SEAB INNOVATION WORKING GROUP

Secretary of Energy Advisory Board (SEAB)
Innovation Working Group Report

Initial Findings

Contents

Executive Summary

This document contains the preliminary findings recommended to the Secretary of Energy Advisory Board (SEAB) from a working group dedicated to DOE's capabilities and future regarding innovation. The preliminary finding is based on expert opinion and on a call for information from the SEAB working group on DOE innovation efforts.

Introduction

The Secretary of Energy Advisory Board (SEAB) has created a working group dedicated to a charge from Secretary Perry and supported by Secretary Brouillette. The charge states:

> One of DOE's challenges is to "produce the innovators." Innovation turns ideas into practical solutions that advance the mission of the organization. Innovation needs to permeate the DOE more than ever for the United State to remain the world leader in technology. Moreover, DOE must invest in and protect the U.S. National Security Innovation Base from competition.
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> **Purpose of the Working Group**: The SEAB Innovation Working Group should examine and report on the following:
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> 1. Identify ways the DOE can foster creativity in a way that turns ideas into mission solutions.
> 2. Identify areas where innovation can make the biggest impact to the DOE mission.
> 3. Identify ways the DOE organization can evolve based on innovations.
> 4. Identify how the DOE can build an enduring culture of innovation.
> 5. Identify serious steps in achieving the goal of enhancing innovation at the DOE.
> 6. Identify innovation models and best practices from peer government and private sector institutions and benchmark these against the DOE.
> 7. Identify strategically significant technology areas on which U.S. defense and national security depend and promote domestic innovation in those sectors.
>
> I request that the SEAB constitute a working group comprised of SEAB members and outside experts to address questions such as these and to advise me on innovation issues related to the Department of Energy.
>
> Rick Perry

Innovation Working Group Members

The SEAB has designated two members to participate in the Innovation Working Group:

- Ankur Jain – *Founder and CEO, Kairos*
- Pedro Pizarro – *President and CEO, Edison International*

Pedro Pizarro, Ankur Jain, Chris Donaghey and Kurt Heckman comprise a steering committee to help manage the Innovation Working Group. Chris Donaghey represents the non-SEAB members of the Working Group as an industry leader, and Kurt Heckman is the DOE's Designated Federal Officer for SEAB.

The full working group membership list:

• Pedro Pizarro	• Ankur Jain
• Chris Donaghey	• Sonny Garg
• Brian Hoff	• Michael Madon
• Sha-Chelle Manning	• Dr. Cheryl Martin
• Dr. Michael McQuade	• Drew Murphy
• Stephanie O'Sullivan	• Laura Renger
• Dr. Nadia Schadlow	• Larry Schuette
• Gen. Larry Welch	• Kurt Heckman (DFO)

Innovation Working Group Process

This document contains the preliminary findings from the Secretary of Energy's Advisory Board (SEAB) Innovation Working Group. The process leading up to this report is as follows:

1. The Secretary of Energy issued a charge to the SEAB regarding the topic of Innovation.
2. A working group was formed under the SEAB. The working group includes two members of the SEAB, Pedro Pizarro and Ankur Jain, and a complement of leaders from industry and academia.
3. A steering committee from the working group developed a list of questions that was sent throughout the DOE.
4. The responses to those questions were compiled into a document that is an appendix in this document.
5. The working group used the DOE responses, their knowledge of the DOE mission and capabilities, and the working group members' own experience to develop these initial findings.

History and Problem Statement

Beginning with the Manhattan Project in the 1940's, the U.S. Department of Energy has had a 70+ year legacy of world-changing ingenuity and impact. The U.S. government's willingness to spearhead long lead technical research areas combined with strong American investment, production and consumption has resulted in unprecedented advances across a wide range of technologies, making America the global leader since World War II.

These advances can be seen across a broad range of disciplines from life sciences (e.g. microbiology and genomics) to chemistry (e.g. catalysis), physics (e.g. isotopes, fusion and cosmology), math, and computer science. These advances have profoundly improved America's security and economy. Repeatedly, the world has seen American advances in science turn into improved quality of life and

economic prosperity for America and our allies. The promise of further advancement continues, particularly with regard to cutting edge technologies such as artificial intelligence, quantum computing, additive manufacturing, and gene editing.

This successful cycle of public and private funding in research and development and economic production can be summed up in a single word: INNOVATION.

However, America's lead in innovation is under threat, and with it, America's security and commercial prosperity. The cold war saw the collapse of the Soviet Union, unable to sustain a credible competition with U.S. innovation. Today, however, China has managed to adopt many western concepts for R&D and build upon them quickly with little regard to intellectual property, human rights and the care of the environment. China is now leading the world in a growing list of research and development topics.

As steward of the great scientific capabilities embodied in the National Laboratory complex, the U.S. Department of Energy must continuously improve efficiency and production across the mission areas of energy, science and nuclear security. Today there is only one way to retain leadership while still respecting human rights, the environment, international partnerships, and hard-earned property rights: INNOVATION. The U.S. government, our industrial base and our academic institutions must innovate in new and faster ways.

Innovation Working Group Preliminary Findings

To champion and build a pervasive culture of innovation, DOE leadership must take a serious look at the factors that successfully create and nurture innovation as well as those that stifle innovation. Furthermore, both leadership and staff must recognize the difference between innovation and invention. While invention is essential, by itself, it is not enough. The best innovations solve real-world problems, are economically feasible, are socially acceptable and are worth the effort to change.

With this in mind, the SEAB Innovation Working group has drafted the following five sections which begin to address key opportunities in enhancing innovation.

I. Innovation Culture

The sustainable impact of innovation is not delivered by just a few within the DOE network. Instead, sustainable impact of innovation will happen when many- if not all- of the employees in the organization develop a mindset that actively seeks new ways of problem-solving and making connections between disparate issues. This observation supports the need to foster not only a culture of 'invention', but also to foster a culture of 'innovation'. Invention is the initial discovery of a something (product, concept or entity); innovation is both the "how" and "why", the actions, attitudes, and ambitions, that result in driving the invention (or combination of inventions) to have the desired sustainable impact. Only with a culture of innovation will people engage in bringing in all relevant stakeholders to scope problem definition, take reasonable risks with new ideas, invite alternative solutions and work efficiently together on an ongoing basis to drive to impactful outcomes. A culture of innovation goes hand in hand with talent development that is covered later in the report.

Three areas have been identified that can have positive impact on the innovation culture:

Leadership Commitment

a. Top-down commitment to innovative practices and celebration of the effort and outcomes is essential. Leadership must celebrate ideas including those that didn't work and were stopped or pivoted as well as those that did work. DOE leadership initiatives (e.g. grand challenges) and other crosscutting initiatives must keep innovation as a driving motivation and factor to be assessed for

success. It was noted that the effort to engage this SEAB Innovation Working Group is an important statement about the importance of innovation culture to DOE leadership.

b. Alignment of incentives promoting innovation throughout DOE and its partners.
   - For example, Office of Human Capital is encouraging its leadership to participate in communities of practice and attend Industry Day Events to "to keep apprised of best practices and emerging technologies that can be adopted within the Department to help drive improvements in HR service delivery." While this isn't specifically identified by the Office of Human Capital as an innovation practice, this work undoubtedly fosters a culture of innovation.
   - Additionally, the Office of Human Capital and CFO are participating in a group of five agencies that is seeking to define the needs for end-to-end software solutions for all aspects of human capital management. This cross-agency collaboration is an example of a process that fosters innovation and should be both recognized and encouraged by DOE.

Physical and Virtual Structures

a. Foster structures that facilitate serendipity and create space for collision of ideas. Creating space (both physical and virtual) which allows for the unplanned engagement of people of diverse technical backgrounds who may have parts of a solution or new ways of framing a problem are important for an innovative culture. These structures can be conferences, thematic meetings or summits where different technologies and ways of solving problems can be shared. The physical structures can be enhanced by well-designed engagement tools. The key mindset is to truly learn the new technology or hear how a problem was solved and to consider that mechanism in one's own space. The key framework empowers the dialogue that opens the potential solution known to one to a new application known to another.

