelligence (AI) tools to find hidden patterns in increasingly massive data sets. Collaboration is essential to making scientific advances, whether across disciplinary boundaries, between institutions and federal agencies, or amongst nations. The breakthroughs of the future cannot be made if we fail to encourage talented students from across all of society to study science, technology, engineering, and mathematics (STEM) subjects and become scientists and engineers. The research on this is clear—more diverse scientific communities are more effective at debating and evaluating theories and evidence.

The Act underscores the importance that DOE's 17 National Laboratories have and will continue to play a foundational role in U.S. leadership in science and technology and in tackling the most pressing challenges of our time. They are where scientific collaboration takes place, where world-leading experimental tools provide crucial insights into nature, and where solutions to our most urgent challenges are being developed. We need look no further than the ongoing COVID-19 pandemic. It was at DOE's scientific user facilities where researchers from the National Laboratories, universities, and industry collaborated to reveal the structure of the spike protein on SARS CoV-2, the virus that causes COVID-19, using X-ray and neutron sources, and where vaccine binding was modeled using DOE's high-performance computers. The future of DOE's national laboratories depends upon fundamental research supported by SC in emerging technologies. SC supported research led to the development of CRISPR-cas9 for gene editing, enabled deployment of the fastest high-performance computers in the world, produced the superconducting materials needed to enable advanced accelerators and next-generation fusion devices, and advanced production technology to expand the portfolio of available isotopes needed for applications as diverse as medicine and national security. DOE's scientific user facilities collect massive amounts of data, which are shared using SC's world-leading Energy Sciences Network and analyzed using state-of-the-art AI-based models running on the Nation's fastest supercomputers. DOE is indeed uniquely positioned to support a transformation of scientific practice.

In the sections below, I will highlight important themes we're addressing at the Department and the role of SC in those efforts. As you will see, the examples demonstrate how SC's efforts, in coordination with the efforts of our applied offices at DOE and our interagency partners, will position the U.S. to rise to the challenges of the 21<sup>st</sup> century. Any reauthorization of the Office of Science must enable us to pursue these goals.

**Maintaining the Openness and Security of DOE's Scientific Enterprise**

America's leadership in science and technology is underpinned by the unique strengths of our open scientific enterprise. The openness of our innovation ecosystem enables international collaboration that advances the frontiers of science and attracts the world's most talented scientists and engineers to our shores. However, it is clear that certain foreign governments, including the People's Republic of China, Russia, Iran, and others, seek to acquire our technologies, using both illicit strategies and legal means that pose unacceptable risks to research security and integrity. DOE, with significant support from SC, is managing these risks while maintaining an open, collaborative, and world-leading enterprise. We do this with the understanding that if our policies to address research security and integrity challenges significantly diminish our ability to attract and welcome global scientific talent, or if they fuel xenophobia, then we will have done more damage to ourselves than any competitor or adversary could. We also recognize that openness and security are not diametrically opposed but complementary: maintaining our openness is essential to preserving our national security and scientific leadership.

Over the last several years, DOE has acted decisively to protect our scientific enterprise. We have established an agency-wide body to coordinate issues related to research security and have instituted policies to manage risks to research security. These policies include prohibiting Federal and DOE National Laboratory personnel from participating in foreign government sponsored talent recruitment programs from certain countries, centralizing oversight of international engagements undertaken by each national laboratory and utilizing our Science and Technology Risk Matrix to manage risks associated with critical and emerging technologies that do not otherwise have control mechanisms. We utilize the Risk Matrix to guide and manage foreign engagements, cooperative research and development agreements, strategic partnership projects, official travel, and access to our labs.

The Department welcomes discussions with Congress on how to support DOE and our sister agencies in developing and maintaining tools and processes for research security, such as DOE's Science and Technology Risk Matrix and associated Directives that we use to manage risks to our research enterprise. Research security measures must be informed by a dynamic understanding of the threats coupled with a deep understanding of the science and technology. Only then can the Department make informed determinations that weigh benefits against potential risks. These tools also support evidence-based decision-making processes for research security that do not create excessive administrative burdens while reducing the risk of misappropriation of DOE-funded research by entities of concern.

Research security is maximized when there is a consistent approach across funding agencies and coordination with the global science community. DOE continues to actively co-chair the National Science and Technology Council (NSTC) Subcommittee on Research Security to ensure a coordinated interagency approach to implementing National Security Presidential Memorandum-33 on strengthening protections of U.S. government-supported research. In addition, DOE continues to engage with allies and partners through State Department-led efforts to exchange information on experiences and best practices on research security. This coordination is essential in order to reduce uncertainty and establish clear, consistent guidelines

for researchers to follow on topics such as disclosure requirements, entities of concern, and penalties for those who violate our research security policies. As this Committee considers appropriate language to support the Department's research security activities, we encourage you to take a coordinated approach with your colleagues in the committees that have jurisdiction over other funding agencies to ensure consistency and to avoid undue burden on our Nation's researchers, with the shared aim of protecting taxpayer-funded research and maintaining America's leadership in science and technology.

#### **Increasing Participation and Training the Next Generation**

For nearly seven decades, DOE has trained and educated scientists, engineers, and technicians, providing a pipeline for talent that serves DOE's science and technology enterprise, as well as that of the Nation. SC strives to advance diversity, equity, inclusion, and accessibility (DEIA) to ensure that the Nation's STEM ecosystems are robust and second to none. Further, SC has a long history of supporting research at Historically Black Colleges and Universities and other Minority Serving Institutions (MSIs) and at institutions unrepresented in the Federal R&D landscape, such as through the Established Program to Stimulate Competitive Research, or EPSCoR. We recognize the great value and opportunity to increase the competitiveness of underrepresented institutions and are committed to increasing financial assistance to these institutions, including those in EPSCoR eligible jurisdictions, to further SC's goals to increase and broaden participation in its research programs and increase institutional research capacity. Meeting this shared goal will require careful planning over several years, in close collaboration with these institutions, to ensure they are prepared to effectively compete for additional funding from across the SC portfolio, including through collaborations with their colleagues at DOE's National Laboratories and other U.S. research institutions.

However, we recognize the need to be more intentional in our efforts to reach individuals and institutions underrepresented in our research portfolio. Expanding opportunities to underrepresented groups is foundational to SC's mission in STEM education and workforce development. The Department is strongly committed to continuing its efforts to ensure that the next generation of scientists and engineers needed to support DOE's mission is inclusive and representative of the Nation.

In 2020, SC established an internal group to develop recommendations for increasing participation of MSIs and individuals from underrepresented groups in SC research, especially in research projects led by faculty from these institutions. Between August and December of 2021, the SC programs hosted over 15 listening sessions and discussions with groups of researchers, faculty, and students from a broad range of institutions to understand barriers to participation in SC programs and identify opportunities to overcome those barriers, including changes to the way SC has historically managed programs. We are working to implement these recommended actions and opportunities.

SC's largest contribution to the training of the next generation of skilled scientists, engineers, and technicians is through research awards to colleges, universities, and the DOE National Laboratories, providing support for over 8,500 undergraduate and graduate students and postdoctoral researchers. In addition, through the Office of Workforce Development for

Teachers and Scientists (WDTS), SC currently supports over 1,000 paid undergraduate internships at all 17 DOE National Laboratories. Over the past 20 years, WDTS has supported more than 14,000 undergraduate research internships for students from 2-year and 4-year institutions. A significant focus of WDTS outreach and recruitment efforts is on connecting with individuals historically underrepresented in STEM. SC also supports targeted graduate training programs, such as the Computational Sciences Graduate Fellowship in high-performance computing applied to scientific and technical challenges (a partnership between SC and the National Nuclear Security Administration); the U.S. Particle Accelerator School for training in accelerator and detector R&D; and the Office of Science Graduate Student Research program, which provides supplemental funding for graduate students to conduct part of their thesis research at a DOE National Laboratory.

Within the FY 2022 President's Budget Request, SC proposed to initiate a new activity, Reaching a New Energy Sciences Workforce, or RENEW, which would significantly expand undergraduate and graduate student training opportunities to underrepresented and underserved groups, including Tribal communities, Historically Black Colleges and Universities, Hispanic Serving Institutions, and other MSIs; place greater emphasis in its competitive solicitations for financial assistance on encouraging applications from MSI institutions and in partnerships with MSIs; and increase outreach activities to institutions historically underrepresented in the SC research portfolio.

#### **Addressing the Climate Crisis: Accelerating New Discoveries in Energy and Climate Science**

Clean, efficient, and affordable energy systems of the future—whether they tap fusion processes that power the sun, store vast amounts of electricity, or make fuel from splitting water or converting carbon dioxide—will be realized not just by incremental improvements in today's technologies, but by leveraging new materials and chemical transformations to enable exquisite control of physical and chemical processes and convert energy efficiently from one form to another. The ability to control these processes may also be inspired by processes employed by nature, which allow plants to convert sunlight into energy and carbon dioxide into biomaterials. Advances in these areas are essential to the success of the Department's Energy Earthshots—integrated, cross-Departmental research and development (R&D) programs designed to rapidly address tough technological challenges—providing the critical fundamental knowledge required to drive the next generation of energy technologies.

Achieving atomic-, molecular-, and genomic -level control of materials and processes for future energy systems requires understanding the fundamental principles that can only be revealed by basic scientific research. Today, SC-supported research is entering a new era in which materials are precisely synthesized atom-by-atom to engineer specific functionalities, and sustainable chemical processes are designed at the molecular scale to support clean, safe, and economic alternatives and methodologies to traditional chemical products and processes. Likewise, through genome engineering techniques, modification of molecular level pathways found in nature will be enhanced to produce fuels and chemicals efficiently. These advances, supported by powerful computational tools, will allow us to predict the properties and dynamic behavior of materials, as

well as chemical processes, before they have been experimentally realized, accelerating the pace of discovery. Next-generation characterization tools will not only reveal the structure of the resulting materials and processes at the atomic level, but also allow us to observe how the atoms are incorporated into and contribute to the material's function, and how that functionality evolves over time while in use.

Addressing climate change requires understanding the complex interplay of atmosphere, land, ocean, cryosphere, and human components of the Earth system. These components are dynamic over enormous length and time scales, ranging from fractions of a second to years and from sub-millimeters to kilometers. Achieving this understanding requires the development of predictive models that incorporate the myriad interactions and feedbacks within the Earth system. SC's Energy Exascale Earth System Model is designed to leverage the power of the Nation's first exascale computing systems to link advanced predictive climate models with experiments, high-resolution field observations, and new approaches to integrate and analyze data that leverage AI and other state-of-the-art analytics. The predictions generated from these models will be critically important because they describe the resilience of energy and related infrastructures, as well as our quality of life.

SC is also developing new experimental sites to extend studies of climate change into mixed environments involving urban, coastal, and other vulnerable regions that are experiencing more extreme climate phenomena, such as severe heat waves, drought, flood, and wildfire. New Urban Integrated Field Laboratories, proposed in the fiscal year (FY) 2022 President's Budget Request (PBR), will incorporate environmental justice as a key tenet of DOE's research involving the most climate-sensitive and vulnerable communities, and in the future will include connecting frontline communities with the key climate science capabilities at the DOE National Laboratories.

For over 60 years, DOE and its predecessor agencies have supported basic scientific research in fusion energy with the vision of establishing commercial fusion as a source of clean, reliable energy. Deploying commercial fusion energy on the grid has garnered substantial interest in the private sector, as evidenced by billions of dollars of private sector investments over the last decade in a growing number of U.S.-based private fusion companies. However, before this vision can be realized, technical challenges remain that can only be addressed by fundamental research. To that end, SC will continue to invest in the research, as well in experimental and computational user facilities, needed to address the challenges associated with deploying commercial fusion energy on the grid. The new Material Plasma Exposure Experiment (MPEX), for example, will provide unique capabilities for studying the behavior of materials under the extreme conditions experienced in a fusion plasma, which will enable development of new, robust materials for fusion energy. These and other activities are priorities identified by the scientific community in the Fusion Energy Sciences Advisory Committee report "Powering the Future: Fusion and Plasmas."<sup>1</sup>

ITER remains critical to advancing our understanding of the science of burning plasmas and is helping to advance technologies that will be essential to future fusion power plants. As an

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<sup>1</sup> [https://infuse.ornl.gov/wp-content/uploads/2021/02/FESAC\\_Report\\_2020\\_Powering\\_the\\_Future.pdf](https://infuse.ornl.gov/wp-content/uploads/2021/02/FESAC_Report_2020_Powering_the_Future.pdf)

international open-science project, U.S. investment in ITER is highly leveraged—we support 9% of the cost but receive access to 100% of the scientific advances and technology development. Continued U.S. participation in ITER is necessary for the U.S. fusion community to remain at the forefront of the field, and to ensure a robust pipeline of fusion scientists and engineers needed for a future of accelerated fusion energy development and deployment.

Going forward, DOE will look to build on its existing partnerships with the private sector to advance fusion energy. Modeled on the Office of Nuclear Energy’s Gateway for Accelerated Innovation in Nuclear (GAIN) program, the Innovation Network for Fusion Energy (INFUSE) program supports researchers at the DOE National Laboratories to collaborate with private fusion companies to accelerate the development of fusion energy technologies. The interest received from private fusion companies in this effort is encouraging and SC will look at ways to build on partnerships with the private sector to support development of advanced technology to enable full-scale fusion systems and, ultimately, a fusion pilot plant.

**Pandemic preparedness and response**

SC has deep expertise and resources at the intersection of biological, physical, and computational sciences, as well as world-leading user facilities, that can provide capabilities in bio-related research that are unique within the Federal research enterprise. Many of these foundational capabilities have been applied in partnership with other Federal agencies to support science and technologies critical to the Nation’s future, and, in return, these partnerships have advanced DOE’s core missions. For example, with the National Institutes of Health (NIH), DOE helped develop sequencing and bioinformatics tools to assist with mapping of the human genome as part of the Human Genome Project.

During the COVID-19 crisis, SC created the National Virtual Biotechnology Laboratory (NVBL) to more rapidly bring to bear capabilities at all 17 National Laboratories to address key issues, including personal protective equipment shortages, development of antiviral therapeutics, diagnostics, and epidemiological modeling, among others. In doing so, NVBL supported decision makers at the regional, state, and national levels, and collaborated with several Federal agencies, including NIH, Centers for Disease Control (CDC), Food and Drug Administration (FDA), and others. Through its NVBL framework, DOE contributed significantly to the Nation’s COVID-19 response, demonstrating the critical impact of the National Laboratories.

Within just a few months, NVBL teams produced innovations in materials and advanced manufacturing that mitigated shortages in COVID-19 test kits and personal protective equipment, creating nearly 1,000 new jobs. They used DOE’s high-performance computers and X-ray and neutron sources to rapidly identify promising candidates for antibodies and antivirals, directly contributing to the development of all three of the COVID-19 vaccines that have been authorized or licensed for use in the U.S., as well as Paxlovid and Sotrovimab, the first antiviral drug and therapeutic antibody, respectively, for the treatment of COVID-19 to receive FDA emergency use authorization.

NVBL researchers also supported FDA, CDC, and Department of Defense (DoD) efforts to establish national guidelines used in administering millions of COVID-19 tests. Researchers supported decision-makers at the local, state, and national levels by using AI and DOE’s high-

performance computers to forecast disease transmission, stress on public health infrastructure, and economic impact, supporting decision-makers at the local, state, and national levels. NVBL teams also studied how to control indoor virus movement to minimize uptake and protect human health to develop controls to prevent the spread of the virus in schools, restaurants, transportation systems, and other venues.

The Emerging Biological Threat Preparedness Research Initiative authorized by the *DOE Science for the Future Act* is a critical step towards institutionalizing this whole-of-DOE approach to addressing current and future biological threats to the Nation. To that end, SC's proposed Biopreparedness Research Virtual Environment (BRaVE) initiative would support a virtual platform, similar to that of NVBL, to develop new capabilities and enable DOE's bioscience-related research assets to be rapidly mobilized in response to future national crises. Specifically, it will support development of DOE's next-generation analytical technologies, user facility resources, national preparedness for medical isotope processing, and biotechnological capabilities. As part of these efforts, BRaVE research teams will draw upon expanded capabilities provided at DOE's scientific user facilities, including high-performance computing resources, X-ray and neutron characterization facilities, and nanoscale research centers.

