**U.S. Senate Committee on Energy and Natural Resources**
**August 3, 2021 Hearing: *The Richmond, Stachelberg, and Berhe Nominations***
**Questions for the Record Submitted to Dr. Asmeret A. Berhe**

**Questions from Ranking Member John Barrasso**

**<u>Question 1</u>: Many of the statutory responsibilities of the Director of the Office of Science and the Under Secretary for Science sound quite similar—for example, monitoring DOE's research and development (R&D) programs, advising the Secretary about DOE's national laboratories, and advising the Secretary about DOE's education and training activities.**

a. **What do you see as your role in these areas?**

If confirmed, I would see my role in these areas as working with the Under Secretary for Science to provide the best, most relevant, and comprehensive scientific advice to the Secretary of Energy across all areas relevant to our understanding of the Earth system, and to the advances in all areas of science and technology relevant to the DOE mission, including the energy, economic, and national security of the United States. In addition, I see my role as being a connection between the advanced facilities and National Labs that the Office of Science stewards and the Secretary to ensure sustained research strength, and support for education and workforce development for the nation.

b. **How would you ensure that your actions are coordinated but not duplicative?**

While the Under Secretary for Science and Energy has a broader set of offices and initiatives that they oversee, my role would be to advise the Secretary on matters related to the Office of Science and scientific bases for important policy decisions they would be considering, as well as issues related to education and workforce development in the research and development space. Furthermore, to avoid duplication, and ensure coordination of efforts related to our responsibilities, if confirmed to the role of Director of DOE's Office of Science, among other things, I would seek to implement several items that would maximize efficiency, including regular communication and updates of not just the Undersecretary of Science and Director of the Office of Science, but also our senior staff, shared list of activities, and regular updates on ongoing matters and advanced agreement on division of tasks and responsibilities.

**<u>Question 2</u>: The science and engineering capabilities of DOE's national laboratories are wide-ranging. To what extent should the laboratories focus on executing DOE's own programs, versus making their capabilities and facilities available to other agencies, U.S. industry, academia, and others?**

DOE has invested in world-class facilities and capabilities at our national laboratories to advance the Department's science, energy, environmental stewardship, and national security missions. These national laboratories represent a very valuable and unique set of assets for the United States. In this regard, the Department provides access to our laboratories to other Federal agencies, private industries, universities, and state and local institutions. All work conducted for these sponsors is subject to DOE policies and procedures and the DOE laboratory contract terms and conditions under which it is performed.

The DOE laboratories are major national scientific and technical assets whose contributions to the United States at large, and in areas beyond the DOE missions, are significant and well-documented. Further, exposing the laboratories to the immediate and future needs of other agencies and the private sector strengthens core capabilities at the laboratories that, in turn, enable them to stay at the forefront of their fields and better serve the Department's missions. Examples of this include computational research and capacity at DOE laboratories funded by many other Federal agencies, national security work supporting the Department of Defense and the Intelligence Community, and the interaction with the private sector that ultimately allow DOE and its facilities to meet their technology transfer missions and strengthen U.S. competitiveness in a continuously more competitive global market.

**<u>Question 3</u>: Science and technology developed by the DOE national laboratories can be valuable to U.S. industry, the economy broadly, and other national goals. How can DOE improve its technology transfer efforts to ensure that its R&D results are efficiently and successfully commercialized?**

The Department is committed to promoting and facilitating the technology transfer efforts of its national laboratories. These efforts continue to be one the central themes of the national laboratory enterprise and DOE recognizes the impact it has made on the lives of every American and people around the world. DOE will continue to enable and enhance a laboratory culture that makes clear our expectations for commercialization and deployment outcomes, including economic development and job creation centered around the national laboratories. The national laboratories will pursue mission-oriented and aligned partnerships with industry and academia that can deploy impactful technological commercialization opportunities.

In recent years, the Department has provided additional tools for the laboratories to use that make it easier to work with industry and university partners. For example, DOE created the novel mechanism - Agreements for Commercializing Technology (ACT) – to provide an alternative approach for non-Federal partners to engage with the national laboratories that allows for more business-like terms and conditions. Also, DOE for the first time has provided relief to these partners as it relates to the general indemnity and liability provisions under certain circumstances in the standard agreements for such partnerships. These provisions have been identified as a key barrier to working with industry and university partners.