> *Fortune favors the prepared mind.*
>
> Louis Pasteur

b. Review best practices and tools for online problem definition and idea sourcing; understand and implement the best practices available to curate and maintain these collaboration spaces.

c. Office placement and the arrangement of building spaces based solely on budget grouping discourages collaboration. One example noted the co-location of DOE scientists and grid storage communities at the Grid Storage Launchpad (GSL) at PNNL to enhance collaboration and spawned innovation. A concerted effort should be made to evaluate if better collaboration spaces could be set up at Forrestal, Germantown and at the labs to bring together different expertise.

d. Another idea to consider is use of virtual collaboration seminars that frame and discuss problems that researchers at all stages of development could access/participate in.

Collaboration

Highly structured organizations create segmentation in the workforce. This results in stovepipes of specialization which can be good for achieving specific outcomes, but which can also limit cross-pollination of ideas and innovation.

a. Cross-office collaboration on problems should be encouraged and funded, empowering "lane sharing vs lane protection". Examples include the cooperation between Office of Electricity (OE) and Energy Efficiency and Renewable Energy (EERE) on the Grid Modernization Technologies efforts and the developing cooperation between Fusion Energy Sciences and ARPA-E. Details of why these are working and where more collaboration would be beneficial should be explored.

b. Incentive structures are very powerful to encourage or inhibit collaboration for impact. Financial reward structures (prizes, grants etc.) for individuals as well as labs/departments should be reviewed for collaboration and impact. For example, Lab Directed Research Development (LDRD) could have funding incentives if fund utilizations showed cross organization collaboration with the

greatest incentives for the furthest gaps that are crossed (e.g. lab to lab). Non-financial recognition mechanisms should also be considered such as attribution and publicity.

c. The DOE should explore where new ML/AI technology could identify collaborators who should be involved with solving a specific problem. Encouraging collaboration of people/teams not usually engaged with DOE via physical or virtual 'teaming lists' as program areas are mapped would allow people to start to work together on problems.

II. Portfolio Assessment and Management

The Innovation Working Group identified the existence of a streamlined portfolio assessment and management process as a key component to fostering innovation within DOE. To that end, the working group requests additional information regarding the current portfolio assessment and management processes, including a description of the current processes that DOE uses to obtain input from academia and industry when prioritizing technology focus areas.

The working group also requests additional information regarding the innovative technologies that DOE is currently prioritizing. Based on industry knowledge and a review of the information provided by DOE to-date, the working group recommends a deeper dive on the current efforts and opportunities for additional engagement in the areas of artificial intelligence and quantum computing.

In evaluating the portfolio assessment and management processes, the working group will recommend steps to improve transparency across the DOE (including, as appropriate, providing transparency with regard to the status, budget and key outcomes of projects), facilitate information sharing of results across DOE, foster the prioritization of key technologies, and ensure that standardized performance indices are used to measure project success.

III. Foster Faster Industry-DOE Collaboration and Communications

The United States must continue to grow energy technologies. To achieve growth, the DOE must partner with industry. This partnership will help define the key problems and provide solutions. This assistance can include insights into standards, testing protocols and scaling pilots that allow assessment of solutions and reduction of risk. However, there are some significant barriers impacting the willingness and ability of industry to engage with DOE. Four key areas for focus identified by the working group include:

- Understand the state of industry engagement today.
- Enhance shared understanding of state of play and where industry can engage.
- Improve understanding and access to national assets important to energy innovation
- Reduce the administrative friction of working with DOE

Understand the State of Industry Engagement

The first step in any engagement is knowing one's portfolio. In the case of the DOE, the DOE needs to holistically know the companies engaged with the DOE today and identify their level of engagement and the role they play in advancing the DOE missions. Furthermore, the DOE needs to understand which significant industry players are not part of DOE's portfolio and why.

Enhance Shared Understanding of State of Play and where Industry Can Engage

a. While some parts of DOE have established roadmaps, the working group did not find any comprehensive set that could be a shared starting point for engagement. DOE should establish roadmaps with all stakeholders and maintain these roadmaps in easy to access locations with user-tested interface.

b. DOE should provide "outcome-based" maps in addition to technology-specific maps and keep them updated to facilitate ongoing engagement. Outcome-based roadmaps are understood as roadmaps that are designed to achieve a beneficial end state, such as a low-cost resilient renewable electric grid. In this example, instead of focusing merely on the technologies to achieve that outcome (such as battery storage, solar, etc.) the roadmap would also look at system level integration elements and also focus on the other components (economic, workforce, market factors) that are necessary to achieve that end state.

Improve Understanding of and Access to National Assets

a. DOE Capability Awareness: For greater innovations to take root, engagement with industry must increase. Just like making space for the collision of ideas within the DOE, the DOE must facilitate the opportunity for collision of ideas with the industrial base outside of government. The major barrier to this is the pervasive lack of awareness of the work done in the National Labs by the American industrial base and the general public. While there is a tremendous amount of public information on the DOE web sites, there is no strategic message to the public that conveys the DOE's mission and capabilities in terms accessible to the general public. While DOE might be known for the efforts of Fossil Energy (FE) and Nuclear Energy (NE), very little is known about its energy efficiency and renewable energy (EERE) mission and virtually nothing is publicly known about the DOE's science mission. Since these missions are not new, the absence of awareness reflects a great need within the DOE for a more strategically executed message to the public regarding the mission space. Without greater public awareness there will be no increase in innovation caused by the collision of ideas between the DOE and industry. The working group viewed the X-Labs program as a key new and innovative tool to overcome the above issues and foster enhanced industry-DOE collaboration.

b. DOE Capability Navigation: Today the DOE has 27 user facilities that have tremendous capability to advance US energy and science priorities. Even if industry is aware that DOE has capabilities aligned with their corporate needs, there is no easy way to find out the breadth of what's available. The companies have to establish relationships with the different labs to get the complete picture. For example, if a company has a nanotechnology material challenge, should it go to the Center for Functional Nanomaterials (CFN) or the Center for Integrated Nanotechnologies (CINT) or the Center for Nanophase Materials Sciences (CNMS) or somewhere else? The DOE needs to provide expertise to guide the companies to the right solution for the user across all DOE facilities. DOE should develop and maintain asset capability mapping (both actual assets and problem-solving capability) across all national labs and any university-located shared facilities. This should be supported with a robust online system available to the public but also include a technical staff with the capability to avail this information to those making inquiries.

c. Learn from Others: Engage non-DOE labs and facilities (. e.g. APL) to tap into their asset awareness efforts; ideally, they could provide same format as above and be listed via similar online portals.

d. Review Retiring Assets for Possible Alternative Use: One concern voiced by the working group was in regard to the availability of the high-performance computing needed to develop AI models for industry. Could DOE's suite of supercomputers that are no longer on the cutting scientific edge be considered for transformation into resources for industry? For example, the Titan supercomputer at Oak Ridge National Laboratory would be in the top 10 super computers, but it was disassembled to make way for the next generation (Exascale) supercomputer.

Reduce the Administrative Friction

The DOE should continue to reduce the difficulty of working with the DOE.

a. Improve the speed and ease of contracting (simplify SPPs, CRADAs, ACTs, NPUAs, and streamline the approval process).

b. Understand time to contract for all offices/facilities; share best practices; measure and publish contracting times and set goals for improvement; does DOE have data today to show what/where best practices in contracting exist and what improvements could be made across the complex?
c. Provide capability to enhance understanding and training of how to utilize various DOE contract instruments
d. Common DOE Engagement Method: Doing business with the government requires certain hurdles to be crossed. Once learned, the process should be identical for engaging other parts of the DOE complex. For example, the paperwork to collaborate with SLAC should be identical to the paperwork to engage with Brookhaven or DOE headquarters. Therefore, the report recommends the development of common agreement formats across all DOE facilities including the labs.