#### **Research and Innovation for Critical and Emerging Technologies**

To ensure the Nation's economic and national security, SC is investing in advancing foundational capabilities in critical and emerging technologies, including advanced computing, quantum information systems (QIS), AI and machine learning (ML), microelectronics, biotechnology, and isotope research and development. These advances will be realized by leveraging SC's core capabilities in materials science, computer science, chemistry, biology, and physics. These technologies are critical because they provide new and expanded research and development capabilities, not just for programs across SC, but for science and technology broadly. They will enable breakthroughs in the sectors of the future and contribute to addressing the climate crisis.

Advanced computing is central to advancing science and technology, from predicting the properties of new materials to modeling Earth systems. SC is making investments in mathematical, computational, and computer science research critical to the advancement of computing capabilities and in developing and providing world-leading high-performance computing (HPC) resources to our scientific community. As we close in on full deployment of Frontier—the Nation's first exascale computer located at Oak Ridge National Laboratory (ORNL)—we continue to look to the future, supporting the R&D needed to develop the next-generation of computing systems “beyond exascale.”

SC is also addressing the increasing demand to store and share the massive amounts of data generated daily from its scientific user facilities. The current upgrade to SC's Energy Sciences Network (ESNet6) will help meet the need for highly reliable data transport capabilities optimized for the requirements of large-scale science. With increasing amounts of data, the need for new data analysis tools is becoming more important. SC continues to support research in AI by developing robust new algorithms to analyze and assimilate data sets, along with other tools and data-focused

approaches that minimize bias and are easily coupled with more traditional physics-based computer simulations.

Realizing tomorrow's data-centered technologies will present considerable computational, communications, and security challenges. High-performance computers and other IT infrastructure still require substantial energy consumption, which contributes to climate change, and potentially limits future advances in performance. SC continues to support development of hardware and software technologies that decrease the energy needs of advanced computing, as well as for increasingly larger data storage demands. For example, when fully deployed, Frontier will require only 20 MW of power for operations, a decrease of nearly 200x in energy use per operation relative to the Department's most advanced computer in 2010. This trend towards increasing energy efficiency must continue, however, and SC's expertise in materials science will be an important contributor to the development of future energy efficient computing systems by developing new approaches in microelectronics, data storage, and QIS.

SC is providing leadership in QIS through investments in research programs and five National QIS Research Centers, established in FY 2020. Each of these centers is led by a National Laboratory in partnership with researchers from universities and industry. These centers are developing workforce training programs, including paid internship opportunities for students, who will be part of the future QIS workforce. In addition, SC held a workshop in March 2021 that recommended actions to assist colleges and universities in developing curricula to train students for employment in QIS-related jobs. These efforts are among the measures outlined in the "Quantum Information Science and Technology Workforce Development National Strategic Plan,"<sup>2</sup> recently released by the NSTC Subcommittee on Quantum Information Science, which was co-chaired by Dr. Steve Binkley, the Principal Deputy Director and Acting Director of SC.

Demands for continued advances in computing and power technologies underscore the need to rethink the fundamentals of microelectronics. The 2018 SC-sponsored "Basic Research Needs for Microelectronics"<sup>3</sup> workshop report outlined advances needed in the foundational science required to meet future needs in microelectronics—including materials science, chemistry, physics, synthesis and fabrication technologies, architectures, algorithms, and software. SC is positioned at the convergence of these scientific disciplines and is in a unique position to both play a critical role in the advancement of microelectronic technologies over the coming decades, and to benefit from the resultant capabilities in computing, sensing, power, and communications that are critical to SC user facilities and other applications in its research efforts. SC is active in interagency planning for microelectronics, including participating on the Subcommittee on Microelectronics Leadership under the NSTC, contributing to the drafting of a National Strategy on Microelectronics Research, and is collaborating with the Department of Commerce (DOC) in planning for an incentives program to support the U.S. semiconductor industry.

SC research in biological systems, including biology of plants, fungi, and microbes, create the foundational knowledge for developing cost-effective and sustainable processes for producing fuels, materials, managing carbon, plastics and waste recycling, and other applications. These

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<sup>2</sup> <https://www.quantum.gov/wp-content/uploads/2022/02/QIST-Natl-Workforce-Plan.pdf>

<sup>3</sup> [https://science.osti.gov/-/media/bes/pdf/reports/2019/BRN\\_Microelectronics\\_rpt.pdf](https://science.osti.gov/-/media/bes/pdf/reports/2019/BRN_Microelectronics_rpt.pdf)

research efforts have also produced tools to support the broader research community, such as the CRISPR-cas9 process for gene editing, computational modeling, and new imaging techniques that have enabled observation of cellular processes at the molecular level. SC investments in fundamental biology and advanced characterization, computational, and imaging tools will catalyze technologies that will contribute to a vigorous bioeconomy.

Finally, isotopes are of strategic national importance. They are essential to many current applications and enable development of emerging technologies for medical diagnosis and treatment, discovery science, national security, industrial processes, space exploration, and QIS, to name a few. The new Office of Isotope R&D and Production, which stewards the DOE Isotope Program (DOE IP), has the unique responsibility to produce critical radioactive and stable isotopes for the Nation (either not commercially available or in short supply). For many isotopes, DOE IP is one of only a few producers in the world, and often the only producer. Robust partnerships with Federal agencies and industry help to ensure DOE IP is able to meet demands for production of available isotopes and focus R&D on novel isotopes needed for broad applications. For example, the partnership between DOE IP and the National Cancer Institute has enabled the transition of promising medical isotopes from the laboratory to clinical trials.

In the coming years, DOE IP will be completing two projects—the Stable Isotope Production and Research Center and Radioisotope Processing Facility—that will significantly expand on the program’s existing laboratory and university-based capabilities in R&D and production of both stable and radioisotopes. DOE-IP will continue to support R&D at the Facility for Rare Isotope Beams (FRIB)—SC’s newest scientific user facility at Michigan State University—to extract and process unreacted isotopes collected after experiments. To assist the DOE IP in planning for the future of the isotope research and production, SC will pursue establishing a dedicated advisory committee for the program.

**Expanding our understanding of the universe**

SC-supported research in high energy and nuclear physics expand our understanding of the universe, from the subatomic scale to the cosmic scale. Our investments ensure that the U.S. maintains its leading roles in these highly international efforts. Many of the groundbreaking discoveries made through the support provided by these programs and their predecessors at DOE—from the discovery of the top quark and the Higgs Boson to the discovery and characterization of the quark-gluon plasma to the recent measurements at the Muon g-2 experiment that call into question the standard model of physics—have been possible only through the coordinated efforts of thousands of scientists in the U.S. and abroad working together at some of the most complex scientific instruments ever conceived. Additionally, SC’s support for research in fundamental physics requires the development of cutting-edge technologies, many of which have found widespread and high-impact use in fields as diverse as medicine, communication, environmental management, and national security. The *DOE Science for the Future Act* provides a clear recognition of this fact and helps position SC to continue to facilitate the development of, and participation by U.S. researchers, in current and future large-scale science projects based both in the U.S. and abroad.

The HEP program’s mission is to understand how the universe works at its most fundamental level by discovering the elementary constituents of matter and energy, probing the interactions between them, and exploring the basic nature of space and time. U.S. investments in this area have been guided since 2014 by the report of the Particle Physics Project Prioritization Panel (P5), a multiyear scientific community effort that identified five intertwined science drivers of particle physics with great promise for discovery.<sup>4</sup> We pursue breakthroughs in these areas through a global program that includes national and international partnerships that have enabled the U.S. to host world-leading facilities like the future Large Baseline Neutrino Facility and Deep Underground Neutrino Experiment (LBNF/DUNE), and for U.S. scientists to access the most advanced facilities located abroad.

SC, through HEP, has played an important role in the collaboration between the U.S. and the European Organization for Nuclear Research (CERN) at the Large Hadron Collider (LHC), the world’s largest and highest-energy particle collider. This collaboration continues with the High Luminosity upgrade of the LHC accelerator and two large detectors, which will increase the particle collision rate and increase the reach for finding new physics. SC is leading in the development of LBNF/DUNE, the next big international mega-science project. When complete, this multi-location facility will be the centerpiece of a U.S.-hosted world-leading neutrino research program. It will use the world’s most intense neutrino beam and large, sensitive underground detectors to reveal answers to fundamental mysteries of the universe.

Going forward, the scientific community is set to undertake the next iteration of the P5 process that led to the highly influential 2014 strategic plan. When completed in 2023, the community’s next strategic plan is expected to help HEP chart a course to support this scientific community through the rest of the decade. HEP looks forward to working with the Committee to build on the support provided by the *DOE Science for the Future Act* in order to implement this vision.

The NP program focuses on discovering, exploring, and understanding all forms of nuclear matter—including not only the familiar forms of matter we see around us, but also exotic forms that existed in the first moments of the universe and that may exist today inside neutron stars. The overarching goal of this program is to understand why matter takes on the specific forms observed in nature. The science supported by NP covers an extraordinary range in both time and scale, and the community requires access to a variety of facilities with unique capabilities to study these systems.

To meet this need, NP supports operations at multiple national accelerator user facilities, including the Relativistic Heavy Ion Collider (RHIC), the Continuous Electron Beam Accelerator Facility (CEBAF), the Argonne Tandem Linear Accelerator System (ATLAS), and FRIB. When it begins science operations this year, FRIB will uniquely afford access to eighty percent of all isotopes predicted to possibly exist in nature, including over 1,000 never produced on Earth. The operations of these facilities will be further enhanced by deployment of data analytics tools for autonomous decision making, currently under development through support from NP as well as parallel efforts being advanced across the SC programs.

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<sup>4</sup> [https://www.usparticlephysics.org/wp-content/uploads/2018/03/FINAL\\_P5\\_Report\\_053014.pdf](https://www.usparticlephysics.org/wp-content/uploads/2018/03/FINAL_P5_Report_053014.pdf)

Looking to the future, SC will lead an international effort to build an Electron Ion Collider (EIC). The *DOE Science for the Future Act* sends a strong message of support to the Department on this project of critical importance to the field. Led by Brookhaven National Laboratory in partnership with Thomas Jefferson National Accelerator Facility, the EIC will provide the scientific community with an unprecedented ability to discover how the mass of everyday objects is dynamically generated by the interaction of quarks and gluons inside protons and neutrons. It will enable progress in long-standing “grand challenge” questions, such as the ultimate limits of nuclear existence, and illuminate the astrophysical sites and isotopic paths to heavy element production in the cosmos.

*S.3699 and S.2232*

**Laboratory Restoration and Modernization**

The DOE mission is supported by the 17 DOE National Laboratories. SC supports research across the entire laboratory complex, with the largest share of contributions going to the 10 SC-stewarded National Laboratories. The expertise of the laboratory staff, and the research capabilities they help develop and operate, are invaluable assets that serve to advance the frontiers of fundamental scientific discovery, train the scientific and technical workforce in the U.S., and develop the tools and advanced instrumentation that keep our Nation at the forefront of innovation. The DOE National Laboratories are essential resources that the Nation turns to in time of emergencies. The optimal operation of this complex is indispensable to the country’s leadership in science and technology development to ensure our energy, economic, and national security.

The DOE National Laboratories were established from the 1940’s to 1960’s, with some approaching 80 years of service. The research facilities at these Laboratories—including general research laboratories, specialized research centers, accelerators, light sources, high-performance computers, and two nuclear reactors—are supported by general-purpose infrastructure and a vast network of utilities that form the backbone of each site. The 10 SC-stewarded laboratories alone comprise an infrastructure portfolio worth nearly \$22 billion, consisting of more than 1,600 buildings accounting for 24 million gross square feet, roads, utilities, and other supporting infrastructure assets on more than 18,000 acres of land. Today, nearly two-thirds of this support infrastructure, including utility systems, is rated as substandard or inadequate, with current deferred maintenance costs totaling \$1 billion. This results in unplanned outages, costly repairs, elevated safety risks, and inefficiencies that impact our ability to maximize contributions to science and society. S.2232, to be referred to as the “*Restore and Modernize Our National Laboratories Act*”, supports the Department’s effort to pursue a robust portfolio of maintenance and modernization construction projects across the entire DOE laboratory complex, which enables our continued innovation in the conduct of scientific discovery itself to address modern problems, including the application of AI and automation to scientific discovery.

Furthermore, S.3699 provides renewed support for the SC Science Laboratories Infrastructure (SLI) program, which enables scientific and technical innovation at the SC-stewarded laboratories by funding and sustaining general purpose infrastructure. Since 2006 and with the support of Congress, the SLI program has invested over \$1.8 billion to support general purpose buildings and utilities in line-item construction, general plant, and focused utility projects that

have successfully provided modern, reliable, and mission-ready facilities and infrastructure to support the SC mission now and into the future. The Department's continued emphasis on addressing core infrastructure issues across the DOE laboratory complex will enhance the ability of these laboratories to continue delivering scientific and technical leadership for the next 80 years and beyond.

*S. 3428*

Bill Number S. 3428, to be referred to as the Fission for the Future Act of 2022, supports the deployment of next generation advanced nuclear energy technologies by establishing a program at DOE that would provide additional Federal assistance for such efforts. Specifically, the bill prioritizes helping communities with retired or retiring fossil fuel generation facilities transition to a clean energy future using nuclear energy technology. This future includes non-electric applications for nuclear energy such as heating, hydrogen production, industrial processes, desalination, and isotope production. Furthermore, the support for fossil communities, Tribes, and institutions of higher education and workforce development in this bill is consistent with the Department's equity and justice considerations.

DOE currently supports efforts to deploy next generation advanced nuclear energy technology by leveraging retiring energy generation assets. For example, TerraPower recently announced siting of a Sodium reactor at a retiring coal plant in Wyoming. TerraPower has a cooperative agreement with DOE—specifically in the Office of Nuclear Energy's (NE) Advanced Reactor Demonstration Program—to advance this project. The partnership includes private sector companies, universities, and National Laboratories. This project is a great example of what successful public-private partnerships can achieve in advancing energy solutions.

*H.R. 3119 and S. 2302*

The energy sector is uniquely critical—providing power and fuel on which all other U.S. critical infrastructure sectors depend to operate. A disruption in our energy system can have a devastating impact on national security, the U.S. economy, and the livelihoods of millions of Americans. We have experienced the devastating impacts of disruption through multiple events just this year. This mission of DOE's Cybersecurity, Energy Security, Emergency Response (CESER) and its responsibilities are critical, and it has been a goal of Secretary Granholm to strengthen the office, including with new leadership and renewed focus. It remains the Department's position that that emergency preparedness and management is best handled by a stable, professional set of employees who have developed relationships with industry partners. We do not want a learning curve when crises happen, and with extreme weather events escalating, having consistent, professional, nonpartisan leadership at the helm of this office is crucial. The Department looks forward to working with the Committee to support cyber and emergency response and protect the nation's grid and energy assets.

*Conclusion*

Chairman Manchin, Ranking Member Barrasso, and members of the Committee, thank you again for the opportunity to speak about the Department in its science and advanced energy technology missions.

As reflected in the FY 2022 PBR, SC will continue to invest in the most compelling foundational research, in providing advanced tools for scientific discovery and technology development, and in a laboratory complex that is unequivocally the world's most comprehensive collection of scientific and technical expertise.

We will continue to make necessary investments in the sectors of the future, and do so in partnership with our interagency colleagues, to advance science and technology that will dominate the 21<sup>st</sup> Century—including AI, QIS, microelectronics, and systems biology. We will continue to overcome the key scientific challenges needed to realize abundant, affordable, and clean energy technologies for the future, including fusion energy, to tackle the climate crisis, and to address the ongoing COVID-19 global pandemic and other emerging threats.