If confirmed, I look forward to working with the Department to continue to look for ways to improve its technology transfer efforts through both creating new and novel programs and streamlining existing mechanisms and developing new ones for use by the laboratories to engage more effectively with industry and university partners.

**<u>Question 4</u>: Security and competitiveness concerns about foreign access to U.S. R&D results have grown in recent years. The scientific user facilities at the DOE national laboratories host thousands of foreign researchers each year.**

a. **How should DOE balance the advantages of scientific openness against the potential risks associated with foreign access to these facilities and the R&D conducted at them?**

Over the past several years, the Department has taken a series of actions to address risks to research security while maintaining an open, collaborative, and world-leading enterprise. These policy initiatives aim to reduce the risk posed by specific threats, including threats posed by certain foreign governments, to the U.S. research enterprise including the DOE national laboratories.

For example, DOE has established a cross-cutting advisory body to identify and manage potential risks to research security. DOE has prohibited federal and laboratory personnel from participating in foreign government talent recruitment programs sponsored by countries of risk and restricted participation in other foreign government sponsored or affiliated activities. DOE worked closely with the chief research officers across our 17 National Laboratories to develop the Science and Technology Risk Matrix, which takes a risk-based approach to identifying critical and emerging technology areas that have potential economic and national security implications, but that do not otherwise have traditional protections in place. The Risk Matrix is used to guide and manage foreign engagements, cooperative research and development agreements, strategic partnership projects, official travel, and foreign national access to our labs.

b. **What additional steps, if any, are needed to ensure that DOE-funded R&D results are not illegally or inappropriately transmitted to potential foreign adversaries?**

DOE should continue to review these policies to ensure that this risk-based approach strikes the right balance between protecting our intellectual property and assets, while also maintaining the openness that underpins our innovation ecosystem. DOE continues to actively co-chair the National Science and Technology Council Subcommittee on Research Security to ensure a coordinated approach to research security, as well as participate in the National Counterintelligence Task Force campaign on research security. In addition, if confirmed, I will work to ensure that DOE continues to engage with allies and partners through State Department-led efforts to exchange information on experiences and best practices on research security.

**<u>Question 5</u>: The qualifications needed to be Director of the Office of Science are not specified in statute.**

a. **What do you believe are the most important characteristics for a successful Director? Previous Directors have often had extensive experience in managing research organizations.**

   I believe the most important characteristics of a successful Director for the Office of Science include interdisciplinary training, strategic thinking and acting, problem solving skills, ability to integrate and synthesize information from multiple fields and streams; ability to work well with others; effective communication with diverse groups of stakeholders, and ability to inspire others.

b. **What is your philosophy of managing an organization like the Office of Science?**

   My philosophy of managing an organization like the Office of Science is a meld between strategic and transformational leadership philosophies. I believe it is important to have a strategic approach to ensure that I maintain a focus on both high-level visions and operations of the office, while also providing regular guidance and structure for the day-to-day support that the team might need from me. At the same time, for an organization like an Office of Science, it is important to maintain a transformational approach that ensures that the office can work on developing new goals, approaches, or benchmarks for continued innovation in the science and technology space. Hence, if I am confirmed to serve as Director of the Office of Science, I will manage the organization in a manner that ensures continued effectiveness of everyone on the team, and the office as a whole. I will also allow and motivate the team through setting both realistic and ambitious goals to enable innovative projects to thrive. I intend to lead by example and demonstrate my passion, drive, and integrity to support our goals.

c. **What skills would you bring to that task that would make you an effective manager and leader?**

I believe I bring multiple skills and experiences that would make me an effective manager and leader for the Office of Science. I have demonstrated that I have been effective at juggling multiple responsibilities as I continued to contribute to multiple leadership roles while leading an active, large, well-funded, and globally recognized research program, and while teaching and mentoring diverse groups of students and other early career researchers in my group and beyond.