IV. Leverage Innovative Funding Approaches

Throughout the history of discovery in America, the everyday citizen, the small business owner, or a startup have been critical contributors for innovation that has changed the world. For this reason, the U.S. government has developed ways to fund innovations that support entrepreneurs, small businesses, and startups.

In our highly competitive environment, it is imperative that the DOE explore ways to leverage innovation funding approaches. DOE can be at the forefront of rethinking the current paradigm of government funding – which is often limited by specific use cases, timing, and narrow pools of recipients – and explore ways to overcome budgetary stovepipes.

DOE has a unique opportunity to lead the nation in developing funding programs to identify and assist innovators in our nation to develop their ideas, turn them into a reality, and make a change in the country. Today a number of DOE offices are focused on developing innovative funding ideas such as challenges and prizes, as well as whole new models like that of ARPA-E. The working group encourages continued focus on new approaches like these and sharing of the best practices learned. In addition, the group also discussed several specific ideas that may benefit from further examination:

a. Reimagine Access of Small Businesses to DOE SBIR funding
Small businesses are the backbone of innovation, but since they are, by definition, small they often struggle to bridge the funding challenges to move their ideas to scale. The Department already has a significant funding stream dedicated solely to small businesses working to bring their innovations to market: The Small Business Innovation Research (SBIR) program.

In 2019, DOE made over 600 SBIR awards with over ~60 technical topics and ~250 subtopics as funding options at a total of over $275M. Reimaging the SBIR program using some of the identified best practices across agencies could be a significant boost to these companies and the mission of DOE. In addition, DOE should evaluate the benefits of being more focused on a reduce number of key topics for SBIRs that can either advance technology transition and or demonstrate an alternative innovative technology solution. The department could then evaluate the benefit of having more coordinated and strategic investments in SBIRs with other offices as part of an investment strategy (i.e. ARPA-e, Basic Energy Science).

b. Address gaps in funding for the non-technical aspects of moving technologies from the laboratory to the market, such as access to experts and facilities. Some initial ideas suggested by the working group include further use of funds to help lower the cost of production, manage changing technologies, and the end-to-end support provided by DOE advisers, researchers, scientists and engineers help commercialize the idea.

DOE should consider funding additional programs that connect individuals and companies with the right adviser, partner, mentor or technology provider and give companies access to facilities. These partnerships will help them transition an idea to commercial reality. This requires an office within the DOE with very strong technical knowledge of the broad portfolio of DOE and the national laboratory complex. Acquiring and sustaining the portfolio knowledge is no small task. In addition, the laboratory voucher program that was piloted several years ago appeared to provide important access. Do metrics exist on its cost / benefit that may suggest it should be re-introduced or reimagined?

The DOE should measure success of technology transfer efforts like these by including more financial metrics such as Internal Rates of Return (IRR), number of exits/IPOs, jobs created, capital generated etc. Identifying the precise, appropriate metrics would be an area for additional study.

c. Investigate Innovative DOD Programs

While DARPA has a long successful history within the Department of Defense (DOD) and ARPA-E was modeled on it, DOD has also been exploring in recent years a number of ways to increase access to technical innovation from companies that have not traditionally done business with DOD as well as to provide capital to bridge demonstrated capability with providing a product in scaled quantities. The working group suggests review of some of these newer DOD entities and instruments as part of an overall assessment of innovative funding that may speed invention to products in the market. Some examples cited during the discussions include:

- Evaluate DOD's Defense Innovation Unit (DIU) model: In 2015, the Department of Defense launched the Defense Innovation Unit Experimental (DIUx) Silicon Valley. The purpose of DIUx was to increase access to technical innovation from companies that have not traditionally done business with the DoD and "accelerate the adoption of commercial technology throughout the military and grow the national security industrial base." Through the use of Other Transaction Authority (OTA) contracts, DIU's objective is to identify and rapidly transition early stage commercial technologies from development to prototype to fielded solution in less than 24 months. DIU can also award production contracts using either OTA or FAR-based contracts.
- Evaluate Air Force's Innovation Funding Model: The Air Force tech accelerator (AFWERX) offers the prospect of an extra injection of capital for commercial startup firms that show promise in developing weapons for the service, via matching funds that start at $3 million with no notional limit. The objective of the so-called commercial solutions opening (CSO), "is aimed at "solutions with significant dual-use potential; ability to scale rapidly; and of strategic interest to the US Air Force." The idea is to help startups bridge the dreaded 'valley of death' between a demonstrated capability and how to turn it into a DoD program of record that can in turn field new capabilities in quantities that are useful. Other such mechanisms are worthy of additional study.

d. Consider Further use of Other Transaction Authority

Unlike FAR-based contracts, Other Transaction Authority agreements do not require the same terms and conditions typically found in government contracts. In some cases, OTAs may be exempt from the FAR and government cost accounting standards. This feature enhances the government's ability to attract innovative emerging technology developers by making it easier for these companies to do business with the government without the typical overhead needed to support traditional government contracts.

Eleven federal agencies are authorized to use Other Transaction Authority agreements with DoE being granted temporary authorization in 2005 and ARPA-E being granted permanent authorization in 2011. However, DoE's and ARPA-E's authorizations only allows them to award research, development, and demonstration (RD&D) projects but not prototype projects. They have a further requirement that the Secretary of Energy provide a written approval indicating a more traditional contracting arrangement does not work.

V. Invest in People: Retaining, Growing and Inspiring Top Talent

The greatest asset of the Department of Energy is the accumulation of brilliant people collaborating on some of the nation's greatest challenges. At the heart of the Department are the scientists, graduate and undergraduate students, engineers, and civilian DOE workers – all working in an environment of collaboration, intellectual exchange, and constant inquiry. It is people that drive the Department's ability to ensure America's security and prosperity by addressing its energy, environmental, scientific and nuclear challenges. It is people that drive the transformative science and technology solutions that emerge from the DOE enterprise. It is the ideas of individuals that have sparked some of the Department's most important discoveries and innovations. Attracting, retaining and motivating the most talented and creative people at DOE is critical to building and sustaining a culture of innovation.

The ongoing globalization of STEM requires that the DOE reconsider its workforce policies and practices to ensure that it retains access to a significant share of the best and brightest STEM talent available. Access to highly qualified STEM talent should be a primary consideration in DOE workforce recruitment and retention policies, guidelines, and practices. Not only is there competition across the private sector for top talent in America, but there is competition across government agencies as well. Given the diverse array of opportunities that DOE offers, it is well positioned to attract talent and to help develop the skills which provide a path to valuable careers in industry, government, and academia. In the presence of high economic competition (e.g. big salaries at companies), the DOE must effectively communicate the importance of the mission. There are still those that will sacrifice a level of personal gain if they believe in the mission they are supporting. Efforts by the Labs to support some shared positions with industry in areas like AI is helpful in this regard.

This working group has identified four lines of effort which DOE can prioritize to attract and retain talent.

1. Appreciate Existing Talent: Retain and recognize talent; early career awards and more.
2. Attract New Talent: Identify methods and approaches that inspire new hires. There are not many places that can boast on the level of positive impact to mankind than the DOE laboratories.
3. Provide opportunities – Ongoing educational and other opportunities to foster creativity and continue education.
4. Understand and Predict: Understand the full range of talent currently within the DOE system and identify (and prepare for) likely future gaps. This is an area where existing platforms can offer important insights. For example, existing AI driven talent management platforms can provide a fuller picture of existing DOE talent and identify emerging gaps and link this information to broader trends in academic and the public sector so that DOE can be proactive about recruitment.