To engage these challenges, we will leverage cross-disciplinary teams of experts with diverse perspectives and backgrounds from universities and National Laboratories, and from partnerships with other Federal agencies and international institutions. This approach will allow us to address these critical issues by conducting science at scales not possible by individual researchers, individual institutions, or even individual countries.

To ensure that we have the talent needed to meet these challenges, we are developing our future workforce, with a strong commitment to the principles of diversity, equity, inclusion, and accessibility. This commitment extends to our National Laboratories, to the research and facilities we support in the scientific community, to our own staff, to the processes we use in pursuit of the mission, and to the investments we make in workforce development programs.

NE will continue to pursue robust public private partnerships to accelerate the development and deployment of the next-generation of nuclear fission technologies, a key source of carbon-neutral power that will be critical to meeting this Administration's goals for net zero emissions in the energy sector and beyond.

We look forward to discussions on how best to take advantage of the unique strengths of all of our Federal R&D funding agencies in order to bolster the U.S. research enterprise and global competitiveness. As described above, we are leading the way in advancing the science and developing the technology that will enable innovations in many of the priority technology areas, including AI/ML, HPC, semiconductors, QIS, synthetic biology, energy storage, and others. We will do so by working closely with our colleagues at the NSF, DOC, DOD, and other agencies supporting R&D to expand coordination and collaboration to maximally leverage our investments towards these shared goals.

I would be happy to take any questions you have.

The CHAIRMAN. Well, thank you. Now we will begin our questions.

The Department of Energy's Office of Science and its National Labs bring world-class expertise, advanced facilities, infrastructure, and resources to address the most pressing challenges the United States is facing. The foundational scientific research conducted by the Office of Science is critical to developing these. However, it is important that technologies are allowed to progress through the research cycle from basic research to application and avoid the so-called "Valley of Death." So if you can, explain the DOE work to ensure a smooth handoff from basic science research to application by avoiding that valley.

Dr. RICHMOND. Yes, thank you very much for that question, Senator Manchin, because that is what I took on the minute I got confirmed. These are unprecedented times for us to be able to make the kind of solutions that we need to make in order to address the climate issues and actually security issues today. When I came into this role, I had much more experience with the Office of Science, and I have spent a lot of time now understanding more of the applied areas. I have also been able to understand better this "Valley of Death" and what we need to do in order to fill that up so it can easily be passed across. In particular, I believe that the key players in this really are our DOE laboratories, because they are really the incubators for a lot of these activities that go from basic to applied. And so, especially the handoff happens much more easily at our laboratories.

That said, what I have been doing in the Department of Energy leadership is working together to more closely align those program officers and leaders in the Office of Science with the applied areas, with weekly meetings together, with bringing together ways in which they can coordinate across programs in ways that it has never been done before. I have been meeting with all of the National Laboratory directors individually and also in groups to talk about how they can make this gap shorten and eventually disappear. They are all on board. I have also been meeting with small groups of the research officers from each of the National Laboratories because they are the ones that really have the tendrils down into their laboratories to understand what is going on, and they are right on board with this too.

And so by working at various levels, I believe that we are starting to make progress in bridging these gaps, especially with our programs—our new Earthshots, the three that have been announced, and those require us to move across all the way to deployment. And so I have spent a lot of time with really talented people, working in all these areas and particularly the Earthshots in being able to pull people together and have a—

The CHAIRMAN. How's it going? Do you feel like we are accomplishing?

Dr. RICHMOND. Huh?

The CHAIRMAN. Do you feel like you are accomplishing?

Dr. RICHMOND. Yes, I do.

The CHAIRMAN. Okay.

Dr. RICHMOND. Actually, I do.

The CHAIRMAN. People are coming together?

Dr. RICHMOND. Yes.

The CHAIRMAN. Okay.

Dr. RICHMOND. Well, you know, you have to have a carrot and a stick, right?

The CHAIRMAN. I understand.

Let me throw this at you too. Senator Barrasso and I introduced the Fission for the Future Act, as you know, the recognition of the value of using advanced nuclear reactors to repurpose coal and other fossil generating plants for nuclear power generation. Senator Barrasso in Wyoming has one, I think, in the building stage, right? They are planning and building? Okay.

Dr. RICHMOND. Yes.

The CHAIRMAN. We just changed the law in West Virginia to allow this.

Dr. RICHMOND. I know.

The CHAIRMAN. I know, I am as happy as you are.

Dr. RICHMOND. Oh, my goodness.

The CHAIRMAN. Thank you. It gives all opportunities.

So can you tell me how you all support this legislation and what you are doing to bring this to fruition?

Dr. RICHMOND. Yes, so as the legislation highlights, there are some key issues for advanced nuclear outside of electric applications. That includes industrial decarbonization, hydrogen production, isotope production, desalination, more and more and more.

The CHAIRMAN. Right.

Dr. RICHMOND. So it is not just about energy.

The CHAIRMAN. Correct.

Dr. RICHMOND. There are all these other things going on too. And so what I have been doing is working both with the nuclear energy side in the applied areas, closely with the nuclear physics side to get them together and now they are collaborating with each other across, in order to help to translate, to understand, in the basic science side to understand what the issues are that the NE side needs to be able to get worked out before you can make progress. And then also getting them—the nuclear physics side—to look more carefully about how what they are doing can be related to more energy—

The CHAIRMAN. If your communications people would consider putting out a statement saying the value chain that is involved, not just in electricity, but things you just talked about—what we can do with that reactor, the hydrogen, things of that sort, because there are an awful lot of applications and opportunities that people just don't know. They just don't know enough in the scientific value. So anything you can do to enhance that, putting a statement out, not just for my state, but for all states who have had a transition going on from their coal-fired plants into a new technology would be very, very helpful.

Dr. RICHMOND. Great. Will do.

The CHAIRMAN. Okay.

Dr. RICHMOND. Will do.

The CHAIRMAN. With that, we will turn to Senator Barrasso for his questions.

Senator BARRASSO. Well, thanks so much, Mr. Chairman.

And following up with this, in terms of nuclear and uranium, you know, the United States has 93 operating commercial nuclear reactors. We are almost completely reliant on imports of uranium to fuel the reactors. About half of that uranium comes from Russia and its allies—Kazakhstan, Uzbekistan. So in 2020, Congress gave the Department \$75 million to establish a strategic uranium reserve. The Department has yet to purchase any uranium from U.S. producers, and in light of Russia's invasion of Ukraine and our interests in sanctioning Russia, does the Department now have any plans to accelerate its purchases of uranium?

Dr. RICHMOND. Thank you, Senator Barrasso, for that question. It is certainly an urgent one today, and with this invasion, it has made all of these issues that we are having and discussions in the Department of Energy even more urgent. So at this point, folks in NNSA as well as in the nuclear energy area are looking for other sources in which we can partner also with our allies in this area and also different ways that we can get different sources of uranium so we are not dependent on Russia.

I would be happy to get back to you more with details on that because it is a rapidly changing picture.

Senator BARRASSO. Yes, there is a sense of urgency that we feel, and I appreciate your interest in continuing. Thank you.

Dr. RICHMOND. Yes, I am happy to get back to you on that.

Senator BARRASSO. The next issue is the advanced nuclear reactors. They need a specific type of fuel—high-assay low-enriched uranium (HALEU). Currently, there are only two sources of high-assay low-enriched uranium. One is Russia. The other is the Department of Energy. So unless the Department acts swiftly, our advanced reactors are going to be, again, dependent upon Russia. It is the same urgency you talked about in the answer to the first question. Is the Department willing to produce high-assay low-enriched uranium and make it available for our advanced reactors?

Dr. RICHMOND. Thank you again for that question, too. Life is changing quickly, as we speak today. But we know—we recognize that this—that HALEU is the fuel needed for most of our reactor developers to fuel their reactors, including nine of the ten awards under our ARDP use HALEU, like TerraPower and our X-energy demo projects. So the HALEU supply program, we realize, must address enrichment, transportation, storage, chemical conversion, and regulatory elements of the HALEU supply chain. And so the most urgent, near-term needs include supporting the ARDP demonstration projects—the X-energy and Natrium. Until recently, the prevailing assumption was that the initial cores of HALEU for both ARDP projects would be supplied by Russia, as you point out, under the provisions of the Russian suspension agreement administered by the Commerce Department.

So NE is in partnership with NNSA programs, and is exploring feasible options to address this issue, but any solution will require a substantial and sustained source of government funding on the order of provisions included in the House-passed Build Back Better bill, with \$500 million for HALEU supply, along with support from industry, the Nuclear Regulatory Commission, and other stakeholders. So we are working on it.

Senator BARRASSO. In terms of the finances, would it be helpful if the Department had the authority to use some of the money remaining in the U.S. Enrichment Corporation Fund for this purpose?

Dr. RICHMOND. I don't know the answer to that at this point.

Senator BARRASSO. You can get back to me on it.

Dr. RICHMOND. I would be happy to get back to you.

Senator BARRASSO. Great.

I want to ask about research. As Under Secretary of Science and Innovation, you oversee the Office of Science. The Office of Science oversees 10 of our 17 National Laboratories. Can you tell us how many citizens of the People's Republic of China work at our National Labs?

Dr. RICHMOND. Thank you for that question. I do not actually have the number with me. I can certainly get back to you on that.

Senator BARRASSO. Yes.

I just want to point out that according to the Department, there are over 5,700 citizens of the People's Republic of China working at our U.S. National Labs. Do you know whether the People's Republic of China allows its citizens to have dual citizenship with the United States?

They don't. It's okay. They don't.

Just, I am concerned, because, you know—

Dr. RICHMOND. Oh, no.

Senator BARRASSO [continuing]. Is there any evidence to suggest that the Chinese government allows its citizens to work at our National Labs without the government's prior knowledge or consent?

Dr. RICHMOND. That is certainly a big concern to us and one that we have been working on with other agencies also in order to make sure that we have the strictest protocols in place in order to check who is working in our laboratory while also being careful that we are not overextending our protections and capturing people that really are completely innocent. So those are ongoing concerns, and we hope that by working with other agencies we can develop a procedure and protocol and strategy that is across all the agencies. And so the concern that we have with regard to this being a focus on the Office of Science is that it really needs to be—it is a very serious issue—but it needs to be taken up more broadly with the other agencies, and I guarantee you, that is what we are working on right now.

Senator BARRASSO. Just to end, and I will not really ask for your response, it is just that, you know, after our secure briefings last night and classified settings and concern about cybersecurity, it just seems to make a lot of common sense that the Secretary would go ahead and put into place a confirmed position to oversee the Office of Cybersecurity in the Department of Energy.

Dr. RICHMOND. And I can understand your concerns for that. We are also concerned about making certain that we have someone in that position that has the qualifications to be able to carry out the duty. We believe that Puesh Kumar, who is in that position right now, is excellent in that area. We also are concerned about the fact that if it requires Senate confirmation, then it may delay our ability to have someone of that quality in place all the time. And so that is a concern for us.

On the other hand, we know that you need to be able to question whether you think the person is doing the job and able to do that job, and we believe that you have mechanisms to be able to do that without them having to be confirmed. So our choice would be not to have that as a confirmed position, but it is more about the fact of having somebody in place that is qualified, that is continuous, and not political.

Senator BARRASSO. Thank you.

The CHAIRMAN. We will bring him in. We can bring him in.

Dr. RICHMOND. Oh, yes.

The CHAIRMAN. We can question him even if he's acting.

Dr. RICHMOND. Yes.

The CHAIRMAN. Sure.

Dr. RICHMOND. He's really good.

Senator HEINRICH. Mr. Chairman, I want to start and just say a few words about what lessons we should be learning from Russia's invasion of Ukraine, and in particular, their weaponization of their hydrocarbon reserves. I certainly agree with you that it makes no sense to rely on Russian oil and gas. But the solution is not more reliance on dangerous fossil fuels that are driving climate change and irresponsibly imperiling the economic future of our children and grandchildren. The solution is to embrace technologies that exist today and make climate-imperiling fossil fuels irrelevant. Clean electricity, electrification—and in particular, heat pumps, can literally free Western Europe from the shackles of Russian oil and gas. And this is a path that can also neuter Russia's economic leverage over Western Europe and the world, and is the only path that really frees American consumers from the devastating price swings that are so inherent to hydrocarbon commodities. So I think we need to be spending a lot more time looking at how we accelerate that transition, particularly in Western Europe, so as to make things like Nordstream II completely unnecessary and we should be looking at industrial policy, because I believe that the United States of America should be manufacturing those technologies—in particular, heat pumps.

Doctor, DOE just announced an organizational realignment to ensure that the Department has the structure needed to effectively spend the \$62 billion provided in the Bipartisan Infrastructure Law and the Energy Act of 2020. Last year, you were sworn in as Under Secretary of Science and Energy, and after the reorganization, you will be Under Secretary for Science and Innovation. Talk to me about how your newly defined role fits into the Administration's larger strategy to meet the target of achieving net zero no later than 2050.

Dr. RICHMOND. Great. Thank you, Senator, for that question.

Senator HEINRICH. And if you want to opine about heat pumps, you can do that too.

[Laughter.]

Dr. RICHMOND. Yes, actually we have one at home. Thank you very much.

So when I came on board and got started in the position, I learned of this reorganization, and so, the person that held my position temporarily, Kathleen Hogan, is now the person that is sitting in the position of taking over the bill. She and I, we talk about

being connected at the hip. We have been working very, very closely because she had been working a lot in the applied science area, not so much in the basic science area, and now she has moved over into that role. And we both believe that in order for us to succeed, that we must be working closely. So, for example, I sit in on bi-weekly briefings that she has with her different units. She sits in on briefings that happen in my space, and we work together to make sure that the transition from the very fundamental work is being passed all the way through.

That said, you cannot just pass the knowledge and expect it to be launched into the deployment area without some problems because you discover problems that then have to come all the way back. So if we do not keep this string of information flow going back and forth, it is not going to work. And so what is good about the position that we are in now is, I can oversee the unit of the fundamental and applied while then working with her in the deployment area. And so we have programs that stretch all the way across that we all keep an eye on as well as those that go all the way—our Earthshots, which pretty much go up to the deployment. And so it is actually well-coordinated also because some of the people that were working in the applied space are now in the deployment space. So they are heavily connected with the people in that area also. I think it has just been really brilliant the way that was designed, and I cannot take credit for that, because I came into it. I think it is a really good plan.

Senator HEINRICH. I do think it is important for us to sort of bake that continuity into the organization of the agency over time because historically, we have always had the focus on basic R&D, but applied science—and in particular, you know, if we do not commercialize these technologies, we are really not doing our economy any favors. And so having that continuity all the way through the process, and having the kind of approach that we have seen from this Administration, even in the DOE Loan Office to deploy, deploy, deploy—that is where our constituents feel the jobs of the future, when things get deployed in their own communities and there is new hope and new jobs. So whatever you can do to bake that into the agency over time and really show the successes that are possible there, I think it will serve not only DOE, but the country in the long term.

Dr. RICHMOND. That is the hope. That is the plan. And you know what is really cool about the National Labs is that some of those in the more applied areas have been going toward deployment anyway. And so it really—by I would say cementing that into the framework of the labs in addition to the Department of Energy with the deployment is—we have to do it. We just have to do it.

The CHAIRMAN. Thank you, Senator.

And now we have Senator Cassidy.

Senator CASSIDY. Thank you.

Let me just respond a little bit to Senator Heinrich's point. I hope Senator Heinrich is not suggesting that we don't attempt to increase oil and gas production in the immediate near-term in order to help the Europeans and ourselves off the dependence upon Russia, denying Russia the income they need to fund Putin's war machine. We can all agree that long-term, there are things we

must do, but near-term, it is clear that what we must do is increase supply of oil and gas to take away the volatility of the pricing that is resulting because of Putin's war. I will just make that point.

Dr. Richmond, you clearly bring enthusiasm to your job, so I appreciate that. Thank you very much.