I have been trained and have long term experience as an Earth system scientist, gaining valuable experience in integrating across physics, biology, chemistry, and geosciences. This integrative perspective is crucial for addressing many aspects of the energy, environment, nuclear, and other basic science issues that the Office of Science addresses. In addition, to successfully running my own research group for over 12 years, I have a long record of leadership and service to the U.S. scientific community. For example, in my own institution, I served multiple roles including Interim Associate Dean for Graduate Education, Chair of the School of Natural Sciences Executive Committee and a member of the Academic Senate's divisional council, including Vice Chair and Chair of the Academic Senate's Diversity and Equity committee.

Nationally and internationally, I have a long record of providing scientific expertise and leadership in efforts related to workforce development through appointments on numerous national committees advising U.S. federal agencies and internationally, including U.S. National Science Foundation, the American Geophysical Union, the German Research foundation; U.S. Department of Agriculture, Department of Energy, the Soil Science Society of America, and most recently the U.S. National Academy of Sciences study committee on Advancing a Systems Approach to Studying the Earth. In addition, I served as a member and Chair of the U.S. National Committee for Soil Science at the National Academies. In this role, I provided leadership in advancement of soil science nationally and internationally, including representing interest of U.S. scientists in international bodies. I also led the committee at the National Academies that advises the academies on all matters pertaining to U.S. participation in the internal area. I also have a long record of contributions to science communication and supporting the recruitment and success of a diverse workforce that represents U.S. taxpayers through independent, university, national and international efforts.

**Question 6: In 2005, a report from the National Academy of Sciences recommended doubling federal funding for basic research, especially research in the physical sciences and engineering, in order to promote U.S. competitiveness. Subsequent Administration policies and enacted legislation, such as the 2007 America COMPETES Act (P.L. 110-69), supported this goal and identified the Office of Science as an agency that should be included in the doubling effort. Yet the enacted FY2021 budget for the Office of Science is still less than double what it was 15 years earlier, even before accounting for inflation.**

a. **To what extent is U.S. competitiveness in the physical sciences and engineering still a concern?**

The U.S. needs to be the leader in the world, including when it comes to the technologies of the future, and the physical sciences and engineering is a key component of developing these technologies. To support U.S. leadership, DOE's Research, Development, Demonstration and Deployment (RDD&D) programs, which include emerging technologies like AI, Quantum Information Science, and High-Performance Computing, are also crucial. These technologies rely on continual advances in scientific R&D. As the nation's largest supporter of research in the physical sciences, the Office of Science is key to supporting R&D on the fundamental breakthroughs needed to help our nation remain competitive in the physical sciences and engineering. Additionally, the Office of Science supports 28 user facilities that are essential to the health and robustness of our nation's scientific enterprise. These facilities are used by tens of thousands of scientists and engineers every year to make advancements across a huge range of scientific fields and are crucial to our scientific investments, in addition to R&D.

b. **Would you support a renewed doubling effort?**

Yes, I support robust federal funding for basic research, especially in the physical science and engineering to promote U.S. competitiveness. The work supported by the Office of Science is critical for ensuring that the U.S. takes advantage of the estimated $27 trillion clean energy economy, exploration and use of rare earth elements, the biological sciences that are major industry of the future that hold key for the health and agricultural sectors, and more. In addition, critical and continued investments are needed in the Office of Science to address aging of critical infrastructure that is critical for successful completion of research and development efforts in the DOE complex, and facilities supported by DOE.

c. **Within the Office of Science, what is the appropriate balance between research in the physical sciences and research in other fields such as the biological sciences?**

I consider all the areas of science the DOE Office of Science enables to be critical for not just pushing the frontiers of science, but also for ensuring U.S. science competitiveness and continuing to train the science leaders of tomorrow right here in the USA. I believe the decision on what is the appropriate balance between research in the physical sciences and other fields such as biology is not something that one individual, even the Director of the Office of Science, should make. I believe this is a decision that should be made after a deliberative process with careful balancing act that decides the priority areas for research (developed through careful consultation with the scientific community) and recognizes that cost of doing research in different fields.