The working group had some specific suggestions within these efforts that build upon existing programs. A theme across these ideas is when developing programs to recognize the best and brightest talent include both the innovators and the inventors:

a. Young Talent - Expand the Young Career Award Program to also include young career scientists that are innovators: The DOE Young Career Program in 2019 competitively selected 73 scientists from

across the nation – including 27 from DOE's national laboratories and 46 from U.S. universities – for outstanding inventions. This program, in its 10th year traditionally focuses on young researchers for their "Inventions". The DOE should expand this program to include additional selection criteria to recognize the value of Innovation in addition to the value of Invention. This type of award lays the groundwork for future career development with investing in exceptional researchers *and innovators* during the crucial early career years, when their formative work is conducted and reflect that creativity in application is valued on par with creativity of discovery.

b. Ensuring the Innovative "DNA" at DOE through Future DOE Recruiting practices: DOE offers postdoc and fellowship opportunities across the lab complex that provide the opportunity to deeply focus on technical work at the labs. A percentage of those postdocs are then recruited and hired at those labs in full-time positions due to their technical excellence which has served us well. The selection criteria should be transparently valuing collaboration across the Lab sites and for transition to Industry.

- For example, Kathy Banks at Texas A&M, Michael Crow, President of ASU, are changing culture and driving innovation by hiring new academic research talent that is both technically rigorous and also innovative. They are changing behavior through new faculty.
- The DOE should also place emphasis on a percentage of new hires, not only hired for technical talent, but also for innovation. This type of DOE "Innovative DNA" ensures the mind-set, or creative thinking of "associating" non-related questions, problems, scientific work and or ideas from a variety of different domains, and fields and labs and carries the DOE forward competitively.

c. The Power of Connectors – Find top connectors that are force multiplier for DOE scientists and labs

- With over 17 Labs and 14,000 DOEs scientists, other US Agencies, US Industry and Universities coupled with geographical and structural boundaries, it is a daunting task to connect the right idea, to the right problem at the right time, with the right talent…and to build the "Medici effect".
- With the slow progress in STEM education and growing international pressure for foreign students educated in the U.S. to return to their home countries, the DOE needs to elevate the effort to retain top talent and maximize their time and expertise by hiring the best connectors. The Working Group understands that there are heightened sensitivities regarding potentially inappropriate influences and access to DOE by adverse foreign actors, and accordingly, DOE has been increasing security controls. At the same time, both scientists within DOE, and those working with DOE, are requesting clarification regarding the current framework. We encourage DOE to continue the discussion with the scientific community to clarify the boundary conditions necessary to protect sensitive science, while also recognizing the strategic value of collaborations on open science topics, so that the US can access the world's very best talent through recruiting and collaborations.

> The **Medici Effect** involves innovation that happens when disciplines and ideas intersect. The concept was highlighted in the book ***The Medici Effect*** by Frans Johansson.

- DOE inventors often know how and why their ideas and technical work can make a significant impact in a domain, but they lack the resources to see it through. A greater emphasis on funding the lifecycle is recommended, with involvement of additional labs, federal agencies, venture funding, university, and or industry partners.
- The DOE should develop a small group of connectors that have the deep trusted networks, and ability to utilize robust organizational mapping, market road-mapping, and research analysis to

connect the right people at the right time to the right research, labs to labs, labs, to industry, and ideas to opportunities.

d. Mapping the People Innovation Ecosystem: It is imperative that DOE know who its top innovators are. Once identified, these should be engaged with a follow-on study/roundtable identify forward steps in expanding innovation at DOE. DOE should then do a deep dive on web science and analytics to identify connectors (e.g. who is working across the labs, who does everyone wants to work with, who is creating value across the entire network). From this information the DOE should be able to identify the barriers to innovation and the challenges to making innovative connections.

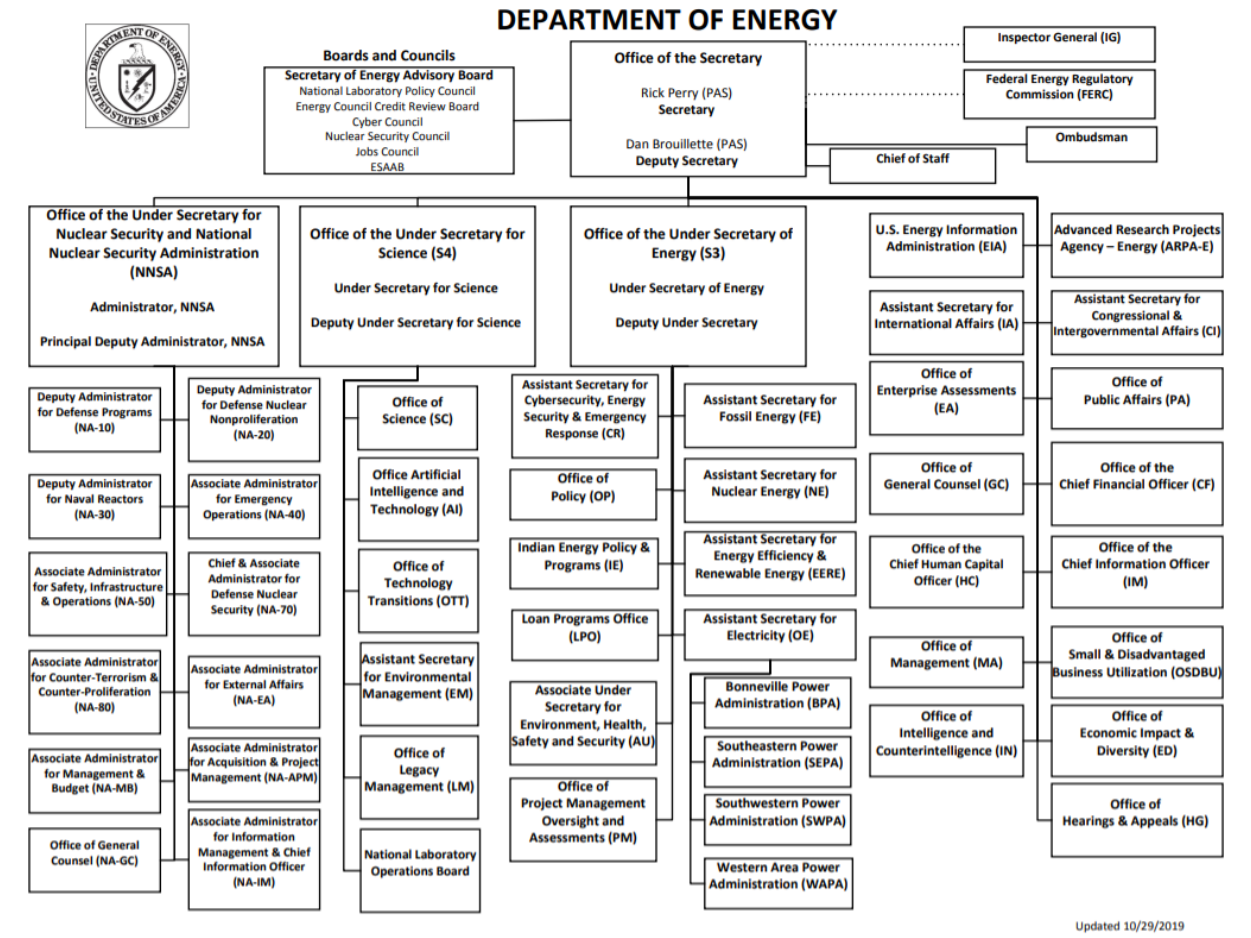
It is imperative that DOE has a strong working knowledge of its patent portfolios, but also who is filing those patents, whose patents are being licensed, and whose papers are being cited in the top patent applications. These insights will indicate when, how, where and why an important piece of science is transitioning.

Conclusion

The SEAB Innovation Working Group respectfully submits these preliminary findings and recommendations to the full SEAB.