I would like to focus right now on the Coastal Zone Research Initiative of the Office of Science Reauthorization for just a minute. And as you might imagine—I am from Louisiana—the Gulf Coast is one of the regions highlighted, and the program's direction is to enhance the understanding of coastal ecosystems. The direction is to develop models to analyze the ecological, biogeochemical, hydrological, physical, and human processes that interact in coastal zones. When I look at your bio, it seems as if this would be something that you have an interest in. And I spoke about this concept to Dr. Berhe during her nomination. Question: how can the work under the Coastal Zone Research Initiative be used to better understand the carbon storage value of coastal zones and wetlands? And related, what other programs in this reauthorization could be used to establish carbon sequestration values of ecosystem restoration?

By the way we are told, there needs to be a kind of dollar value, if you will, related to the net amount of carbon sequestration that would result with coastal restoration. So it seems as if that science has to be developed so that if we wanted a negative carbon offset, everybody would be sure about the values that we are using. Now, I will turn it back to you.

Dr. RICHMOND. Well, you know, our coastal areas—your region of the country—are just incredibly important, and I think that in terms of what we are doing in the Office of Science and BER is addressing exactly where you want to go with this. Let me say that what we need to do more of, and we are currently working on, is improving our computational models to be able to predict things in the future. And this is really important. And so tying in our BER activities with regard to soils and coastal issues, along with our computational methods that are in ASCR, are allowing us to develop models that can give us predictive values for not only cost, but also damaging effects of climate change on our ecosystem in these areas. So this is a really—

Senator CASSIDY. Now, let me ask, because what I am specifically told is that there has to be some sort of, “oh yes, this is the net amount of carbon that would be sequestered if you rebuild a hectare of coastline.” How far along are we in terms of establishing that model?

Dr. RICHMOND. So this is not my area of expertise. It is more Dr. Berhe's, but I would be happy to get back to you on that issue.

Senator CASSIDY. Sounds great. Let me ask you about something else. I have been very interested in the use of blockchain and artificial intelligence in order to track emissions and other such things, and the Bipartisan Infrastructure bill can trace its energy provisions back to this Committee's actions last summer, which included requiring DOE to publish a study within a year of the use of digital tools in analyzing and addressing climate change and the impacts. Are you aware of the study? And do you anticipate the Office of

Science contributing to the report considering its extensive history in AI, supercomputing, and other digital needs?

Dr. RICHMOND. In that area, I do believe that the Office of Science is working very hard on this, particularly the ASCR area, but on the other hand, I do not know the state of that report right now. But I would be happy to get back to you on the details of that.

Senator CASSIDY. Sounds great. And then, let me just kind of talk about carbon oxide sequestration research and the geologic computing initiative. The proposed legislation would continue to invest in the research into computing that can identify pore spaces for carbon sequestration. How can the increased funding help us to better understand and, if you will, transfer the EPA to help expedite the permitting and siting of carbon sequestration wells?

Dr. RICHMOND. Well, I think any progress that we make with regards to increasing our computational capacity using AI, and particularly to increase our capabilities for resolutions so that we can actually be looking at specific areas in order to do the predictions, is very important. And I know that that is not only in the Office of Science, but it has also been instituted at a number of our different National Laboratories. They put that as very much as a priority with regards to being able to do those simulations to do the predictions. And this is a work in progress, you know, the Office of Science is doing very basic research to build up this capacity. And so it is sort of flying the plane while you are building it, but we are trying to get as many results out as we can while we are also building that plane. So stay tuned.

Senator CASSIDY. Thank you, Dr. Richmond. I yield.

Senator BARRASSO [presiding]. Senator Cortez Masto.

Senator CORTEZ MASTO. Thank you. Dr. Richmond, it is great to see you. Thank you for joining us.

Let me ask you this: in your written testimony, you touched on some of the values and opportunities that increased funding for EPSCoR could provide the Department and our country overall. And you reiterated the Department's commitment to ensuring that the next generation of scientists and engineers are more inclusive and diverse. So can you please speak to existing workforce needs in the energy sector as well as the ways that DOE is currently seeking to enhance geographic diversity in research through initiatives like EPSCoR?

Dr. RICHMOND. Well, thank you for that question. EPSCoR is a really, really important program, and the Office of Science has a long history, as you probably know, of supporting research at institutions represented and in the federal R&D landscape, including HBCUs and other minority-serving institutions through EPSCoR. It also recognizes the great value to increase the competitiveness of underrepresented institutions, of which we have many really good ones, and is committed to increasing financial assistance to them, including those in EPSCoR-eligible jurisdictions.

What I find when I go talk at institutions that don't have much federal funding, and many of them are in EPSCoR states that I have, in my career—a lot of the problem is that the PIs at the—the faculty at those institutions—oftentimes are an institution that don't have the resources to put together a research office, or the research office is pretty limited, so their ability to get knowledge on

how to apply for grants and how to get the funding and the kind of grantsmanship you need to do can be holding them back. And so what the Office of Science has been doing—and DOE in general, in these COVID times in particular, is having many webinars in order to reach out to them. So it is not only the money, but it is being able to recruit and capture those that have the ideas but are afraid to apply, or they apply once and they get turned down and then they quit, which, anyone that is experienced at this knows that you get turned down a lot and you just keep doing it.

And so I think it is a combination of being able to have funding in our EPSCoR state institutions but also to be able to get the knowledge to them and encouragement. And I think many of our program officers in the Office of Science are very good at this. It's just that we can always improve and be better. But I think it is important for the institutions also to recognize, to kind of push their PIs to keep trying, because we are merit based. We make decisions based on merit in addition to making certain that we are funding diverse institutions in other parts of the country besides just the Bay area of Boston and Boston in general.

Senator CORTEZ MASTO. Well, as an EPSCoR state, I agree with you wholeheartedly.

Let me ask you this, because S. 3699 provides important funding for EPSCoR programs, and do you think that the grants that are opportunities in this legislation as well as the fellowships will help to enhance and further promote diversity in STEM?

Dr. RICHMOND. Well, let me just give you what we have now in terms of 2021—the total support to universities in EPSCoR-eligible jurisdictions was \$125 million in the Office of Science, or 12 percent of the total support to provide it to universities, and \$25 million of that total was provided through the DOE EPSCoR program. So we already give a lot of money to our universities in EPSCoR states that do not come through the regular EPSCoR program. So what I do have concerns about is establishing a quota in terms of a number that we need to meet for a percentage of the total research funding because that would not be compatible with our principles of merit-based allocation of research funding, but also it would take a big chunk out of our merit-based research funding that is already tight for funding. So I think a balanced approach and continuing to work and to find more of those institutions in EPSCoR states where we can pull more people in is important, but I'm not so keen on sort of a quota that's there.

But I do think that we have a lot of incredibly talented young people in our EPSCoR states that are in remote areas at small colleges and universities. And I believe that one of the most important priorities is that we have to grab them—they are actually in our summer internships that we have at our DOE laboratories. I hear stories all the time about someone, like myself, that came from a fairly remote part of Kansas originally, and went to a DOE lab in college and so be it, here I am. So I am passionate about making certain that we are grabbing the talent that is out there, giving those—can I call them kids?—the confidence that they can be successful to be full participants because we critically need them right now like we have never needed them before.

Senator CORTEZ MASTO. Yes, thank you. Dr. Richmond, thank you. Thank you, Mr. Chair.

Senator BARRASSO. Thank you very much, Senator Cortez Masto. Senator Lankford.

Let's see if Senator Lankford is coming. If we don't hear from him, I know he is online and has been participating.

Let me ask you while we are getting Senator Lankford lined up. Specifically on medical isotopes, you know, medical isotopes are elements which doctors use to diagnose and treat diseases like cancer. As you know, the United States is dependent on other countries, including Russia, for most medical isotopes. If we lose access to these isotopes, American lives could be lost—said that we need to stop relying on Russia for uranium. I asked about that earlier. I think the same can be said for medical isotopes. Will you discuss how our bill improves our nation's ability to produce medical isotopes?

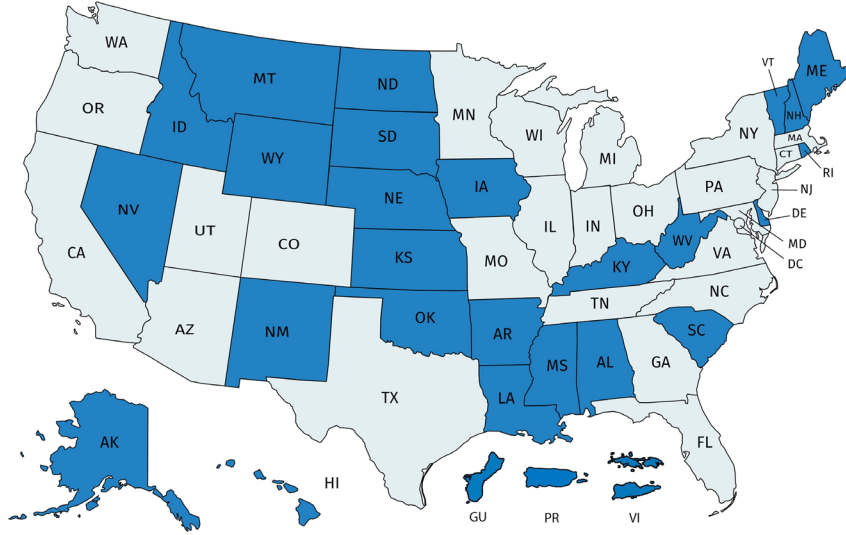
Dr. RICHMOND. Thank you for that question. It is really important. It is a really important bill, and we fully support it because that is absolutely true. These isotopes are so key to a lot of the things that we do in medicine and other things. So anything that we can do to reduce our dependence in this area as well as in a lot of the critical materials is urgent, and unfortunately, it was urgent before, but now people understand how urgent it needs to be as we are looking to limit the sources of some of these from other countries.

Senator BARRASSO. I would like to ask you a bit about EPSCoR because both Senator Manchin and I come from states that qualify, as a number of the other Senators—members of this Committee—do. This has become an interesting topic of concern of people here and, you know, Congress created this program—the Established Program to Stimulate Competitive Research—to broaden the geographic distribution of federal research funding. There are about 25 EPSCoR states, 15 of which are represented on this Committee.

Dr. RICHMOND. I know.

Senator BARRASSO. We have a map right here. Nevada, right there. You know, New Mexico, Oklahoma—that is this Committee.

[Map showing EPSCoR-eligible jurisdictions follows:]



Dr. RICHMOND. A lot of great states. A lot of great states.

Senator BARRASSO. And with great institutions. Great opportunities.

Dr. RICHMOND. And great institutions too, I agree.

Senator BARRASSO. Yes. So less than two percent of the Office of Science's research budget goes to universities in all of these states. Less than two percent for universities in 25 states when we take a look at the money, and Senator Cortez Masto, who is here, has been part of those discussions. Is it fair to say that the Office of Science can and should do more to build research capacity at research universities in these EPSCoR states?

Dr. RICHMOND. Well, we need to do as much as we can to build that. I need to check into—I have to trust you on the two-percent number because I am not aware of that number, but if that is the case, then it would cause me concern too. That said, I will take it back to the Office of Science and we will talk about that more and get back to you.

Senator BARRASSO. Yes, because when you talked about your history and where you are now, but where you came from.

Dr. RICHMOND. I know. I know. And I love those states. I have been to all of them. Okay, I love those states, even Nevada, I do, I do. So I get it.

Senator BARRASSO. And a follow-up—the Office of Science has six advisory committees which collectively include a total of 133 members. Of those 133 members, only nine come from universities in EPSCoR states—nine of the 133 from those 25 states. Notably, these six advisory committees include just as many members from outside of the United States as members from universities in the EPSCoR states. So what is the Office of Science doing to include more members from universities in EPSCoR states on its advisory committees?

Dr. RICHMOND. Good question. Thank you for asking that. I think, in terms of having advisory board members from—having been on one of those committees and chair of it a number of years ago, I understand to some degree how they are put together. I think it is important for us to have international folks that are on it, but I agree with you. Thank you for those statistics because I was not aware of those and so I will go back with that message because I think it is really important that we have representation from the EPSCoR states on it.

Senator BARRASSO. And part of the role of committees, as the chairman and I continue to say, is sometimes we actually really want the answer, and other times it is to just bring the level of understanding of what is happening out there and what we see and what we hear about at home to the attention of people who are in positions of influence in the various administrations. So thank you.

Dr. RICHMOND. And these committees help to set the agenda for the particular division of the Office of Science. So it is important, and particularly so I take your message back because it is important that there is that view there and also the fact that many of your states are very diverse racially, and we want to make sure that that is represented in the committees too.

Senator BARRASSO. Senator Cortez Masto.

Senator CORTEZ MASTO. Thank you.

Let me talk a little bit about quantum computing.

Dr. RICHMOND. Sure.

Senator CORTEZ MASTO. Yes. In your written testimony, you underscored existing efforts to further secure the nation's economic and national security through this area, and researchers, right now, at the University of Nevada Reno, the Argonne National Lab, and Pacific Northwest National Lab, they received \$2.5 million in grants from the DOE to develop a center that designs molecules for QIS applications. From your perspective, how would the DOE Science for the Future Act, or any of the legislation that we are talking about today, build on partnerships like this to ensure that the U.S. continues to be a world leader in fostering new technologies such as quantum superposition? I am curious—your thoughts?

Dr. RICHMOND. So that is really a great question, and what a hot topic these days and a very competitive topic too with other countries, particularly China. So in this realm of quantum computing, one of the really hard issues—and I think the funding that went to your state is to address this issue—is the materials. So, you know, when we have normal computers, we have the silicon chip and it has been etched and got bits and so forth, and with quantum we have qubits. I am not going to go into all the details, nor do you need to know the details. All you need to know is that what is really hard—the big challenge in quantum computing—is that what you have there, the material you have there to work with has to be so pristine and perfect with almost—well, no defects because defects kill the qubits, and that takes incredible materials science. Now today, the model system that is used are diamonds—fabricated diamonds, right? Because they can be in a crystalline form that the number of—can we say potholes?—in there are pretty small.

And so developing materials that can be so incredibly pure and structured so that they do not kill off—if I can say that—the qubits, is really important. And so it is a huge effort in materials science, but it also is, you know, a lot having to do with lasers and intense lasers and short-pulse lasers and so forth involved too, but in my mind, it is really this issue of the materials, and we have seen some really cool research come out lately. I believe one study from Argonne actually is showing some progress in some carbide material, and I get very excited about that because it gets us closer. I cannot remember if it was five seconds or five minutes that the qubit lasted, but it is still making progress. So it is really important that we have all-hands-on-deck—people that are interested and qualified working on this because it is in a very discovery mode before we can move forward in the quantum area. And that means, in many respects, that discovery mode means you can be doing it at a lot of different places as long as you are capable to be able to test things, like you have your collaboration with Argonne, to be able to test out what you are—

Senator CORTEZ MASTO. And so would you say, for that reason, it is important for Congress or us to come to the table with the research and development continuing because of the opportunities we have here, and it is at the beginning stages and we need to continue that development in research. Correct?

Dr. RICHMOND. That is right.

Senator CORTEZ MASTO. Yes.

Dr. RICHMOND. But I would say that in a lot of areas, whether it be carbon capture or hydrogen or any of those areas or, you know, when you are talking about critical minerals, a real problem is separating those critical minerals, whether they be rare earths, from the dirt, you know, and separating it with great purity. And there has just been this cool study that came out this past week where at Lawrence Livermore National Lab, a group is using a bacterial protein to grab on to rare earths and separate them rather than the cost of chemicals you usually use. I mean, is that like too cool? And it really is, because it is just a new way of thinking about things. It is a discovery that somebody from Penn State was involved in, too.

Senator CORTEZ MASTO. Well, Dr. Richmond, I just have to say, it is such a pleasure as well to see your passion and enthusiasm for the job and the opportunities around what we are talking about in science. So thank you. Thank you for, again, answering the questions and being here today as well.

Dr. RICHMOND. Great.