<u>**Question 7**</u>**: Within the Office of Science, a key effort of the Fusion Energy Sciences program is U.S. participation in the ITER international fusion demonstration facility, currently under construction in France.**

a. **What can DOE do to improve the cost and schedule performance of ITER?**

The Department has a proven record of employing project management systems and personnel to ensure the best possible use of appropriated project funds. The U.S. ITER Project Office has optimized appropriations since its inception and will continue to do so in the future. A key part of DOE project management is to ensure that the Department hires and retains high-quality project management professionals and that they use appropriate project planning tools. DOE provides direct and frequent oversight through daily interactions as well as external project cost, schedule, and management reviews to ensure the project is on track. DOE also engages with the ITER Organization and other Members to monitor not only the progress at the ITER site but also at the other Members' Domestic Agencies and contractors. The international ITER project has adopted many project management practices from the U.S., including strong cost and schedule management regimes, steady management oversight, and periodic independent reviews.

b. **How would you balance the resource needs of this international effort against the resource needs of domestic fusion research projects?**

The Department balances the funding for the ITER project with funding for other important initiatives in the Fusion Energy Sciences (FES) program. International collaborations, such as ITER, provide capabilities that the U.S. does not possess, nor could construct and operate within reasonable funding levels. The results from such international collaborations are synergistic with domestic facilities and research efforts. DOE and other foreign entities have determined that the scale of certain international mega-science research facilities is beyond the financial and technical capabilities of any one nation, and this drives the U.S. and the international community toward collaborations in all areas of large-scale science, including the ITER project for fusion.

c. **To what extent should the Fusion Energy Sciences program direct resources to alternative fusion approaches?**

It is my understanding that the support in the President's FY 2022 request for stellarator research is consistent with previous years, including both domestic activities as well as international collaborations with Germany and Japan. In addition, consistent with the Long-Range Plan, FES plans to hold a basic research needs workshop in FY 2022 to explore initiating an effort in inertial fusion energy research in future budget requests. Basic research needs workshops are a proven and effective tool frequently used by the Office of Science, when initiating a new research activity, to help identify the most impactful science and technology research that needs to be undertaken. FES also supports several projects relevant to alternative approaches (including magnetized target fusion) through the Innovation Network for Fusion Energy (INFUSE) program.

**<u>Question 8</u>: As a national steward of major scientific facilities, the Office of Science must often balance the resources needed to build and upgrade facilities against the resources needed to operate existing facilities. How would you approach this challenge in order to maximize the return on federal R&D investments?**

The Office of Science supports a balanced portfolio of forefront research to advance the frontiers of science, construction and upgrade of world-leading scientific user facilities, and operation of these facilities. Each facet of this portfolio is essential to maintaining international competitiveness and advancing the energy, economic, and national security of the United States. Approximately sixty percent of the Office of Science budget supports facility operations and construction and upgrade of facilities.

**<u>Question 9</u>: Over the past decade, funding for the Advanced Scientific Computing Research program has nearly doubled as a share of the total Office of Science budget.**

a. **To what extent do you expect this trend to continue?**

Congress has invested in the Advanced Scientific Computing Research (ASCR) program over the past decade and these investments in facilities, computational partnerships and applied mathematics and computer science to develop algorithms, tools and methods underpin progress in all of the Department's missions. In addition, the investments that the DOE made with U.S. vendors in Exascale have had a large positive impact on the competitiveness of U.S. vendors and science because they directly improve commercially available products. While funding levels are ultimately up to Congress, I expect that increased investment could continue because there is an increasing demand for advanced computing to solve the Nation's toughest challenges and to accelerate progress in science and engineering.