DOE Organization

The Department of Energy has three core missions: Energy, Science and Security reflected in the organization of the DOE where there are three Under Secretaries: Under Secretary of Energy (S3), Under Secretary for Science (S4) and Under Secretary for Nuclear Security (S5). In addition to the core missions, ARPA-E also reports to the Secretary of DOE.



The Department of Energy also has management functions for the DOE enterprise. These report to the Secretary through the Deputy Secretary's office.

Data Call to DOE

In response to the Secretary's charge, the following questions were disseminated throughout the DOE:

1. Excluding AI, what innovative technologies are being developed in the DOE?
2. Excluding AI, what innovative technologies from industry are being used in the DOE?
3. What systems or processes does the DOE employ to foster innovation internally?
4. How do the labs foster innovation?
5. How has or should the DOE built platforms to help others be innovative?

The questions excluded innovations associated with artificial intelligences since there is a separate initiative dedicated to artificial intelligence.

S3 – Under Secretary of Energy

Office of Nuclear Energy

Excluding AI, what innovative technologies are being developed in the DOE?

NE is supporting the development of a number of revolutionary advanced reactor concepts and fuel cycle concepts. At an individual technology level, NE is developing sensors that can operate under different operating environments to support the advanced reactor concepts including high temperatures and high irradiation environments. Other technologies include integrated energy systems to support flexible operation of nuclear power plants.

Excluding AI, what innovative technologies from industry are being used in the DOE?

Technologies developed in industry being used by DOE include drone self-navigation indoor technology, imaging systems to capture analog gauge measurements from a video stream, testing equipment, and cloud services.

What systems or processes does the DOE employ to foster innovation internally?

There are a number of programs intended to foster innovation within the DOE complex. The Laboratory Directed Research and Development (LDRD) programs help to maintain the technical vitality of the laboratories and encourage innovation amongst the researchers. Other programs include the Technology Commercialization Fund and Energy I-Corps. The Consolidated Innovative Nuclear Research (CINR) Funding Opportunity Announcement (FOA) is another very successful mechanism that fosters innovation at universities, national laboratories, and within industry.

How do the labs foster innovation?

Laboratories foster innovation through the aforementioned LDRD programs and by proactively engaging DOE program managers to support programs that enable innovative thinking.

How has or should the DOE build platforms to help others be innovative?

NE established the Nuclear Science User Facilities in 2007 to provide access to the unique capabilities in the national laboratory network to support innovative research to the nuclear community. Since then, the Gateway for Accelerated Innovation (GAIN) Initiative was established to directly provide access to the DOE complex as well as financial support for accelerated development of innovative technologies. Finally, NE recently announced the kickoff of the National Reactor Innovation Center (NRIC) which is focused on the demonstration of innovative technologies.

Office of Electricity

OE's overall vision is, in partnership with private and public sectors, to use a mix of technology and policy solutions to harness innovation for a stronger, more resilient and reliable North American energy system.[1] The Office's Grid Storage Launchpad (GSL) and sensor R&D initiatives further this vision, though in different ways. Whereas GSL addresses the current absence of an integrated national capability to independently test next-generation materials, devices, and energy storage systems under grid operating conditions, the development of new sensor technologies will allow system operators to anticipate, identify, and respond to threats in a manner more expeditious than currently possible. OE's efforts on these fronts will help ensure that the Department succeeds in establishing a grid that will withstand the tests and challenges of the future, while ensuring that Americans continue to enjoy the benefits of our amazing energy abundance.[2]

Grid Storage Launchpad

Though the Department has the technical expertise and know-how required to assess new energy storage technologies that would benefit our Nation's electric grid, it currently lacks a dedicated physical location at which to perform this task. Construction of the GSL, a modern, flexible, and sustainable energy storage technology facility, at Pacific Northwest National Lab, will address this critical mission gap.

The Launchpad has three main objectives: 1) to validate, 2) to accelerate, and 3) to collaborate. GSL's validation of technologies at earlier maturity stages will allow for reductions in both time and cost regarding the development of storage chemistry (e.g. battery) innovations- current industry efforts are focused later stage prototyping. Similarly, GSL will enable the independent

[1] "Our Vision," Office of Electricity, accessed October 31, 2019, https://www.energy.gov/oe/mission/our-vision.
[2] *As per Undersecretary of Energy Menezes' announcement of $40 million of funding for the GMI*. "DOE Announces $40 Million for Grid Modernization Initiative," Energy.Gov, January 24, 2019, https://www.energy.gov/articles/doe-announces-40-million-grid-modernization-initiative.

testing of next-generation grid energy storage materials and systems under realistic grid operating conditions. Through the propagation of rigorous grid performance requirements at all stages of development, benchmarks and systems development will be accelerated and de-risked. The Launchpad's provision of new and dedicated capabilities that are currently non-existent in industry, such as an in-operando storage characterization capability, is critical to the acceleration of materials development. Finally, through the collocating of DOE scientists and storage R&D communities in a collaborative environment, GSL will lower the barriers to entry for innovative storage technologies, from benchtop to grid deployment.

OE's Grid Storage Launchpad will enable the continuation of and enhance research on novel materials and system components in order to resolve key cost and performance challenges for batteries and other storage technologies,[3] helping to ensure that our Nation is seen as a global leader in R&D and grid storage efforts for years to come.

Sensor R&D

Aging electrical infrastructure, increasing complexity and variability in electricity generation and demand, extreme weather events, cyber-attacks, acts of terrorism, and human and system errors are major threats to our Nation's grid and are exacerbated by suboptimal situational awareness of real-time grid conditions. Malfunctions on the grid may also manifest themselves into other issues altogether, as was the recent case of two wildfires in Lafayette, California.[4] Additionally, factors such as the proliferation of new technologies, a major shift in generation mix, and greater customer involvement, have stimulated the major system-wide transformation our grid is currently undergoing, which "has generated the need for greater [visibility] throughout the electric power system to manage the capabilities of its increasing number and diversity of assets."[5] Recognizing the potential in sensing technologies for mitigating the abovementioned risks and filling capability gaps, OE is conducting and supporting sensor R&D through a number of projects, including the multi-year program plan, Sensor Technologies and Data Analytics, and Arcing Detection and Data Analytics for Fire Prevention.

OE's sensor program, Sensor Technologies and Data Analytics, focuses on four core technical areas: 1) enhancing power system resilience by improving operational awareness, to include developing the capability of distinguishing between outages resulting from man-made events and naturally, regularly occurring faults and failures; 2) detecting incipient failures/faults through real-time system health monitoring; 3) forecasting behind-the-meter distributed energy resource impacts on the T&D system; and 4) monitoring for critical infrastructure interdependencies in order to provide early warning of deteriorating system conditions, establish wide-area system visibility, improving resilience any reliability, and enabling interconnected system diagnostics.[6]

[3] These components may include: electrode materials, membranes, electrolytes, interconnects, and supporting power electronics and power conversion systems.
[4] Matthias Gafni, "PG&E to State: 2 Lafayette Fires Linked to Electrical Malfunctions," *San Francisco Chronicle*, October 28, 2019, https://www.sfchronicle.com/california-wildfires/article/PG-E-to-state-2-Lafayette-fires-linked-to-14568505.php.
[5] Advanced Grid Research, *Sensor Technologies and Data Analytics* (Washington, D.C.: Office of Electricity, 2018), p.1, https://www.smartgrid.gov/files/Sensor_Technologies_MYPP_12_19_18_final.pdf.
[6] Ibid., p. iv.

Arcing Detection aims to use optical voltage and current sensors to monitor and detect arcing events which, in combination with SCADA system alerting, offers the possibility of preventing wildfires. The developed sensor cluster will utilize machine learning and AI to extract signal signatures of identified existing or upcoming arcing faults in order to establish an arcing fault signature library.