Senator BARRASSO. Senator Hickenlooper.

Senator HICKENLOOPER. Dr. Richmond, what a pleasure.

Dr. RICHMOND. Good to see you.

Senator HICKENLOOPER. I believe, according to Mark Kelly, I am the only scientist, which is to say I had a couple articles published as a geologist in peer reviewed journals, so Senator Kelly refers to himself as an engineer, which I would argue with. I think there are several of us.

Dr. RICHMOND. I like to think that we are all scientists at some level.

Senator HICKENLOOPER. One hopes, if being a scientist is careful observation of the world around us and using those observations as the foundation for better life, then yes, I hope we all are.

The Restore and Modernize our National Laboratories Act calls out for the Office of Science as the specific recipient of at least one-sixth of the bill's funding.

Dr. RICHMOND. Yes.

Senator HICKENLOOPER. And I certainly—obviously Colorado has a lot of labs, a number of energy labs.

Dr. RICHMOND. It does.

Senator HICKENLOOPER. I am a big fan. But also, I see no reason why other agencies that oversee labs should not also get called out to make sure that we integrate and allocate properly all the funding for research and that we are getting the maximum benefit and synergy by that integrated funding. So do you see any harm in requiring minimum amounts of funding for other DOE agencies in addition to the Office of Science?

Dr. RICHMOND. You know, this is an important issue because right now we need to be—in my mind, there is a lot of interesting research going on right now, but there are also some really urgent things that we need to do, and the Office of Science has a big role, but so do the applied labs, like in your state with NREL. And so I do not, we would have to go, I mean, I have to—just getting started with this, I need to understand whether there is—what the min-

imum should be, but all I can say is we need to have all the labs, whatever funding can permit, to be able to do what they need to get done in order to work through these fundamental and applied issues as we go to the deployment.

Senator HICKENLOOPER. I couldn't agree more, but I will keep following it because I do think that we have to figure out how we are going to integrate and coordinate all the different funding that we do through the Federal Government.

Dr. RICHMOND. Yes.

Senator HICKENLOOPER. I was pleased to see the inclusion of the emerging biological threat preparedness research initiative within the Office of Science in the DOE Science for the Future Act. I think this is exactly what pandemic preparedness is all about, something I have certainly been speaking about for close to a year now. If this bill is enacted, how will DOE prioritize the initiative and work with private sector researchers on the R&D efforts?

Dr. RICHMOND. Well, you know, they have already made contacts with industry. So, for example, let me give you a good example, and that is, do you realize that for most all drugs that are commercially created, put out on the market, they have to have an X-ray structure of the crystal structure of it, right? Where are they going to do that? Right? Where are you going to do that? You have to do that at a DOE light source. Who else has a light source? NIH doesn't have a light source. We have the light sources, right? Right?

Senator HICKENLOOPER. Sure.

Dr. RICHMOND. So when you think about the fact that we have already been connecting with companies in that area, in addition to the COVID-related issues, which they are continuing to work on now, but it is really, you know, what I find really exciting, since I have been around a while, so when I reflect back on the Office of Science when I was chair of BESAC many years ago, it was sort of, "ooh, got to stay away from the biological stuff because NIH does that stuff." And although you could tinker in it, there was a fear that that would be looked at as a redundancy, when actually, it is a true partnership today with regards to working with other agencies through the BRaVE initiative as well as with companies. And the sense of the freedom that I see now of the Office of Science being willing and happy to start working with industry in order to help them along as well as get the ideas of what discoveries still need to be done is a transformation that, again, I welcome and I have been so happy to see that in my few months that I have been on the post.

Senator HICKENLOOPER. Great. Perfect.

If you talk to almost any lead researcher in basic science today, they will tell you—or at least they tell me—that too much of their time is occupied with paperwork—filling out forms, not the research aspect. I have heard concerns from both university institutions in Colorado and other states, but as well in some of the agency labs that the research security requirements in this bill that we are talking about could add to that requirement of time substantially. And I think we do have to balance our need for security with freeing up our scientists to do what they do best, which is think, discuss, and innovate. So would DOE support taking a more holis-

tic interagency approach to this overall topic so that we could maybe streamline some of what the reporting requirements are?

Dr. RICHMOND. Well, that is exactly where we are going. That is exactly where we are going because we cannot afford to have people wasting their talent on the fact that this agency does something different than this agency does and this agency. Now, most people that are funded to do their science cannot survive on one grant. They have two or three. In my program, I always had two or three. And there is paperwork associated with each of those and there are rules associated with each of those. And so now with the security issues, you also have to have practices in place that are different for all three. It is not going to work and people are going to figure out how to get through, you know, wiggle their way through the, you know, the lowest barrier. So I think it is really important that the agencies are working together, and that is what we are doing, is trying to work across agencies.

As you may recall, I served on the National Science Board, before I took this position, for ten years, and they understand this issue too.

Senator HICKENLOOPER. Right.

Dr. RICHMOND. Absolutely.

Senator HICKENLOOPER. Well, if we can be of any help, obviously, I think I speak for many senators when I say that we would work diligently to try and systematize and integrate all those reporting requirements.

Dr. RICHMOND. We will take your help. We will take your help because it really does need to be agency-wide. It needs to be agency-wide.

Senator HICKENLOOPER. Thank you. I yield.

Senator BARRASSO. Thank you.

Senator Lankford.

Senator LANKFORD. Senator Barrasso, thank you. I do want to associate myself as well with the opening comments that you and the Chairman both made today on our energy and our responsibility and what's happening in Ukraine right now and to Europe. They are in need of energy resources quickly, and I know while there have been comments of some to say let's do some work so that we can provide resources for them in the next 10 to 15 years, they cannot wait for the next 10 to 15 years. They need some help right now. And so if there is research in ways—if there are permitting changes that can be done to be able to increase the capacity for the United States to be able to provide energy there, that would be very, very helpful.

I also wanted to be able to say there are several good bills that are in this dialogue today, but one of them is just what I would affectionately call a nuisance bill. It is a bill where Congress wrote up whistleblower protections for the Department of Energy and the Nuclear Regulatory Commission. We thought we made it pretty clear, and some creative attorneys are now reinterpreting it and saying no, the whistleblower protections are not the same in that. And so we are providing clarity to be able to make sure there are whistleblower protections there in the way the text is actually written to make it very, very clear that this is what we intended to be able to provide. And so we are working our way through that.

Dr. RICHMOND. Well, that is great. That is great to hear—

Senator LANKFORD. Glad to be able to get that. Glad to be able to get that.

Senator Barrasso made a comment as well earlier, just about the lack of variety in locations for investment. There is a bill obviously that we are dealing with today as well that says not less than 10 percent of the research funding goes to the set of states where they get very little research funding in the days ahead. My concern is that that becomes a ceiling rather than a floor. And so I would only encourage us, as we get this implemented, to be able to make sure it doesn't become that no more than 10 percent goes to those states and the other 90 percent will get it since the vast majority of these other institutions get it.

My question to you really is to be able to follow up on some of the things that Senator Barrasso was talking about as well. I mean, that is the actual advisory committees and the selection groups that actually select where grants are going to go. It seems interesting to me that there seems to be, in many of these selection groups for grants, a group of folks that, let's say, eight of the ten of them graduated from Harvard or Berkeley or wherever it may be and Stanford, and then amazingly, the research grant goes to that university as well, disproportionately. And so it ends up, I understand, they have a loyalty where they came from. They have a lot of relationships with faculty there and they trust the research that is coming out of there, but we have to find not only ways to be able to increase variety in the advisory groups, but also increase variety in the actual selection of where grant dollars go and how we are actually investing those dollars, not just the state that they are from, because we may have a variety of states.

Dr. RICHMOND. Yes.

Senator LANKFORD. But the same institutions end up getting the investment research dollars over and over again when there are other institutions around the country that also have creative ideas, and as you know very well from science, there is a great benefit to getting new ideas into the mix rather than the same group circling around the same research again.

Dr. RICHMOND. Thank you, Senator Lankford, for those comments because they are very thoughtful. Let me say just a few things about that. The advisory boards themselves, they are not really so intimately involved in making the decisions about where the grants go, that really falls on the program officer getting reviews from a contingent of reviewers.

Senator LANKFORD. Right.

Dr. RICHMOND. And those, I have to say, that those reviewers are usually from quite a diverse group of institutions. And the Office of Science works very hard at that. The National Science Foundation works very hard at that too.

Getting enough reviewers to do all this work is always a challenge. And so what I recommend when I go visit smaller institutions that have less research, what I recommend is to have faculty in those other institutions volunteer to be on those committees because the program officer is delighted to see someone volunteer because that is where you learn how the process works. That is how you could put input on other institutions like yourself. So it is real-

ly one where we have to make sure that—and I do believe that we are doing a good job of that. It is just that even if you have people on the committee that are from a wide distribution of institutions, you know, they are going to see a place like MIT and say “woo hoo,” and versus you know, another institution. So they have to not have biases that way too.

Senator LANKFORD. Right.

Dr. RICHMOND. And so you increasingly are seeing agencies, including the DOE, talk about not only conflict of interest, so you have to declare any conflict of interest—

Senator LANKFORD. Right.

Dr. RICHMOND [continuing]. But also get away from these biases that are so inherent in what we are doing. Now, can I tell you one more thing? And that is that what is amazing is that we recently did a study with regard to mentorship of graduate students in chemistry of the top hundred chemistry departments in the country. What is the quality of mentoring of your graduate students that is done there? Broke it up into the top ten rated by how much money they get and so forth. So who do you think got rated the worst in terms of mentorship? Top ten.

So we need to have a way, and that then goes to retention. So we need to have a way, and this is what I am really working on, we need to have a way for universities to report what their retention rate is of their graduate students and the demographics of those graduate students so we can identify which institutions are doing the best job at mentoring students. The ones that are up here—50 to 100—are doing a much better job.

Senator LANKFORD. Right.

Dr. RICHMOND. Smaller groups, more attention. Now, that is just for chemistry, but I think it is things like that we need to put into place to have those that are in the other, you know, rated higher, rated, you know, you know, lower, you know, the number, that they get recognized for really putting out good students and mentoring them because that is the retention that is going to fuel what we are doing.

Senator LANKFORD. Right. That is why I raised the issue on the advisory committees and the selection groups, because what I want to follow up on is what Senator Barrasso was saying. The advisory committees are important, but if it is the same group of folks making the selections over and over again, they are going to return grants back to the same locations where they have relationships—they visited it, they were there last year to be able to see what happened, they talked to those folks that were there last year, and they know they are doing good work and so they continue to accelerate dollars there. You are right. There is good work going on in lots of other places. They just don't know it. And so it is expanding that, whether that is creating rotations, whether that is creating term limits for those individuals, they can only do it for X number of years. And I have talked to folks in the research area, and they say well, we cannot do that because there is a limited number of people, but there are folks all around the country, it is just a matter of recruiting them and knowing that there is going to be an opening and getting more faculty to be able to step up and be able to volunteer to be able to engage with it.

I agree with both. I am just saying it is putting in the structure to be able to make sure that we do break this cycle.

Dr. RICHMOND. Yes.

Senator LANKFORD. To look at more research in more places.

Dr. RICHMOND. Yes, but I do think that in the Office of Science we do work very hard at that. I mean, I have been down here and now up here and so I have seen things go through. Everything can be improved. You can always improve things. But on the other hand, I feel very good about the commitment of the program officers that I have worked with over the years to really put together a diverse team of reviewers, and it is also age, right? Because the younger people that get on those review panels, they learn how the system works, right? And so even the age demographics are really important.

Senator LANKFORD. Thank you.

Senator BARRASSO. Senator Kelly.

Senator KELLY. Thank you, Mr. Chairman, and thank you for holding this hearing today. Dr. Richmond, thank you for testifying.

Today, as you know, we are facing a serious microchip shortage all across the country—the planet, in fact. At the same time, China is working very hard to outcompete American leadership in microchip research and development. To address these challenges, I worked with Republicans and Democrats to negotiate a \$52 billion plan to boost American microchip manufacturing. This plan passed both the Senate and the House and is headed to conference, which is a good thing. But I believe we have to do more, including within DOE, we must ensure that the next generation of microchips are designed and manufactured right here in the United States, not somewhere else. And if anyone can engineer a solution to the challenge of continuing to fit more circuits on a chip, I am confident that it is going to be American scientists and American engineers. And I understand that DOE National Laboratories have existing microelectronics research programs, but they do not have explicit authorization from Congress, and I am working on a bill to fix that. My bill would also promote workforce training and technology transfer programs at DOE. I encourage the Administration to support my bill once it is introduced.

Dr. Richmond, how could Congressional authorization for microelectronics research and development programs at the Department of Energy support and accelerate work already being done by the Department?

Dr. RICHMOND. Well, thank you, Senator, for that question because that is a biggie, and that is an important one, and it is urgent. It is urgent. You know, for decades the Department of Energy has been on the leading edge of microelectronics, both as a consumer as well as an engine of scientific discovery in this area. And DOE supports a robust research portfolio on issues at their scientific facilities, as well as chemical, physical, mathematical, computer science—all of these areas in modeling and simulations. We have been on the forefront there. But we need to have more funding in order to make this happen.

So you know, when you talk about in areas of—because it's the whole range—it's materials science, it's chemistry, it's processing, it's fabrication. And it goes all the way from the very fundamental

research to actually putting it in your computer or whatever, your phone or whatever it is and that is what the laboratories have in place right now. It is a matter of being able to fuel that with more funding, but smart funding. Smart funding that really goes after the key issues that we have to get at in order to pack more stuff on that chip. But you know, there is something that is so important to understand with regards to microelectronics, and you probably understand this, and that is there are no longer microelectronics, like micron-size, they are nanoelectronics, right?

Senator KELLY. Right.

Dr. RICHMOND. And so you are talking about, you know, if you are going to put this roadmap on your chip, you know and pack stuff in there, that you have to be working on this teeny tiny scale. So how are you going to do etching? How are you going to do all of this is if you do not have the tools to be able to figure out whether you are doing it and what it looks like after you did it? And so what is really cool in this particular area is our big light source facilities, for example. They are able to see what your “etch” looks like. They are able to then—and so the companies go in and can test some procedure in order to do their chip. Then they can go to the facility, check out what happened, and go back and forth with the facility. There is no place else that you can do that but at the DOE labs.

But in this case, it just means being able to have more collaborative efforts with industry because having a consortia of industry would work really well that way. And so beefing that up too, because they, you know, they are coming in to use the facilities, and having staffing to be able to help them with it. So there is just a lot of stuff going on for testbeds as well as taking it all the way. It is—

Senator KELLY. Well, yes, we want to fix that. And we want to make sure that we are not going to be testing our chips over in China as well.

Dr. RICHMOND. You bet.

Senator KELLY. And, I mean, I do not think folks realize this but the chip in this phone, it is a square centimeter, two and a half billion transistors on it—two and a half billion. We need to get that to five billion, but it needs to be made here in the United States.

Dr. RICHMOND. Yes.

Senator KELLY. Not somewhere else, and that is why the CHIPS Act and, you know, the legislation just making us more competitive with China is going to go a long way to bringing a lot of this manufacturing capability back to the United States. We have to get this across the finish line. We have TSMC—the Taiwan Semiconductor Manufacturing Company—building right now a fabrication facility in Arizona. Intel is building two that are going to be underway soon. And this is going to help us get back toward—might not get us the whole way—but we went from 40 percent of chip production, global supply of chips that we manufacture, down to about 12 percent today. We have to reverse that. But more than that, we have to be making the best chips in the world.

Dr. RICHMOND. And we have to be on the innovation front in terms of the next stage. What is the next stage and can we beat everybody else to it? And what does concern me is that in China

you have all these—so we have our laboratories and they are aging, right? And we need the infrastructure to build them up because China is building all new laboratories, modeled after ours, including our light sources and other facilities, and they are all going to be brand new. So it is going to take a bit to build it, but you know, we have to be competitive. Our capabilities and our laboratories have to be competitive and stay competitive in order to be ahead all the time.