Over the past decade, the Department made a visible commitment to advancing high performance computing, advanced networking, and computational science through the deployment of the Nation's first fully optical network for science, ESnet-5, retaking leadership in HPC with world leading systems at the Oak Ridge Leadership Computing Facility (OLCF) and advancing U.S. Leadership with the launch of the Exascale Computing Initiative (ECI). With the deployment of the Nation's first exascale computer system later this year at the OLCF, the country will embark on the exascale era that encompasses the era of big data and artificial intelligence at scale. To fully leverage its impact on scientific discovery, ASCR will need to create an ecosystem of capabilities, facilities, instruments, and expertise connected to the world's most powerful supercomputers and data tools through the world's fastest research network. In the longer term, ASCR will need to balance supporting traditional areas while making strategic investments in technologies beyond exascale such as neuromorphic computing, quantum computing and advanced networking technologies to accelerate scientific discovery.

b. **What do you see as the most important opportunities for this program to contribute to scientific advances?**

The Advanced Scientific Computing Research (ASCR) program, through sustained investment in strategic technology areas research teams, continues to provide enhanced computing by developing computing and data capabilities, innovative software, and algorithms; increased productivity by leveraging advances in computer science, including artificial intelligence and new hardware capabilities, to drastically reduce the time from idea to trusted implementation; and accelerated discovery by combining advanced data analytics, simulation, and artificial intelligence to derive more scientific insights faster than ever before.

ASCR will need to continue to invest in algorithms, tools and techniques to ensure that the next generation of advanced computers are more energy efficient and easier to use and that experimental and observational data is findable, accessible, interoperable and reusable to accelerate discovery in areas such as creating digital twins for systems biology, modeling complex experiments such as ITER, and increasing our preparedness for emergencies such as COVID-19 and extreme weather events. ASCR needs to look beyond Exascale and build the foundation for quantum computing and quantum internet to continue the forward progress that today's advanced computing and the Internet have enabled. We also need to make our scientific user facilities and the data they generate accessible to a broader community through our Integrated Computational and Data Infrastructure investments.

**<u>Question 10</u>: Historically the main focus of the Office of Science has been in the physical sciences, with the Biological and Environmental Research program being an important exception.**

a. **As an expert in soil biogeochemistry, what do you see as the appropriate role of the Office of Science in biological and environmental research?**

   The Biological and Environmental Research Program supports research that addresses major biological and Earth system sciences. The BER program has enabled advances in our understanding of the fundamental processes in the Earth system that regulate life (including biotechnology and the industries of the future that these advances are enabling), energy systems, as well as the climate system, and impacts of climate change (among other things); and contributed to advanced analytical and computational tools that have paved the way for discoveries well outside areas covered in BER. As a scientist with broad disciplinary interest in multiple areas covered by BER, BES, ASCR, and other cross-cutting research areas, I understand that questions that traditionally fall within the realm of BER funded science have also inspired work across other DOE programs. I believe the physical and biological systems in the Earth system (including those that support energy and the Earth system's responses to variety of human and non-human perturbations) are inextricably linked. Hence, I see the appropriate role of the Office of Science in Biological and Environmental Research as being to continue to enable cutting-edge research across the current and other areas within BER, as our lives and energy systems literally depend on it.

b. **Which of the priorities and capabilities of the Biological and Environmental Research program would you consider either expanding or deemphasizing?**

   As someone who prizes being a consensus builder before making major decision about the future directions of critical areas of research covered in programs such as BER, I would have to consult with the current DOE leadership, the scientific community, and all relevant stakeholders (including congress) before expanding or deemphasizing one area or another.

**<u>Question 11</u>: In April, the Office of the Director of National Intelligence released a report that said, "China will remain the top threat to U.S. technological competitiveness" and that China "uses a variety of tools, from public investment to espionage and theft, to advance its technological capabilities." Will you please describe how you intend to prevent China from stealing the intellectual property developed through research supported by the Office of Science?**

The U.S. government must protect taxpayer investments from technology theft, interference, and exploitation from China and other foreign governments while also maintaining an open environment to foster research discoveries and innovations that benefit our nation and the world.

Over the last several years, the Department of Energy has taken a series of policy actions to manage risks to research security. These include the development of the S&T Risk Matrix in coordination with our National Laboratories to identify and manage risks associated with critical and emerging technologies that are not otherwise protected by classification or export controls. The Matrix is used to guide and manage foreign engagements, cooperative research and development agreements, strategic partnership projects, official travel, and foreign national access to our labs. DOE also put several actions in place to prohibit DOE employees and contractors, including laboratory personnel, from participating in foreign government sponsored talent recruitment programs sponsored by certain countries, including China.