The sensors developed through OE's R&D efforts will play an integral role in the timely prediction, diagnosis, and prescription of all system assets and variables, during both normal and extreme-event conditions, supporting not only enhanced grid resilience and reliability, but national security and public health and safety.

Office of Energy Efficiency and Renewable Energy

Excluding AI, what innovative technologies are being developed in the EERE?

EERE utilizes the world leading enterprise of National Laboratories, university and industry partners to drive innovation and continue to advance technologies and research in fields that support American prosperity, security and competitiveness. Among EERE's many innovative technology initiatives, the following represent key priority areas:

Critical Minerals: DOE is pursuing advance transformational research and development across the critical materials supply chain to strengthen U.S. critical materials supply chains and industrial base. This program is focused on: 1) improvements in domestic production, 2) reuse and recycling, and 3) research into substitutes for critical materials. R&D investments and partnerships at DOE National Labs, universities, and industry will drive innovation, de-risk and scale technology to reduce the cost of materials, scale processes economically, and reduce environmental impacts of domestic production.

Advanced Energy Storage: DOE's Advanced Energy Storage Initiative (AESI) takes a holistic approach to energy storage. AESI is focused on developing technologies to create 1) more flexible generation and 2) more flexible load, thereby increasing the reliability and resilience of the U.S. electric grid. The activity will drive improvements in bi-directional electrical energy storage and other technologies to increase the flexibility of energy supply and demand.

Grid Modernization Technologies: The Grid Modernization Initiative (GMI) focuses on developing new architectural concepts, tools, and technologies that will better measure, analyze, predict, protect, and control the grid of the future. EERE collaborates closely with the Office of Electricity to co-manage the initiative.

Energy-Water: Present day water and energy systems are interdependent. The United States has historically benefitted from access to low-cost water supplies, but challenges for freshwater supplies could threaten U.S. economic competitiveness and water security. EERE is supporting the Water Security Grand Challenge, a White House initiated, U.S. Department of Energy led framework to advance transformational technology and innovation to meet the global need for safe, secure, and affordable water. EERE utilizes a coordinated suite of prizes,

competitions, early-stage research and development to develop innovative solutions to address this complicated issue.

Circular Economy: The circular economy concept represents a paradigm shift of the conventional linear energy model to a circular model with potential to make energy more affordable; secure supply chains; and enhance domestic manufacturing and industry. As technologies within the EERE portfolio continue to grow, R&D must address end-of-life considerations for EERE technologies as part of a "circular economy" strategy. EERE's circular economy effort will develop new economical deconstruction technologies for existing plastics, increase upcycling, and develop infinitely recyclable plastics. EERE will develop a cross-office circular economy strategy that spans the EERE portfolio. One of the key tenets of this strategy will be to ensure that new EERE technologies are designed for recyclability and reliability ("recyclable-by-design").

Excluding AI, what innovative technologies from industry are being used in the EERE?

EERE partners with U.S. companies, universities and National Labs to develop new technologies. Through these partnerships, EERE leverage developments in private sector and in science for opportunities to translate them into practical innovations in technology. Below are examples of innovative concepts from industry that have been incorporated into EERE R&D initiatives:

- General Electric developed a magnetic device for a magnetocaloric heat pump regenerator. The regenerator can be used to move working units of magneto caloric material through the fields of magnetic flux to provide for heating and cooling as part of heat pump cycle. EERE's Building Technologies Program (BTO) is partnering with GE and ORNL to develop a residential refrigerator/freezer utilizing the magnetocaloric effect (MCE) with 20% lower energy consumption relative to current U.S. Department of Energy minimum efficiency standards. Refrigeration technologies based on MCE are fluorocarbon-free and offer potential energy savings of 20%–30% over conventional vapor compression systems.
- Hewlett Packard Enterprise (HP) and NREL successfully developed the most energy efficient high-performance computing system. Together, NREL and HP pioneered the use of warm water liquid cooling for HPC and led the transformation in HPC to highly efficient warm water liquid cooling enabling high power density racks of IT equipment. This type of approach is now used in DOE's largest HPC systems including Summit from IBM, the world's fastest system at ORNL.
- Delphi Automotive developed the ultrafast (femtosecond) laser that can overcome limitations of machining. EERE AMO partnered with Delphi and Microlution, Inc. to further development of Microlution's ultrafast laser and precise motion control technologies for micromachining difficult-to-machine materials. Delphi successfully transferred laser machining technology to its production line in Rochester, NY to supply over 1 million direct fuel injectors per year while reducing process times by 80%.

Microlution also offers derivative laser machining products for other materials and applications across other industries.

What systems or processes does the EERE employ to foster innovation internally?

A major EERE priority to help drive new and innovative thinking internally is to enhance cross-office collaboration, improve information sharing, and break down silos across technology areas to drive maximum impact. EERE fosters collaboration and has been actively identifying opportunities to co-fund activities through multi-office FOAs and lab calls. Additionally, EERE actively reaches out across the DOE complex to ensure our efforts are coordinated with and complimentary of activities funded by other DOE offices.

How do the labs foster innovation?

The intellectual and physical assets at DOE's National Laboratories offer world-class science and technology (S&T) capabilities to the Nation. EERE's National Renewable Energy Laboratory (NREL), fosters innovation both within the lab and throughout the industry by offering opportunities to leverage the laboratories unique capabilities. EERE and the laboratory encourage "seed" projects, similar to the LDRD program, which allow scientists and engineers the opportunity to develop creative solutions to complicated research questions. Additionally, NREL sponsors the Wells Fargo Innovation Incubator (IN^2), which supports early stage commercial building technology companies through technology development, validation, and pilot opportunities. NREL just introduced the 6th Cohort with 10 new companies and has extended this program from energy efficiency into new building technology for commercial and residential. Another example of NREL's ability to foster innovation is the Industry Growth Forums, which are held annually to help early stage clean energy entrepreneurs and lab innovators develop market presence by facilitating relationships with potential commercialization and financial partners.

The laboratories are also encouraged to collaborate and leverage the diverse knowledge and skillset available at each of the laboratories. One example of this successful collaboration across DOE and the lab complex is the Grid Modernization Lab Consortium. One of the main components of the consortium portfolio is the Grid Modernization Lab Call, which is a comprehensive effort of innovative projects that span over the course of three years managed by the national laboratories aimed at developing technologies and processes to modernize the US electrical grid.

How has or should EERE built platforms to help others be innovative?

EERE has invested in a variety of platforms to help others innovate, including advanced user and test facilities and energy innovation hubs. In FY15, EERE launched the initial cohort of the Energy I-CORPs program, which pairs teams of researchers with industry mentors for an intensive two-month training. The program enables lab researchers to define technology value propositions and develop viable market pathways for their technologies. The successful EERE program has become a DOE-wide effort managed by the Office of Technology Transitions.

EERE also sponsors the Technologist in Residence Program, which pairs senior technical staff from national laboratories and manufacturing companies to work together towards long-term strategic collaborative partnerships and impactful manufacturing solutions. Some examples of current EERE innovation platforms include:

Energy Systems Integration Facility (ESIF) at NREL: As an EERE user facility, ESIF provides the flexibility that partners require to explore projects that they could not execute anywhere else. Specifically, ESIF is a unique national asset providing the public and private sectors with the ability to conduct critical analysis on multiple technologies and energy sources in integrated energy systems; and enables design and energy systems performance optimization. The user facility provides partners a platform to identify and resolve any risks of integrating their emerging energy technologies into their system process. A priority focus is to enable a resilient, secure modern grid that can accommodate a variety of domestic energy resources.