Senator KELLY. And then, Dr. Richmond, then we need the scientists and engineers to work in these facilities. So we need to encourage STEM education starting at a very young age and help young people get the education they need for these good-paying jobs.

Dr. RICHMOND. Absolutely true, but we need to do something else, too, and that is that we need to make sure that going into graduate programs, they can afford to go to graduate school. So right now, graduate stipends that we offer are basically minimum wage. I just saw Target saying it is going to pay 25 bucks an hour to work at Target. That is more than we are paying our graduate students in their 20's doing the best research in the world, and we are asking them to work 80 hours a week making basically minimum wage. We have to get those stipends across and through all agencies up to at least 45K a year. We have to do that. And it is particularly important for our underrepresented minority students because a lot of times they come to graduate school with debt and they cannot afford to stay in graduate school. The retention rate is much lower for them and for women too.

And so we have to figure out how to keep them in there, but also pay them a decent wage so that they can spend their 20's maybe saving a little bit of money, or maybe having a couple of kids too, you know, like normal in your 20's because you can afford to do that. So I am just passionate about that issue, too, because I think we just cannot afford to do this anymore.

Senator KELLY. Well, thank you, and I yield back the two minutes extra I took.

Senator BARRASSO. Thank you very much, Senator Kelly. And thank you, Dr. Richmond. We are very grateful for your time and the excitement that you bring to the office. The enthusiasm is notable and appreciated.

Members are going to have until the close of business tomorrow to submit additional questions for the record. And if there is nothing else, this Committee stands adjourned.

[Whereupon, at 11:20 a.m., the hearing was adjourned.]

**APPENDIX MATERIAL SUBMITTED**

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QUESTIONS FROM RANKING MEMBER JOHN BARRASSO

- Q1. Advanced nuclear reactors need a specific type of fuel, high-assay, low-enriched uranium (HALEU). Currently, Russia and the Department of Energy are the only two sources of HALEU. Unless the Department acts swiftly, our advanced reactors will be dependent on Russia. Would it be helpful if the Department had authority to use the money remaining in the U. S. Enrichment Corporation Fund for this purpose?
- A1. As a result of the U.S. Enrichment Corporation (USEC) Privatization Act (42 U.S.C. § 2297h-2(e)) and Pub. L. No. 105-204, 112 Stat. 681, July 21, 1998, the USEC Fund is authorized only for two uses: (1) environmental cleanup expenses pursuant to Pub. L. No. 105-204, 112 Stat. 681, July 21, 1998, and (2) "expenses of privatization" pursuant to the USEC Privatization Act. Any use, other than expenses of privatization, would require Congressional appropriations, as was done in Fiscal Year (FY) 2021 and FY 2022 when Congress transferred \$291 million and \$841 million, respectively, of collections in the USEC Fund to the Uranium Enrichment Decontamination and Decommissioning Fund for its authorized purposes including cleanup of plants at Portsmouth, Ohio and Paducah, Kentucky. The FY 2023 President's Budget requests an additional \$405 million transfer for the cleanup of the plants and \$123 million for disposition of depleted uranium hexafluoride at those two sites, which would leave an estimated balance of \$83 million in the USEC Fund. The Russian invasion of Ukraine adds to the urgency for domestic production of HALEU. The FY 2023 Budget proposes funding for various activities to support implementation of the HALEU Availability Program and promote investment in nuclear supply chain infrastructure and capabilities.
- Q2. According to the Department, there are over 5,700 citizens of the People's Republic of China working at our National Labs. Is there any evidence to suggest that the Chinese government allows its citizens to work at our National Labs without its prior knowledge or consent?
- A2. The Department of Energy (DOE) is not aware of any evidence suggesting that the People's Republic of China (PRC) requires its citizens to alert them or seek their consent before working at DOE National Labs. While the PRC has the ability to require cooperation from its citizens, it has primarily utilized incentives, such as financial support mechanisms, to improve its domestic talent pool. These include government-sponsored talent programs and fellowships to incentivize return to the PRC from overseas talent, and scholarships to enable Chinese nationals to pursue education and conduct research abroad, which in some cases require recipients to provide regular updates on their activities. To manage and

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mitigate risks to DOE National Lab R&D that these programs may present, DOE employees and contractor personnel are prohibited from participating in foreign government-sponsored talent recruitment programs and restricts other Foreign Government Sponsored or Affiliated Activities associated with foreign countries of risk, which includes the PRC (see DOE Order 486.1A). Furthermore, the Department has established clear requirements for unclassified foreign national access to DOE sites, which includes a risk-based review and approval process that is consistent with U.S. law, as well as a process for documenting and tracking access by all foreign nationals to DOE sites or involving access to DOE information or technologies (DOE Order 142.3B).

- Q3. What is the Office of Science doing to include more members from universities in EPSCoR states on its advisory committees?
- A3. The Office of Science (SC) pursues opportunities for diversity, equity, inclusion, and accessibility in the membership of the Department's Federal advisory committees to which SC provides primary support, such as diversity in work sector and representation of traditionally under-represented groups. These factors are carefully considered to achieve fairly balanced membership in terms of the points of view represented and the functions to be performed by the advisory committee. Members provide a breadth of representation and expertise across the disciplines and subdisciplines relevant to the mission and function of each advisory committee. Other factors considered for committee membership include the geographical region of the U.S. represented by each member (including members from institutions in EPSCoR states), career stage, and gender. SC Advisory Committee Membership increased from 129 members to 157 members in the past two years to address a number of diversity criteria, including geographical distribution and EPSCoR states representation. As of 2021, all SC advisory committees have EPSCoR representation. For example, members from EPSCoR states increased from two to five on BESAC's recent membership package.

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QUESTIONS FROM SENATOR JAMES E. RISCH

- Q1. Ms. Richmond, it appears that the Department continues to advocate for the CESER office to be led by a career civil servant, rather than nominate someone. I remain concerned that the Department is sending the message to our adversaries, the energy sector, and other federal agencies with cyber responsibilities that DOE does not consider cybersecurity and emergency response a priority anymore. This is especially concerning right now given Russia's cyber capabilities and history of disrupting critical infrastructure. At the Department and within the interagency, does a career civil servant have the same decision-making authority that an Assistant Secretary, Under Secretary or other political appointee has?
- A1. Cybersecurity and emergency response capabilities are of the utmost priority for the Department of Energy. Career civil servants serving as the highest-ranking official in charge of a Department of Energy Office or Directorate have the same decision-making authority as that of a politically appointed Assistant Secretary to effectively manage their offices and lead the Department's work within their mission areas, including coordination with other federal agencies, private-sector partners, and international allies. Moreover, a non-political Director ensures that continuous nonpartisan leadership can provide a consistent relationship for these critical partners.
- Q2. Do the career civil servants at CESER have the authority to make decisions on behalf of the Department when engaging with other federal cyber response agencies like the Department of Homeland Security?
- A2. Yes. As Director and highest-ranking official leading the Office of Cybersecurity, Energy Security, and Emergency Response, Puesh Kumar, a career civil servant, has the authority to represent the Department and make decisions within his delegated authority in inter-agency engagements.
- Q3. Is the Acting Principal Deputy Assistant Secretary for CESER present in weekly or regularly scheduled briefings and meetings with Secretary Granholm and other political appointees at the Department?
- A3. Yes. CESER Director, Puesh Kumar, attends regular meetings with Department of Energy leadership, including Secretary Granholm, Deputy Secretary Turk, and other political appointees.
- Q4. The Department contends that CESER should not be led by an assistant secretary to ensure continuity from one Administration to another. Is it the Department's belief that offices with an assistant secretary, like the Office of Energy Efficiency and Renewable Energy, does not have continuity when there is a change in presidential administration?
- A4. CESER plays a vital role in the DOE's efforts to secure and protect the Nation's critical energy infrastructure from all threats and hazards. As the office responsible for executing DOE's risk

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management, preparedness, and emergency response capabilities for the U.S energy sector, CESER's mission and functions should be led with consistent, nonpartisan, experienced senior executive leaders. To ensure the long-term success of the office, DOE is committed to hiring strong career staff who have both the subject matter expertise and relationships with the sector that can span multiple Administrations.

CESER has strengthened its leadership team with a new senior career energy and cybersecurity expert in Director Puesh Kumar. Director Kumar has public and private sector energy experience and is a recognized expert in the industry. With this background, Mr. Kumar brings unique expertise to DOE and is exhibiting his strengths in advising DOE leadership on energy and cyber security and guiding the Department in tackling the evolving risks and threats facing the energy sector. When it comes to responding to threats to our nation's energy systems, the need for continuity and consistent leadership is absolutely critical.

- Q5. Can career civil servants remain in their roles at the Department when there is an Administration change?
- A5. Yes. Career Civil Servants are not political appointees and continue in their roles when there is a change in Administration to ensure continuity in the availability of their valuable subject matter expertise for the new incoming team. They are however subject to discipline, up to and including removal, for misconduct or unacceptable job performance or subject to a reduction-in-force due to agency reorganizations, lack of work, or shortage of funds. Civil servants also have certain procedural rights under the law and OPM regulations before such actions may be taken.
- Q6. Ms. Richmond, the Department of Energy's national lab system is the envy of the scientific world. Many facilities at the labs are aging and in need of rehabilitation and other infrastructure improvements. These improvements are critical to ensure that the labs can continue to lead the world in scientific discoveries and meet their many missions. Do you agree that it is important to address the deferred maintenance needs across the entire national laboratory complex, including the applied energy laboratories?
- A6. The DOE agrees that addressing deferred maintenance needs across the DOE National Laboratory complex is critical to our success and ensuring our competitive posture in the scientific world. Over the past few years, we have gone to great lengths to conduct condition assessments of our infrastructure and

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are systematically developing projects to address the challenge in a methodical approach, leveraging our general-purpose project investments to improve our infrastructure and to reduce deferred maintenance. The key issue for deferred maintenance is aging facilities that have exceeded their normal life cycle. Such facilities are expensive to maintain and operate and can fail, unexpectedly interrupting operations. Aging utility systems, especially potable and non-potable water, steam, electrical and storm/sewer systems, are of particular concern. Continued funding in the DOE National Laboratory complex to modernize existing facilities and replace them as appropriate reduces maintenance costs, the deferred maintenance backlog, and operating and utility costs while increasing functionality, reliability, and resilience.

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QUESTIONS FROM SENATOR STEVE DAINES

- Q1. Dr. Richmond, given ongoing Russian aggression and cyber threats, what is the Department doing to create resilience against cyber-attacks for the energy sector and at its facilities? Do any of the bills discussed today help bolster DOE's role in protecting the energy sector from cyber-attacks?
- A1. As the Sector Risk Management Agency (SRMA) for the energy sector and coordinating agency for Emergency Support Function (ESF) #12, the Department of Energy (DOE) has been working closely with industry and government partners to provide awareness of ongoing geopolitical tensions in Eastern Europe and ensure preparedness for any potential related threats to the homeland. DOE has proactively recommended that the energy sector prepare to the highest possible level for potential Russia-linked cyber and disinformation activity or cybercriminal activity from actors seeking to exploit the ongoing geopolitical situation.

DOE's Office of Cybersecurity, Energy Security, and Emergency Response (CESER) manages DOE's SRMA and ESF #12 responsibilities, maintaining regular contact with the three energy sector information sharing and analysis centers (ISAC) – the Electricity ISAC (E-ISAC), Downstream Natural Gas ISAC (DNG-ISAC), and the Oil and Natural Gas ISAC (ONG-ISAC) – to ensure the distribution of timely, actionable information.

In December 2021, DOE, in partnership with industry, hosted a technical workshop on criminal ransomware activity and cyber tactics used by Russia in the 2015 and 2016 Ukraine cyber-attacks. More than 500 electricity, oil, and natural gas companies participated.

In 2022, DOE issued cybersecurity guidance specific to the energy sector, hosted threat briefings for industry partners, and released a DOE product with suggested mitigations to help energy sector entities evaluate the risk to their systems from identified threat vectors. In addition, the Secretary of Energy distributed a letter to thousands of industry partners, urging them to review the guidance and take the "Shields Up" actions recommended by the Cybersecurity and Infrastructure Security Agency (CISA) and DOE.

DOE continues to monitor for cyber threats to U.S. energy infrastructure both through sensor

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technologies and intelligence channels.

Regarding efforts to secure DOE facilities, in late January 2022, DOE's Chief Information Officer (CIO) Ann Dunkin and Chief Information Security Officer (CISO) Greg Sisson began communicating with information technology (IT) and cybersecurity senior leaders across the Department about the high likelihood that malicious actors will attempt to use activities in Ukraine as phishing campaign themes and attempt to spoof legitimate domains and users. The Deputy Secretary also notified DOE personnel to be vigilant and warned that any communication from the region or with a subject title related to the ongoing regional activities should be considered suspicious until verified.

DOE has a decentralized cybersecurity program that provides significant guidance while still enabling heads of department elements to assess risk according to their mission and implement defensive measures accordingly. At the department level, we took several immediate actions to heighten awareness and alerting:

- Used all available methods to scan for indicators and threats and sharing across the Department.
- Partnered with CISA and the intelligence community to understand the latest threats and mitigation measures available and sharing those across the Department.
- Provided relevant input to the DOE Emergency Operations Center (EOC) daily update urging leaders to review incident response plans, recall rosters and cybersecurity manning considering recent cybersecurity threats and the potential for increased attacks.

As federal members of the utility sector, DOE's Power Marketing Administrations (PMA) are required to meet both the cyber security standards in Federal Information Security Modernization Act (FISMA), as well as the North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection standards. This compliance is subject to regular audit and oversight, including NERC compliance and enforcement.

The PMAs participate in Electricity Sector Coordinating Council (ESCC) and are part of the ongoing public-private sector efforts across the ESF #12 community to ensure unity of effort and information sharing in preparation for potential adversarial activity against domestic critical infrastructure. In

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addition, the PMAs receive analysis, support, and timely information from DOE's Office of Intelligence, the E-ISAC, CISA, and the Federal Bureau of Investigation (FBI).

The Department and the PMAs will remain focused and prepared to rapidly act on any new cybersecurity threat information related to the Ukraine crisis.

- Q2. Dr. Richmond, recent legislation required DOE to submit to Congress a report related enumerating the total amount of direct and indirect jobs lost due to President Biden's executive order canceling the Keystone XL Pipeline. That report is now overdue and has not been sent to Congress in the required timeline. The same legislation that required the Keystone XL Pipeline Job Losses report also required DOE to provide a number of other reports to Congress. Further, some of the bills on today's agenda also require annual or one-time reports to Congress. What are the outstanding congressionally mandated DOE led reports that have missed the deadline for transmission to Congress and will you commit to ensuring that DOE does not miss report deadlines in the future?
- A2. The Department of Energy conducts analysis and studies in support of all directed reports to Congress. As directed by the Bipartisan Infrastructure Law, the report on the job loss and impacts on consumer energy costs related to the Keystone XL (KXL) pipeline is under final review and near completion.
- Q3. Dr. Richmond, Montana is becoming a hub for quantum computing and photonics research, development and commercializing. How does S.3699 affect DOE's ability to support and bolster quantum computing in Montana?
- A3. S.3699 would authorize DOE to augment its existing QIS investments in a manner that would benefit, and broaden, the QIS research community across the United States, including the quantum computing communities in Montana. Quantum information science (QIS) spans the technical breadth of the Office of Science (SC), and SC Programs invest in quantum R&D within their mission scope, which span areas such as high-end computing to chemistry and materials, high-energy, nuclear and fusion physics, and biological and environmental research. The wide range of SC's mission areas are reflected in the diversity and scope of quantum R&D projects that focus on key topics in basic research in materials and photonics, quantum sensing, computing and networking as well as exploration of quantum technologies application space.
- Q4. Dr. Richmond, Montana State University and the University of Arkansas recently partnered together to establish the MonArk Quantum Foundry to accelerate the development of quantum materials and

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devices. If S.3699 or H.R.3593 were to be signed into law, how would that affect programs like MonArk Quantum Foundry?