DOE will continue to review these policies to ensure that this risk-based approach strikes the right balance between protecting our intellectual property and assets, while also maintaining the openness that underpins our innovation ecosystem.

As an agency co-chair of the National Science and Technology Council Subcommittee on Research Security, the Office of Science played a leading role in the development and issuance of the National Security Presidential Memorandum-33 (NSPM-33) on United States Government-Supported Research and Development, released in January of this year. If confirmed, I am committed to continuing to actively coordinate with science and security agencies on implementation of this policy.

**<u>Question 12</u>: Five of the last six directors of the Office of Science were physicists, and four of the last six had extensive experience managing large research portfolios for the federal government. What skills and managerial experience would you bring to Office of Science to make you an effective leader?**

If confirmed, I would approach the role of Director of the Office of Science with the experience of an Earth system scientist that works across and synthesizes knowledge from multiple scientific areas and teams. I believe the integrative systems perspective that I bring is uniquely suited for this role, especially for the current time when we need to urgently address multiple issues that are critical for not just pushing the frontiers of science, but also to address the ongoing climate emergency, need for workforce development, and to promote better understanding and trust in the scientific processes. My experience with scientific investigations across multiple disciplines, covering spatial scales ranging from molecular to the globe, and processes that occur from seconds to geologic timescales is an asset as we seek to address fundamental processes that hold the key for the environmental, energy, and nuclear challenges of our time.

**<u>Question 13</u>: Will you commit to hiring and grantmaking on the basis for scientific and technical merit?**

Yes.

<u>**Question 14**</u>**: Universities pride themselves on conducting open science, which includes collaboration with foreign nationals. International collaboration may help science, but as a recent FBI report states, "…this open environment also puts academia at risk for exploitation by foreign actors…" Before radically increasing funding to universities, that the FBI identifies as easy targets, shouldn't we ensure that these institutions have the necessary safeguards in place?**

Principled international collaborations and foreign contributions are critical to the success of the United States research enterprise. International collaborations enable cutting-edge research that no one nation can achieve alone; train a robust S&T workforce capable of solving global problems, and leverage resources, including funding, resources, and expertise. These international collaborations should adhere to principles such as objectivity, transparency, fairness, accountability, and stewardship. International students and scholars also contribute significantly to the U.S. research enterprise.

To guard against foreign government exploitation of our research enterprise, the United States government must be clear about the risks to research, clarify existing disclosure policies so that research institutions and funding agencies can make informed, risk-based decisions, and work in partnership with the research community to address threats. Transparency and full disclosure enable a system where grant decisions are made based on complete and accurate information, including the ability to properly identify, assess, and manage risks.

Much of this activity is already underway through the development and implementation of National Security Presidential Memorandum-33 (NSPM-33), which is taking a coordinated approach to disclosure policy, oversight, and enforcement. Specifically, NSPM-33 calls for research organizations that receive substantial federal R&D funding (in excess of $50 million annually) to maintain research security programs, which should include elements of cyber security, foreign travel security, insider threat awareness and identification, and as appropriate, export control training. DOE is actively working with the interagency National Science and Technology Council Subcommittee on Research Security to develop clear and effective implementation guidance for NSPM-33.

<u>**Question 15**</u>**: The Office of Science manages large user facilities and often must balance competing needs to build and upgrade facilities and to operate existing facilities. How would you approach this challenge to maximize the return on federal R&D investments?**

The Office of Science supports a balanced portfolio of forefront research to advance the frontiers of science, construction and upgrade of world-leading scientific user facilities, and operation of these facilities. Each facet of this portfolio is essential to maintaining international competitiveness and advancing the energy, economic, and national security of the United States. Approximately sixty percent of the Office of Science budget supports facility operations and construction and upgrade of facilities. Each annual budget request is formulated with this portfolio approach to support our existing investments while planning for future needs.