NREL Flatirons Expansion
EERE is investing in an expansion of the diverse capabilities of the National Wind Technology Center (NWTC) now called the NREL Flatirons Campus. The expansion fills an important need for an integration capability beyond the current 1 MW ESIF limit to up to 20 MW with multiple controllers and a linkage to a substation. Upon completion, the Flatirons campus will be a fully integrated, large-scale experimental research platform that will include an Enhanced Grid/Energy Systems Control Center. In addition, a High-Speed Data Link will connect the NWTC and the ESIF at NREL to other National Laboratories. The expansion will also include a Beyond Megawatt Scale Extreme Fast Charging Station to research, integrate, and evaluate fast charging station impacts on the grid. These expanded capabilities will allow DOE to test a suite of technologies supported under the Advanced Energy Storage Initiative and leverage the future power capacity of the campus.

Biomass Feedstock National User Facility (BFNUF): The Biomass Feedstock National User Facility (BFNUF) is an EERE funded user facility that offers technology and expertise to help the bioenergy industry overcome biomass challenges during scale up and integration of biomass preprocessing facilities. The BFNUF includes a full-scale, fully-integrated Process Development Unit which is flexible enough to allow industry partners to customize process flow and insert third-party equipment to pilot a wide range of biomass preprocessing options.

EERE's Energy Innovation Hub and Institute Concepts: Energy Innovation Hubs and Institutes are helping to advance promising areas of energy science and engineering from the earliest stages of research to the point of commercialization. By design, these partnerships, foster integration across the spectrum of basic and applied research, drawing on resources and capabilities developed by both the Office of Science and EERE, to achieve its goals. This concept enables technologies to move out of the lab into the private sector by bringing together leading scientists to collaborate on critical energy challenges. A model EERE Hub is the Critical Materials Institute (CMI), one of four Energy Innovation Hubs funded by the Department. CMI consists of 290 scientists, engineers and support staff at four national laboratories, six universities, and 13 industrial partners.

Office of Fossil Energy

Excluding AI, what innovative technologies are being developed in the DOE?

The vast majority of recent progress made on fossil energy technology development started with investments made by the U.S. Department of Energy (DOE) [1]. The Office of Fossil Energy (FE) maintains a portfolio of more than 1,000 active projects, covering a wide range of technologies. Many active projects have a public webpage that describes the effort, along with links to any presentations [2]. Some recent achievements include [1]:

- Advances in the recovery of critical rare earth elements (REEs) from coal and coal by-products—which could create new industries and jobs.
- Highly efficient coal technologies that achieve near-zero emissions and are commercially deployable in a competitive energy market.
- Horizontal drilling and stimulation methods that paved the way for oil and gas operators to create the shale revolution, which set us on the pathway toward energy independence for the first time in decades.

Currently, FE's research and development (R&D) effort is focused on five technology areas to address challenges currently confronting the industry [1]:

- Modernizing the aging coal fleet.
- Revolutionizing energy systems to give power producers options in the future.
- Engineering an evolving energy infrastructure.
- Water management.
- Mastering the subsurface to engineer geologic systems.

References

[1] Fossil Energy 2018-2022 Strategic Vision.
[2] https://netl.doe.gov/node/2476.

Excluding AI, what innovative technologies from industry are being used in the DOE?

The National Energy Technology Laboratory (NETL) celebrated more than 35 notable FY 2018 accomplishments with an interactive poster session focused on key research priorities [1]. Many of these technologies were developed by industry with NETL funding assistance. The innovative technologies were categorized into five R&D pillars [2]:

- Improving the Performance, Reliability, and Efficiency of the Existing Coal-Fired Fleet
- Advancing the Next Generation of Modular, Highly Efficient, and Flexible Coal-Fired Power Plants
- Reducing the Cost of Captured Carbon and Putting it to Work for America
- Creating New Jobs, Products, and Markets for Coal
- Leveraging Big Data and Machine Learning to Unlock our Nation's Vast Unconventional Oil and Gas Resources

Recently, an effort was taken to identify FY 2019 accomplishments [3]. A notable example is that NETL collaborated with Carnegie Mellon University, Metglas, and Eaton to develop a cobalt-based nanocrystalline alloy and an innovative strain anneal manufacturing process that produces inductive components with unprecedented magnetic capabilities for use in motors, electrical machinery, and more [3].

References
[1] https://netl.doe.gov/accomplishments.
[2] https://netl.doe.gov/sites/default/files/2019-04/2018%20S%26T%20Accomplishments_Book_20190411.pdf.
[3] https://netl.doe.gov/node/9314.

What systems or processes does the DOE employ to foster innovation internally?

FE regularly seeks out opportunities to engage with other DOE offices in areas where synergies exist between their programs. Some of the most notable collaborations include energy-water systems, subsurface science and engineering, critical materials development, grid modernization, high-performance computing, and cyber-security.

FE's Technology Development Pathways are intended to increase the pace of innovation to realize rapid impacts of technologies that span the entire fossil energy value chain and to ensure that those technologies, with maximum commercial application and impact, reach maturity.

FE conducts management and innovation lunchtime forums to promote cross-communication and information-sharing across offices in FE, which nurtures an improvement and innovation culture [1].

References
[1] Fossil Energy 2018-2022 Strategic Vision.

How do the labs foster innovation?

Annually, the Office of Science engages its laboratories in a strategic planning activity that asks the laboratory leadership teams to define a long-range vision for the future of their respective institutions [1], which execute long-term government scientific and technological missions, often with operational challenges requiring innovative solutions [2]. This information provides the starting point for a discussion between leadership and the laboratory about the laboratory's future directions, strengths and weaknesses, immediate and long-range challenges, and resource needs [1].

In addition, DOE's Lab Partnering Service (LPS), part of the Office of Technology Transitions' (OTT) Technology Commercialization Fund (TCF), is a suite of online applications enabling access to leading experts, innovations, and patents from across DOE and the national laboratories. It delivers a myriad of information to provide access to a portfolio of investment opportunities. The LPS enables fast discovery of expertise and serves as a conduit between the investor and the innovator by providing multi-faceted search capabilities across numerous technology areas and the national laboratories [3].

Lastly, DOE/NETL has been a frequent participant in TransTech Energy conferences, where information about the lab's energy technology innovations are presented as pitches for funding opportunities [4].

References

[1] https://www.energy.gov/science/office-science-lab-planning-process.
[2] https://www.energy.gov/science/science-innovation/office-science-national-laboratories.
[3] https://search.labpartnering.org/.
[4] https://netl.doe.gov/node/9311.

How has or should the DOE built platforms to help others be innovative?

OTT develops DOE's policy and vision for expanding the commercial impact of its research investments and streamlines information and access to DOE's national labs and sites to foster partnerships that will move innovations from the labs into the marketplace [1].

OTT provides support in each step of technology transition, which is a dynamic process, with numerous and varying handoffs between scientists, innovators, and entrepreneurs, that begins with an idea that is ultimately transitioned to a commercialized technology by the private sector [2]. OTT conducts data management and analysis, evidence-based impact evaluations, and stakeholder engagement. The office also oversees two major DOE initiatives—TCF and the Energy Investor Center [2]. Together, OTT works with internal and external partners to enhance the nation's economic competitiveness and strengthen its leadership in innovation and transformative, impactful technologies [2].

In addition, the Energy Data eXchange (EDX) is FE's website for public curation of its R&D data and tools [3]. EDX is developed and maintained by NETL Research and Innovation Center (RIC) researchers and technical computing teams to support private collaboration for ongoing research efforts and tech transfer of finalized DOE/NETL research products.

References

[1] https://www.energy.gov/technologytransitions/office-technology-transitions.

[2] https://www.energy.gov/technologytransitions/about-us.

[3] https://edx.netl.doe.gov/.