- A4. Since FY 2017, DOE's Office of Science (SC) has been increasing its investments in a diverse portfolio of quantum information science (QIS) research. For instance, in FY 2020, SC launched the National QIS Research Centers program, an investment of \$575 million over five years, with a portfolio of research topics across QIS and QIS-inspired areas including co-designing algorithms, developing quantum materials and devices and engineering solutions to deliver quantum advantage in scientific applications. Montana State University is a partner in the Co-design Center for Quantum Advantage (C2QA), led by Brookhaven National Laboratory. S.3699 or H.R.3593 would authorize DOE to continue contributing to the Nation's leadership in QIS and technology by expanding our investments in basic research, fully supporting the National QIS Research Centers and fostering coordination and collaboration within the cohesive U.S. government QIS effort.
- Q5. Dr. Richmond, what is the Office of Science doing to work with states, like Montana, who are seeking to build and invest in advanced nuclear power? If S.3428 were enacted, will you commit to working with interested parties in Montana to deploy advanced nuclear energy?
- A5. The development of advanced nuclear reactors is a priority for re-establishing U.S. leadership in the nuclear industry. The Department of Energy's Office of Nuclear Energy is responsible for the research, development, and demonstration of advanced nuclear reactor technologies. In this regard, the Office of Nuclear Energy engages with communities and parties interested in nuclear energy, including community representatives in Montana, as appropriate. If enacted, S.3428 would authorize a program by which the Office of Nuclear Energy can make competitive awards to communities around the United States, including in Montana, that are interested in hosting advanced nuclear energy projects.
- Q6. Dr. Richmond, how does the research and development funding contained in S.3699 contribute to the viability and readiness of future nuclear power projects in the United States, particularly in Montana and the western United States as a whole?
- A6. Section 3(d) of S.3699, which discusses "Foundational Nuclear Science," could authorize additional support to advance basic science focused on nuclear materials science, computation, electrochemistry, and instrumentation research for the advanced nuclear technologies of the future.

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Q7. Dr. Richmond, how does S.3699 affect the research and development of advanced hydropower, pumped hydro storage, and in-stream hydrokinetic energy?

A7. The bill includes provisions to support interdisciplinary research to significantly advance our understanding of water availability, quality, and the impact of human activity and a changing climate on urban and rural watershed systems. In addition to power generation, some multi-purpose hydropower projects perform a key role in consumptive water supply, irrigation, and flood control. The impacts of climate change are expected to significantly alter the hydrologic cycle particularly with respect to water availability. Therefore, water system foundational research is important for the future development of advanced hydropower systems that can continue to meet energy demands while contributing to water system resiliency.

Applied research and development for advanced hydropower, pumped storage, and in-stream hydrokinetic systems can also be enhanced by other foundational work the Office of Science supports. The provisions in the bill for fundamental biological research, advanced computing, new materials, and climate science can support valuable scientific advances for use by applied researchers and other members of the hydropower community.

Q8. Dr. Richmond, does any of the funding/authorizations in these bills allow DOE to advocate, promote, or study the removal of hydroelectric dams?

A8. The bills S.3699, S. 3428, S. 2733, S. 2896, S. 2232, S. 2302, and H.R. 3119 do not include any provisions relating to advocating, promoting, or studying the removal of hydroelectric dams.

Q9. Dr. Richmond, what safeguards is the Office of Science employing to ensure that sensitive research and development is secure from intellectual theft by foreign actors within or outside of the United States?

A9. The DOE, including the DOE Office of Science (SC), is employing several research security measures to safeguard sensitive R&D from intellectual property theft by foreign actors while maintaining an open, collaborative, and world-leading enterprise. Within the DOE, SC has established an agency-wide body to coordinate issues related to research security and have instituted policies to manage security risks. These policies include prohibiting Federal and DOE National Laboratory personnel from participating in foreign government sponsored talent recruitment programs and restricting participation in other foreign government sponsored or affiliated activities from certain countries (DOE Order 486.1A), developing a

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risk-based review, approval, and monitoring process for foreign national access to the DOE National Labs (DOE Order 142.3B), and centralizing oversight of international engagements undertaken by each National Laboratory. In addition, SC utilizes a Science and Technology Risk Matrix to manage risks associated with critical and emerging technologies that do not otherwise have control mechanisms.

Furthermore, SC continues to work closely with other science and security agencies to develop a clear and consistent approach to research security. For instance, DOE co-chairs the National Science and Technology Council (NSTC) Subcommittee on Research Security to ensure a coordinated interagency approach to implementing National Security Presidential Memorandum-33 on United States Government-Supported Research and Development National Security Policy. In addition, DOE continues to engage with allies and partners through State Department-led efforts to exchange information on experiences and best practices on research security.

- Q10. Dr. Richmond, how would S.3699 help reduce U.S. dependence on foreign countries for critical minerals and other critical materials?
- A10. In the wake of Russia's further invasion of Ukraine, it has become clear that the U.S. must reduce its dependence on foreign suppliers of critical materials, including uranium and other radioisotopes. S.3699 would allow the DOE's Office of Science (SC) to continue to support foundational theoretical and experimental science related to understanding unique chemistry and materials properties associated with rare-earth elements (REE), substitution for platinum group element (PGE) catalysts, and novel battery materials and chemistries, among other critical materials. This fundamental work provides the foundations for robust and reliable domestic supply chains for key energy technologies, reducing reliance on foreign sources. Another important emphasis area is advancing geoscience and separation science to enhance the extraction and chemical processing of critical elements. Integration of the related fields of synthesis, characterization, predictive theory/modeling, and data science will advance understanding of the role of REE, PGE, and other critical elements in the determination of the properties of functional materials such as magnets and catalysts, and on the use of such knowledge to reduce, eliminate, or find substitutes for critical materials in energy-relevant technologies. DOE also operates major x-ray, neutron, nanoscience, and high-performance computing user facilities that provide

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advanced synthesis, fabrication, characterization, and computational capabilities to this community for basic, applied, and industrial research.

Q11. Dr. Richmond, how is the DOE working with states and organizations to identify, diagnose, fund, and alleviate infrastructure deficiencies in science laboratories?

A11. The Department of Energy (DOE) including DOE's Office of Science (SC) takes its stewardship responsibility very seriously and has programs in place to identify, diagnose, fund and alleviate infrastructure deficiencies in the ten SC DOE National Laboratories. In addition, when possible, DOE uses its strong partnerships with other Federal agencies, states and local communities to leverage investments and funding through those organizations to construct and upgrade modern research and support facilities at our laboratories. Some examples are listed below. The State of New York has provided investments at Brookhaven National Laboratory (BNL) in the National Synchrotron Light Source II and BNL Discovery Park. Similarly, Stanford University has invested at SLAC National Accelerator Laboratory in new buildings like the Arrillaga Science Center, beamline expansion and a new micro-fab manufacturing capability. The State of Tennessee has funded construction of 3 buildings at Oak Ridge National laboratory (ORNL): Joint Institute for Computational Sciences, Joint Institute for Biological Sciences, and Joint Institute for Neutron Sciences. The State of California contributed to construction of Chu Hall Solar Research Center at Lawrence Berkeley National Laboratory (LBNL). The State of Washington provided research equipment at Pacific Northwest National Laboratory (PNNL) for the Energy Sciences Center, the Grid Storage Launchpad facility, and the Battery Energy Storage Systems. The State of Illinois has provided funds for various facilities at Argonne National Laboratory (ANL) including: the Argonne Guest House, the Center for Nanoscale Materials, the Advanced Protein Characterization Facility, and the Energy Innovation Center.

Q12. Dr. Richmond, what groups does the Office of Science classify as "underrepresented" in fields relevant to the mission of the Department?

A12. The DOE's Office of Science (SC) considers "underrepresented" a relative term and depends on knowing an appropriate baseline for comparison relative to the particular focus or goal of a program's efforts. Individuals from particular demographic groups may be underrepresented in physics at the undergraduate level but not underrepresented in biology. Likewise, individuals from a particular

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demographic group may not be underrepresented at the undergraduate level in a particular field but are underrepresented when you look at their presence among faculty in that field at academic institutions across the U.S. or in management positions at the DOE National Laboratories or in industry. Similarly, some academic institutions may be classified as a Minority Serving Institution (MSI) because they meet the institutional requirements as accredited, degree granting institutions of higher education with an undergraduate enrollment level above a certain threshold for a particular demographic group but may be among the top U.S. institutions that receive DOE or Federal R&D funding. We need to be very intentional in our efforts to support those individuals and institutions historically underrepresented in the SC research portfolio and use recognized baseline data, such as data sets reported by the National Center for Science and Engineering Statistics' report on *Women, Minorities, and Persons with Disabilities in STEM*, as well as SC's historic application and funding data, to ensure the SC Programs are significantly expanding opportunities for research and STEM training to those underrepresented across its portfolio.

- Q13. Dr. Richmond, what is the Office of Science's methodology when deciding which universities are awarded research and development grants?
- A13. The DOE's Office of Science (SC) follows government-wide regulations in 2 CFR 200.205 requiring that applications be assessed for merit. The details of the Office of Science merit review process were published in the Federal Register (56 FR 10244) and are available at <https://science.osti.gov/grants/Policy-and-Guidance/Merit-Review-System>. Specific merit review criteria and program policy factors are described in every Funding Opportunity Announcement.
- Q14. Dr. Richmond, how much does the Department of Science typically spend on maintenance of user facilities in a fiscal year? What are the leading maintenance activities that influence this cost? If S.3699 and S.2232 were to be signed into law, would DOE be able to eliminate deferred maintenance and fully fund cyclical maintenance in order to keep future maintenance projects from accumulating and becoming deferred?
- A14. The DOE's Office of Science (SC) supports 28 scientific user facilities. Of the annual appropriations in FY 2021, approximately 36% of the total supported the user facilities. For FY 2021, a total of \$2.58 billion of the SC Appropriation funded facility operations, which included support for the staff to run and maintain the facilities and replacement parts. In FY 2021, SC funded approximately \$55M in Direct-Funded Maintenance and Repair and \$264M in Indirect-Funded Maintenance and Repair, which

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included deferred maintenance. To ensure these facilities remain state of the art and on the cutting edge of technology, SC also supports separate line-item construction projects under the science programs to upgrade these facilities.

If SC received appropriations up to the levels authorized by S.3699, the Department would be better positioned to optimally fund operations of the facilities, including maintenance. Additionally, if SC received appropriations up to the levels authorized in S.2232, the Department would be able to address additional deferred maintenance and critical infrastructure projects. Such investments would reduce future maintenance and operations costs, and increase reliability and resilience, for current and planned new facilities, including user facilities. Fully addressing laboratory maintenance needs will depend upon actual annual appropriations and on the evaluation of needs across the complex.

Q15. Dr. Richmond, what agencies, if any, and in what capacities does the Office of Science currently partner with to make use of artificial intelligence technologies?

A15. The DOE's Office of Science (SC) operates some of the most capable high-performance computing (HPC) systems in the Nation, including the 200 petaflop Summit system at Oak Ridge National Laboratory. Summit adds extraordinary power to Artificial Intelligence (AI) applications and is used by other agencies, industry, academia and small businesses for this purpose. Recent projects include National Cancer Institute (NCI) researchers studying mechanisms that trigger cancer and recurrence, National Aeronautics and Space Administration researchers studying massive galactic outflows that seed the Universe with elements important to life, Department of Defense researchers using machine learning to answer questions in extremely complex systems from helicopters to weather, Department of Veterans Affairs researchers looking for genetic links to early onset prostate cancer, and numerous National Science Foundation researchers studying everything from Astrophysics to Proteomics.

In addition, SC has partnered directly with the NCI to support joint research that fosters use of HPC and AI at scale to accelerate cancer cure as part of the whole of government Cancer Moonshot. These efforts spanned the molecular dynamics of cancer mechanisms, cellular response, drug discovery, and population monitoring. Recently, we have been exploring possible new efforts in radiation effects and digital twin technologies.

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- Q16. Dr. Richmond, S.3699 requires DOE to establish a research initiative within the Office of Science to prevent, prepare for, and respond to emerging infectious diseases, including the ongoing Covid-19 pandemic and prohibits gain of function research. What role does DOE's Office of Science currently have in preventing and preparing for emerging infectious diseases?
- A16. The Department of Energy (DOE), including DOE's Office of Science, (SC) has extensive capabilities in biology, chemistry, materials science, and high-performance computing, as well as extensive capabilities at its user facilities, that have supported biomedical research for decades. Examples of these activities include developing sequencing and bioinformatics technologies as part of the Human Genome Project, producing medical isotopes for disease treatment and imaging, and participating in the Cancer Moonshot program, among others. Most recently, DOE established the National Virtual Biotechnology Laboratory (NVBL) to assemble capabilities and expertise across all of DOE's 17 national laboratories to address key technical issues in the fight against COVID-19. Within a few months, the NVBL delivered highly impactful results that provided epidemiological information to decision makers, assessed and developed new virus testing protocols, identified high potential candidates for antiviral drugs, provided information on the fate and transport of the virus in buildings and other enclosed spaces, and delivered manufacturing solutions to stem the shortages of face masks, test kits and other supplies. In addition, SC's user facilities supported researchers from academia, industry, and government in the fight against COVID-19. For example, DOE's X-ray light sources provided structural information that supported the development of all three vaccines approved in the U.S., as well as Federal Drug Administration - approved antiviral drug and antibodies.

The FY 2022 Congressional Budget Request supports initiation of the Biopreparedness Research Virtual Environment (BRaVE), which will both leverage the highly successful framework established by the NVBL and broaden its capabilities to provide a virtual platform to rapidly mobilize DOE's bioscience R&D assets in response to national crises in the future. As such, BRaVE will provide a single portal through which a distributed network of capabilities and scientists across the DOE laboratory complex can work together on multidisciplinary and multiprogram priorities to address future needs in biodefense and emergency response, as well as harness the broad science and technologies capabilities of the DOE Office of Science (SC) to advance the bioeconomy. BRaVE will also serve as a focal point for coordination with researchers in universities and industry, as well as will the interagency during crisis

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events. BRaVE will support and expand biology-related capabilities across DOE's national laboratories in key areas, such as computation and AI/ML-enabled models and data analysis utilizing DOE's high-performance computing resources; development and maintenance of biology-related capabilities at DOE's user facilities for use by the broader biology research community; realization of next-generation biological and analytical technologies to understand biological processes and function at the molecular level; and production of important medical isotopes. BRaVE is a critical component in DOE's strategy for maintaining its leadership and that of its national laboratories at the frontiers of biology.

- Q17. Dr. Richmond, how does the Office of Science review or audit research processes and projects to ensure that funding is being used appropriately or for its appropriated purpose?
- A17. DOE's Office of Science (SC) grantees are required to submit annual progress reports, which are carefully reviewed by program staff to ensure the research performed is within the scope of the award and that adequate progress is being made. Projects are also subject to external merit review to assess progress. Recipient institutions are audited under the Single Audit Act process to ensure their compliance with all administrative requirements for receiving Federal funds.
- Q18. Dr. Richmond, in light of recent international events and the spike in energy prices. How is the Department working towards protecting immediate U.S. energy independence?
- A18. Right now, energy security is more important than ever. In recent weeks Secretary Granholm has been meeting with domestic energy producers as well as with producing countries to encourage production and grow available supplies. The Energy Information Administration's (EIA) latest Short-Term Energy Outlook (STEO) shows that the U.S. market is poised to reach record natural gas and near-record crude oil production levels in 2022, which should drive prices downward for both natural gas and co-produced propane. Unlike some oil and gas producing countries, the United States Government does not manage production levels but relies on private-sector markets to match supply with demand. The U.S. must also ensure energy security for nuclear power by reducing reliance on Russian enriched uranium, and promoting the domestic nuclear industry.
- Q19. Dr. Richmond, S.2733 defunds the U.S. Enrichment Corporation Fund and transfers the remaining funds to the Treasury. Federal money has remained in the Fund despite the Fund being privatized over two decades ago. Are there similar funds, corporations, or entities that have been privatized where federal monies remain tied up?