<u>**Question 16**</u>**: The Experimental Program to Stimulate Competitive Research ("EPSCoR") within DOE's Office of Science is designed to improve energy-related research in 24 largely rural states, including Wyoming. DOE needs to continue to build basic research capacity in EPSCoR states. How do plan building up the capacity of universities in EPSCoR states?**

If confirmed, I would work to continue the Office of Science's full commitment to advancing a diverse, equitable, and geographically inclusive research community. I believe this to be key to providing the scientific and technical expertise for U.S. scientific leadership. In particular, the DOE EPSCoR program will strengthen investments in clean energy research for U.S. states and territories that do not historically have large federally-supported academic research programs, expanding DOE research opportunities to a broad and diverse scientific community. In FY 2022, EPSCoR funding will emphasize state-lab partnership awards, single principal investigator and small group grants that promote interactions with the unique capabilities and expertise at the DOE National Labs with a technical focus on clean energy research. Investment will continue in early career research faculty from EPSCoR-designated jurisdictions and in co-investment with other programs for awards to eligible institutions. By the historical alternating biennial EPSCoR cycle, the plan for FY 2023 is to emphasize implementation awards, larger multiple principal investigator grants that develop research capabilities in EPSCoR jurisdictions.

**Questions from Senator James E. Risch**

**<u>Question 1</u>: My home state of Idaho is home to the lead DOE nuclear energy laboratory, the Idaho National Lab. The INL is an applied energy lab in the Office of Nuclear Energy, but my understanding is that the Office of Science sometimes incorporates applied energy research into its programs. Can you speak to the relationship between the Office of Science and applied energy programs at DOE?**

I understand that coordination between the Department's basic research and applied technology programs is a high priority within DOE and is facilitated through joint planning meetings, technical community workshops, annual contractor/awardee meetings, joint research solicitations, focused DOE program office working groups in targeted research areas, and collaborative program management of DOE's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. DOE leadership has established formal Science and Energy Technology Teams that cross the Department and meet on a regular basis to discuss R&D activities and goals. Coordinated funding of research activities at the DOE National Laboratories, support for ancillary equipment and end stations at scientific user facilities, and partnership/collaboration-encouraging funding mechanisms facilitate research integration across the basic and applied research communities. The Office of Science's R&D coordination also occurs at the interagency level.

**<u>Question 2</u>: Do you support continued appropriate interactions between the Office of Science and the applied energy programs?**

The relationship between the Department's applied energy programs and the Office of Science (SC) is strong. Coordination of basic research and applied energy programs is a high priority within DOE and is manifested through multiple activities including cross-program dialogue; participation in meetings, reviews, and strategic planning activities; and the formal Science and Energy Technology Teams that cross the Department and meet on a regular basis to discuss R&D activities and goals. This integrated relationship between SC and the energy technology programs is crucial to bringing basic science innovations to bear on the fulfillment of DOE missions and in maintaining strong communication of the challenges for current and future energy technologies to the basic research community. We look forward to the enhancement of this relationship in the reorganized Office of the Undersecretary for Science and Energy.

**<u>Question 3</u>: Can you please provide a list of research projects you have led that has a direct nexus to the Office of Science?**

I have had many research projects that I led (including projects I co-led or led critical components of) and have had direct nexus to the Office of Science. Below is a short summary of these projects.

- **Biogeochemistry** (including projects related to soil carbon sequestration, and carbon capture, utilization and storage, and fires)
    - Persistence of organic matter in soil
    - Effect of changing climatic conditions on storage, distribution and stabilization mechanisms of soil carbon
    - Role of weathered bedrock as a large, potentially active pool of soil carbon
    - Stability and partitioning of deep soil organic matter – work with implication on quantifying the global amount of carbon stored in soil
    - Effect of cover crop on soil carbon sequestration.
    - Role of soil water retention characteristic on aerobic microbial respiration.
    - Role of the physical properties of soil in determining biogeochemical responses to soil warming
    - Roil nitrogen storage and stabilization in dynamic landscapes
    - Alternation of Phenolic Lignin to (Poly)Aromatic Hydrocarbons as Revealed by Pyrolysis-Gas Chromatography-Mass Spectrometry (Py-GC-MS), effect of burn intensity
    - Wildfire Severity Controls Pyrogenic Dissolved Organic Carbon and Nitrogen Properties
    - Effect of soil moisture and organic matter quality on microbial decomposition following boreal forest fires
    - Effect of fire on active layer permafrost microbial community and metagenomes in boreal ecosystems

- **Microbial ecology**
    - Soil depth gradients in microbial growth kinetics under deeply- vs. shallow-rooted biofuel plants; implication for the contribution of biofuel crops for soil carbon sequestration
    - Climatic controls on deep soil microbial community activity and composition
    - Fire effects on microbial community composition and activity (see also next bullet point)

- **Nano-geochemistry** (material sciences related)
    - Characterization of the physical and chemical properties of natural, nanoparticulate metal oxides that play critical roles in a number of fundamental chemical and biochemical processes in nature
    - Role of natural, reactive nanoparticles in mediating biogeochemical process
    - Magnetic properties of ultra-small goethite nano particles

- **Application of advanced DOE supported technologies in soil science, biogeochemistry, atmospheric science, basic material sciences**. These projects represent work related to research within the scope of BER, BES, and ASCR, and were conducted in conjunction with DOE facilities:
    - Lawrence Berkeley National Lab (LBNL) – long-term research collaboration (started from when I was co-advised by a scientist at LBNL), and includes, fractionations, radiocarbon prep, gas flux analyses, Fourier transformed infrared (FTIR) spectroscopy with researchers at LBNL's Earth and Environmental Sciences area; and x-ray spectroscopy work conducted at the Advanced Light Source;
    - Stanford Linear Accelerator (SLAC) – x-ray spectroscopy on soil samples with a goal of characterizing speciation of carbon, iron, and phosphorus in soil;
    - Pacific Northwest National Laboratory (PNNL) – long-term research collaborations that enabled one of the earliest works on applying nuclear magnetic resonance (NMR) to soil to infer composition, and in addition, to NMR the collaborations have also been extended to application of pyrolysis gas chromatography mass spectrometry (Py-GC-MS), and Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR-MS);
    - Lawrence Livermore National Laboratory (LLLNL) – long-term research collaborations that have enabled work on many aspects of soil carbon dynamics, notable among these are our ongoing collaborations with researchers in LLNL to apply accelerated mass spectrometry (AMS) for radiocarbon analyses of different environmental samples, and on-going collaborations that will enable use LLNL's advanced facilities for material characterizations, including through isotopic approaches such as Nanoscale secondary ion mass spectrometry (NanoSIMS) and other isotopic probing approaches that target microbial communities and organic matter in environmental samples; and
    - Ongoing collaborations with researchers at Oak Ridge National Laboratory (ORNL) on research related to effect of fire and distribution of pyrogenic matter in soil and streams post-fire; and broadly soil biogeochemistry.

## Question from Senator John W. Hickenlooper

**<u>Question</u>: Direct air capture (DAC) is one of the more potentially transformative technologies in the clean energy space, but as of now there are only a very small handful of companies that have operating direct air capture projects, even at pilot scale. Meanwhile, some of the major barriers to DAC come in at the level of fundamental science: for example, the solid sorbent technologies that the CO2 molecules stick to when we pull them from the air are major cost drivers of some of the DAC platforms already out there. Do you see a strong role for the Office of Science in driving down the costs of these materials so that we can foster a vibrant ecosystem with dozens to hundreds of such companies?**

As one of the principal sponsors of U.S. basic research in the Federal government, DOE's Office of Science is committed to delivering the discoveries, capabilities, and major scientific tools that advance strong scientific foundations for creating clean energy technologies. Direct air capture is an emerging technology that requires significant investments in research and development to create an economically viable technology that can be deployed at scale and in time to achieve net-zero emissions by 2050.

To begin meeting this need, in FY 2020, Basic Energy Sciences (BES) made its first investments to explore and develop new methods of capturing carbon dioxide directly from the air, funding three projects led by National Laboratories. BES expanded its direct air capture investments in FY 2021 by funding nine research projects at universities and national laboratories to support breakthroughs in understanding how to overcome the limitations of currently available technologies. These projects will advance new energy-efficient approaches that use electricity or light to control the capture and/or release of carbon dioxide and will explore and develop new materials and chemical compounds with the potential for improved efficiency for carbon dioxide capture and regeneration.