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- A19. No. The Department of Energy does not have any other type of fund like the U.S. Enrichment Corporation Fund.
- Q20. Dr. Richmond, DOE recently released the “America’s Strategy to Secure the Supply Chain for a Robust Clean Energy Transition.” Within the report DOE highlights the need to “Review and update Federal mining laws and regulations to provide for more efficient permitting.” Is DOE coordinating with federal land management agencies on regulatory reform and what reforms do you believe would be most helpful to reducing permitting timelines for critical mineral production?
- A20. Yes. The Department of Energy (DOE) is coordinating with Federal land management agencies in mining law reforms including permitting. An interagency working group, launched by the Department of the Interior (DOI) in February 2022, is working to review Federal permitting processes with respect to critical mineral production on Federal land. Membership of this interagency working group includes DOI, Department of Agriculture, the Environmental Protection Agency, the Department of Commerce, the Department of Defense, DOE, the State Department, and the Executive Office of the President. The interagency working group will work together to identify gaps and potential reforms that may be useful in promoting domestic mining production.

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QUESTIONS FROM SENATOR MAZIE K. HIRONO

- Q1. You noted that the FY2022 Budget Request proposed to establish the Reaching a New Energy Sciences Workforce (RENEW) program to expand undergraduate and graduate student training opportunities to underrepresented and underserved groups. What is the status of this proposal, what level of appropriation did SC request for it, and does it require any new authorization from this committee to carry out?
- A1. The DOE's Office of Science (SC) is increasing its outreach to institutions that have not historically participated in its programs. In FY 2021, SC Office of Nuclear Physics (NP) issued a Funding Opportunity Announcement (FOA) titled, *Research Traineeships to Broaden and Diversify Nuclear Physics*, to support proposals aimed at supporting traineeship opportunities in nuclear physics for undergraduates from Minority Serving Institutions (MSIs) in collaboration with DOE National Laboratories. Twenty-one awards were made that included 37 colleges and universities, of which 28 were MSIs, including 14 Historically Black Colleges and Universities (HBCUs). NP's Traineeships effort informed our planning for the proposed Reaching a New Energy Sciences Workforce (RENEW) initiative in FY 2022. RENEW will significantly increase outreach and expand the workforce training opportunities to underrepresented and underserved stakeholder groups, including tribal communities, HBCUs, Hispanic Serving Institutions, and other MSIs. RENEW will leverage SC's world-unique national laboratories, user facilities, and other research infrastructures to provide undergraduate and graduate training opportunities for students and academic institutions not currently well represented in the U.S. S&T ecosystem. The experiences gained through the RENEW initiative is expected to open new career avenues for the participants, forming a nucleus for a future pool of talented young scientists, engineers, and technicians with the critical skills and expertise needed for the full breadth of SC research activities, including DOE national laboratory staffing. SC engaged the broader community – from scientific professional societies to MSIs and current and past participants in SC's science, technology, engineering, and mathematics (STEM) training programs – in a series of over 15 listening sessions and discussions to better understand the barriers to participation in SC-sponsored research opportunities. The valuable input from these discussions will inform the focus of RENEW. SC requested \$30 million for RENEW in FY 2022 and plans to issue multiple FOAs, pending appropriations, in research areas related to the SC mission. No new authorizations are needed for RENEW.

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- Q2. Regarding S. 3428, the Fission for the Future Act of 2022, how many advanced nuclear facilities would DOE be directed to support under the bill, and what would the DOE's expected cost per facility for the assistance that would be authorized in the bill?
- A2. If S. 3428 were enacted into law, the Department would work to maximize the number of advanced nuclear facilities supported under this program, subject to available appropriations. It is expected that the cost for assistance would vary given the facility, its location, and the specific type of assistance needed for the facility.

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QUESTIONS FROM SENATOR JOHN HOEVEN

- Q1. In your written testimony, you reference the Office of Science’s core mission and note that your office is “the lead in supporting fundamental scientific research for our energy future.”

Current domestic and broader geopolitical events underscore the need to focus on our energy future, because secure access to energy is directly connected to our economic and national security.

Do you believe global demand for coal, oil, and natural gas will continue to be significant and play a role in the energy mix?

- A1. While the current energy mix is primarily composed of fossil fuels and U.S. fossil fuel and energy exports are an important part of that mix, we must continue to reckon with the impact of climate change and push for more clean energy at home and around the world.

Clean energy—including nuclear power—is diverse, cheap, and reliable. Best of all, clean energy is homegrown and creates domestic jobs. It will make us more energy independent and less vulnerable to price shocks from the volatile and often weaponized oil and gas markets. The imperative to stop our reliance on fossil fuels to protect the climate has long been clear, but high energy prices only reinforce the need to diversify our energy sources. Clean energy is already cost-competitive with or cheaper than fossil energy in much of the country. The Bipartisan Infrastructure Law, coupled with the President’s full climate agenda, will give American families and businesses more options for cleaner and cheaper energy, which will help protect them and the U.S. economy from the price volatility associated with today’s energy mix.

- Q2. In considering Russia’s invasion of Ukraine and Europe’s energy security challenges, would you agree that it is in our country’s strategic interest to leverage our abundant fossil energy resources?
- A2. Vladimir Putin’s unjustified and unprovoked further invasion of Ukraine has disrupted global oil markets and increased oil prices. The U.S. has been coordinating with our allies and partners around the world to increase global energy security. We are prepared to help our allies and leverage our role as a net exporter of oil and natural gas while minimizing harm to American families. That is why Secretary Granholm chaired an emergency meeting of the International Energy Agency on March 1, 2022, where all 31 member countries committed to release a collective 60 million barrels of oil from strategic petroleum reserves. The U.S. agreed to contribute half—President Biden authorized a release of 30

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million barrels from the Strategic Petroleum Reserve. The President also signed the Executive Order banning all Russian oil, gas, and coal imports and limiting investment in Russia's energy sector. This means Russian energy will no longer be acceptable at U.S. ports, and the American people will deal another powerful blow to Putin's war machine. And we stand prepared to take additional measures if conditions warrant.

Additionally, on March 16, DOE issued two orders that enabled the currently operating Sabine Pass (LA) and Corpus Christi (TX) LNG projects to export additional LNG to non-free trade agreement (non-FTA) countries. These orders will not increase total LNG exports because the facilities were already authorized to export their maximum capacities to countries with which the U.S. has a free trade agreement. However, with these authorizations, now every operating U.S. LNG export project has the authority to export all of its approved capacity to both free trade countries and non-free trade agreement countries. DOE also issued two long-term non-FTA authorizations in April 2022 for additional exports from the Golden Pass and Magnolia LNG projects. Neither of the authorizations will result in immediate increased LNG exports from the U.S. as neither of the projects is currently operational, but Golden Pass is currently under construction and expecting first exports in 2024.

U.S. LNG exports are at all-time highs and at or near the operating capacity of approximately 13 billion cubic feet per day (Bcf/d) (source: [EIA](#)). U.S. LNG exports are expected to further increase throughout this year and 2023 as additional capacity comes online. So far, in 2022, over 70% of U.S. LNG exports have gone to Europe.

- Q3. The *Department of Energy Science for the Future Act* establishes a "Carbon Oxide Sequestration Research and Geologic Computing Initiative," intended to expand data collection, analysis and modeling of subsurface geology for the purpose of advancing carbon oxide sequestration.

Should this provision be enacted into law, will you commit to working with us to ensure that carbon storage combined with enhanced oil recovery technologies would be studied under this initiative?

- A3. As one of the principal sponsors of U.S. basic research in the Federal government, DOE's Office of Science (SC) is committed to delivering the discoveries, capabilities, and major scientific tools that advance strong scientific foundations for creating clean energy technologies such as carbon dioxide removal, which includes geological sequestration. The Office of Basic Energy Sciences' (BES)

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investments in carbon dioxide focus on new approaches to capture carbon dioxide from dilute sources (such as the air). In March 2022, BES – in coordination with DOE’s Offices of Fossil Energy and Carbon Management (FECM), Energy Efficiency and Renewable Energy (EERE), and the Advanced Research Projects Agency (ARPA-E) – organized the Roundtable on Foundational Science for Carbon Dioxide Removal Technologies to identify the scientific and technical barriers for carbon dioxide capture, conversion, and storage. The roundtable identified five priority research opportunities including one for fundamental research to elucidate the geochemical and geomechanical processes activated by carbon dioxide injection into geologic formations deep underground. This research direction includes the development of validated methods to integrate data and simulations that bridge atomic and field scales with the goal of secure carbon storage enabled by a systems-level understanding of subsurface processes. The priority research opportunities from this roundtable will define the BES research agenda in carbon dioxide removal for years to come.

- Q4. The *Department of Energy Science for the Future Act* establishes a “Carbon Materials Research Initiative,” intended to expand fundamental knowledge of coal and carbon ore chemistry. North Dakota lignite coal contains higher concentrations of rare earth elements compared to other types of coal.

Would you agree that the development of new coal-derived materials could help address supply chain disruptions and strengthen our domestic manufacturing capabilities?

- A4. The Department of Energy (DOE) is addressing the full range of options to secure our critical mineral supply chains with RDD&D through the Critical Minerals and Materials (CMM) crosscut. The DOE Office of Fossil Energy and Carbon Management (FECM) Minerals Sustainability Division (MSD) is addressing the entire supply chain while producing CMM, rare earth elements (REE), and carbon ore products from unconventional and secondary sources such as coal waste and industrial by-products, including coal refuse, clay/sandstone over/under-burden, ash, acid mine drainage, produced water and industrial by-products from steel, cement, and refining industries.

CMM are important for energy technologies and subject to supply risk. Underpinning our ability to meet our economic, national security, and climate goals is the need for a reliable, resilient, and secure CMM supply chain. These supply chains range from REE for permanent magnets in electric vehicle (EV) motors and wind turbines; to cobalt, lithium, manganese, nickel, and graphite for EV and grid batteries; and to platinum group metals in fuel cell catalysts and catalytic converters. DOE has been successful at

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standing up multiple pilot facilities demonstrating that high purity rare earth materials can be produced from coal, coal waste, and coal byproducts, such as coal ash or acid mine drainage. These advancements and additional investments from the Bipartisan Infrastructure Law are bringing us very close to demonstrating that coal-derived materials will be economically and environmentally effective sources that will provide diversified sources of critical materials that will strengthen our domestic supply chains and manufacturing capabilities.

Developing a sustainable, safe, and robust domestic supply chain for CMM can also create jobs, support the manufacturing economy, and aid in a just transition for coal and fossil-based communities. These communities have expertise that could be transferrable to technology development throughout the supply chain, largely in RD&D areas supported by FECM and EERE, including:

- Upstream unconventional technology and technique development from resource characterization and prediction, through novel extraction from sources such as acid mine drainage, refuse, geothermal and produced water brines
- Midstream technology development for environmentally sustainable, efficient, and cost-effective extraction, processing, refining of resources from unconventional and secondary sources
- Downstream technology development for the transformation of carbon ore to synthetic graphite and graphene for battery anodes as well as graphene for quantum dots for use in solar cells

**U.S. Senate Committee on Energy and Natural Resources**  
**March 1, 2022 Hearing: *Pending Legislation***  
**Questions for the Record Submitted to the Honorable Geraldine Richmond**

QUESTIONS FROM SENATOR MARK KELLY

- Q1. Since we spoke at the hearing, I introduced the *Microelectronics Research for Energy Innovation Act* with Senator Blackburn. Will you commit to reviewing the text and provide technical assistance or feedback?
- A1. Yes. The Department stands ready to provide you and your office with ongoing technical assistance as requested.
- Q2. Will you also commit to working with the Office of Budget and Management to ensure that Department-provided technical assistance is provided to our offices and to committee staff in a timely manner?
- A2. Yes. The Department will work to ensure technical assistance is provided in a timely manner.
- Q3. In response to my questions at the hearing, you stated that federal research programs need to be targeted at the “key issues” and research areas which enable the development of next generation microelectronics. Based on your review of the text, do you believe that the *Microelectronics Research for Energy Innovation Act* is correctly focused on the key research areas needed to enable DOE National Labs and programs to help develop cutting edge, next generation microelectronics?
- A3. Yes, the Microelectronics Research for Energy Innovation Act directs DOE to carry out research, development, and deployment in key areas needed to provide the knowledge and capabilities for cutting-edge future microelectronics technologies including foundational science; computing architectures and paradigms; modeling and simulation; system integration; photonics; and co-design frameworks for all stages of microelectronics design, development, fabrication, and applications. Rapid advances in all these areas will be needed to drive the innovation pipeline for key technologies in computing, communications, and sensing.
- Q4. You also mentioned at the hearing the importance of focusing R&D efforts on developing next generation tools, which are capable of developing smaller and smaller microchips. How is DOE contributing to the development of these next generation tools, in partnership with other researchers and the private sector?
- A4. The DOE National Laboratories have both the expertise and R&D infrastructure to play a key role in the advancement of microelectronic fabrication technologies, bringing together academic and National Lab researchers with industry partners. Technologies of the future will require novel materials and discovery of new ways of synthesizing, characterizing, and configuring them at atomic length scales—all of which

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are beyond today's capabilities. Existing DOE user facilities, including the Nanoscale Science Research Centers and X-ray and neutron scattering facilities, are uniquely positioned to address this challenge through expanded/enhanced instrumentation and capabilities that are specifically targeted at future microelectronics devices and systems. In the near term, it will be important to address sub-10 nanometer design, synthesis, fabrication, and characterization challenges at a fundamental level. Advanced accelerator-based light source technologies providing intense sources of X-ray radiation could enable higher-resolution optical metrology tools and unique capabilities in lithography. For example, for decades the Center for X-Ray Optics at Lawrence Berkeley National Lab has partnered with industry to drive forward the development of extreme ultraviolet (EUV) lithography, which is now used in leading semiconductor manufacturing facilities for patterning of features below 10 nanometers.

- Q5. How do DOE microelectronics research programs differ from other programs focused on research and development at the Department of Commerce, the Department of Defense, or the National Science Foundation?
- A5. In contrast to other agencies, DOE's microelectronics research programs span the entire research, development, and demonstration (RD&D) spectrum, including fundamental materials and chemical sciences, fabrication and processing, devices and circuits, systems and architectures, and computing algorithms and software. Across DOE, microelectronics RD&D is primarily supported by the DOE's Office of Science (SC), the Advanced Manufacturing Office (AMO), and the National Nuclear Security Administration (NNSA). In addition, DOE offices such as the Loan Programs Office (LPO) and the Office of Technology Transitions (OTT) provide support for commercialization of microelectronics technologies. This breadth of support, from basic science to commercialization, sets DOE apart.

The 17 DOE National Laboratories, including the open-access user facilities, bring unparalleled expertise and capabilities to address the most challenging scientific and engineering obstacles for next-generation microelectronics.

DOE, through the Advanced Scientific Computing Research (ASCR) program and the NNSA, is the steward of the Nation's largest and fastest high performance computing facilities, supporting the Department's mission in science, energy, and national security. DOE has a close and established

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partnership with leading U.S. semiconductor manufacturers to design, build, and operate these world-leading computers.

- Q6. Do you believe that there are sufficient mechanisms currently in place to ensure that DOE microelectronics research efforts are coordinated alongside research and development programs at other federal agencies?
- A6. Yes, I believe that there are sufficient mechanisms currently in place to ensure that DOE microelectronics research efforts are coordinated alongside research and development programs at other Federal agencies. The National Science and Technology Council Subcommittee on Microelectronics Leadership (SML), established by the White House Office of Science and Technology Policy in early 2021 based on direction in the 2020 National Defense Authorization Act, is an appropriate and effective forum for interagency coordination of microelectronics R&D. DOE has representatives on the SML and participates actively in dialogue and coordination with other agencies, including the Department of Commerce, Department of Defense, and the National Science Foundation.