S4 – Under Secretary for Science

Office of Science

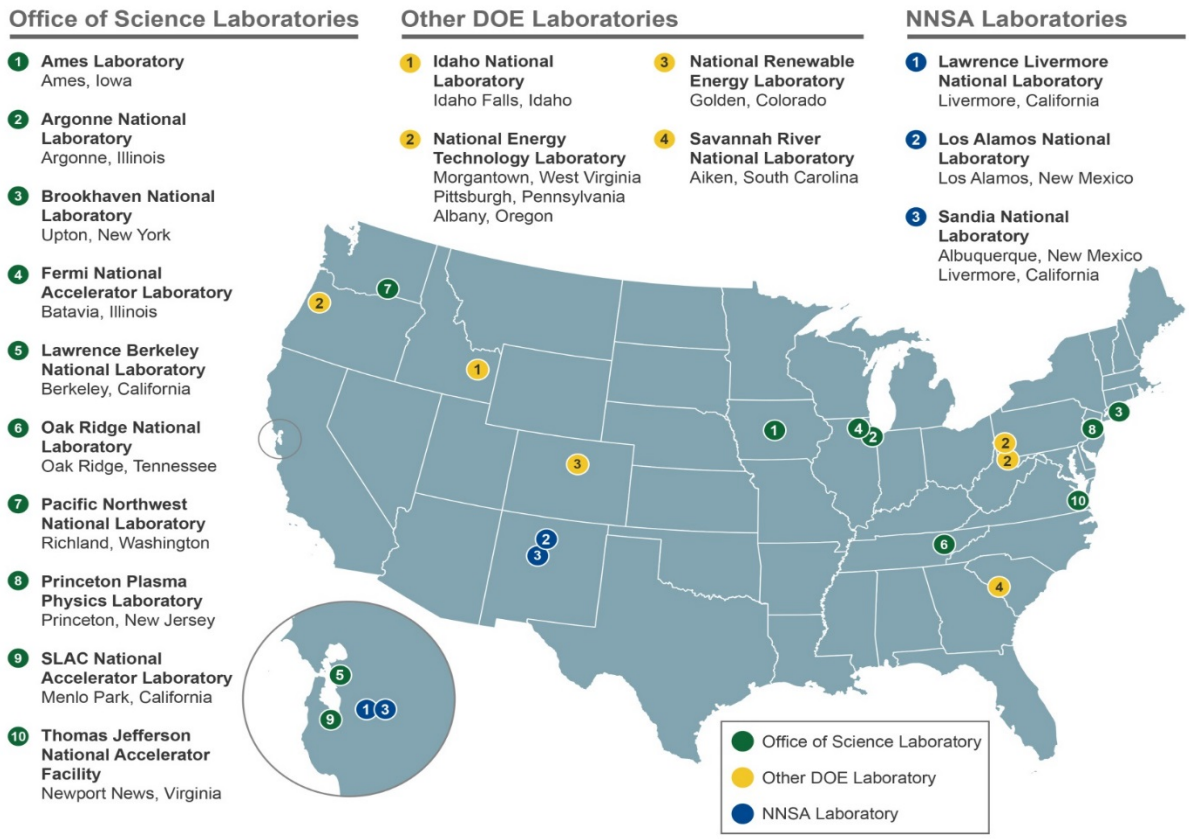
The Office of Science is broken into six program offices:

1. **(ASCR) Advanced Scientific Computing Research (FY 2019 budget $935.5 million) –** Advances applied mathematics, computer science, and computational research to discover, develop, and deploy computational and networking capabilities to analyze, model, simulate,

and predict complex phenomena important to the U.S. Builds and operates some of the fastest computers in the world for open science. Leads the U.S. effort to develop the next generation of computing tools (exascale).

2. **(BES) Basic Energy Sciences (FY 2019 budget $2,166 million) –** Advances fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels to provide foundations for new energy technologies. Supports a large portfolio of core research in chemical sciences, geosciences, biosciences, and materials sciences and engineering, and targeted areas to advance DOE energy priorities. Constructs and supports scientific user facilities that enable atomic-level visualization and characterization of materials of all kinds, including biological materials.
3. **(BER) Biological and Environmental Research (FY 2019 budget $705 million) –** Advances fundamental research to achieve a predictive understanding of complex biological, climatic, and environmental systems for a secure and sustainable energy future. Supports core research in genomic sciences of plants and microbes, research to understand climate-relevant atmospheric and ecosystem processes and to understand the dynamic physical, biogeochemical, microbial, and plant processes interactions.
4. **(FES) Fusion Energy Sciences (FY 2019 budget $564 million) –** Advances the theoretical and experimental understanding of matter at high temperatures and density, including plasmas, plasma confinement, and fusion science.
5. **(HEP) High Energy Physics (FY 2019 budget $980 million) –** Advances understanding of the basic constituents of matter, deeper symmetries in the laws of nature at high energies, and mysterious phenomena that are commonplace in the universe, such as dark energy and dark matter.
6. **(NP) Nuclear Physics (FY 2019 budget $690 million) –** Advances experimental and theoretical research to discover, explore, and understand all forms of nuclear matter. Supports DOE's isotopes production and applications program for production of stable and radioactive research isotopes.

The Office of Science is also the steward of the science national laboratories (green below).



The following are the Office of Science answers to the Innovation Working Group data call.

Excluding AI, what innovative technologies are being developed in the DOE?

Accelerator and Detector R&D:

- Next-generation Office of Science facilities depend on significant advances in the underlying particle accelerator and detector technologies. Advances in performance of these scientific tools are generally applicable in other domains (not just scientific discovery), often with great effect. Examples include the development of compact accelerator technologies that make cancer therapy more effective and affordable; high power industrial accelerators that sterilize medical devices, kill pathogens in food and water, and increase durability of materials; and more performant or novel active interrogation and detection technologies that improve U.S. security.
- The acceleration of charged particle beams (electrons and protons) is a core technology lying at the heart of the twelve BES scientific user facilities. High energy electrons are used to generate intense x-ray pulses at the BES light sources and they also serve as the direct probes for the electron microscopes in the nanoscience centers. High energy proton beams are used to generate intense neutron pulses by the spallation process at the BES neutron facility. BES maintains a very active R&D program to develop core technologies such as high intensity

electron and ion sources, superconducting radio frequency (RF) accelerators, magnets, electron/x-ray/neutron optics and detectors.

Fundamental science for innovative technologies: BES supports a diverse portfolio of fundamental scientific research to understand the materials and chemical processes that underpin a broad range of technologies. Examples of areas with scientific advances that have translated to technology innovations in industry include:

- **Energy storage**: Scientific advances at the Joint Center for Energy Storage Research (JCESR) and Energy Frontier Research Centers (EFRCs) have spun out three start-up battery technology companies: Nanograf Technologies; Sepion Technologies; and Blue Current.
- **Separations science for environmental technologies**: Sustained BES support resulted in key scientific advances recognized by the 1987 Nobel Prize in chemistry for the development and use of molecules with high selectivity. Building upon these advances, separations science developed specific solvents to extract cesium from nuclear wastes. Parsons Corporation has implemented this innovation at the Savannah River Site in the industrial scale separations of nuclear waste with increased efficiency of 200-fold in cesium separation that translates to billions of dollars of saving in the processing.

The Fusion Energy Sciences (FES) program is investing in the development of innovative technologies such as:

- High-temperature superconductors
- High-performance computing for whole-device modeling
- High-energy-density extreme states of matter for development of quantum information science
- New breeder blanket and tritium fuel cycle technologies for fusion reactors
- Low-temperature plasma applications (such as microelectronics, sterilization processes, medical, materials synthesis)

Within Advanced Scientific Computing Research (ASCR), the **Exascale Computing Project** is developing an Exascale software stack to hide the complexity of future heterogeneous computer architectures from users.

Within Nuclear Physics (NP), participation in **QIS sensor technology developments, novel isotope production techniques and instrumentation** which enable novel isotopes for emerging technologies are in this category; examples include development of centrifuge technology for isotope production and production of rare isotopes which enable development of new radiopharmaceuticals. Some aspects of accelerator technology (e.g. high brightness sources, electron cooling) require innovative technology development as well.

The Biological Environmental Research (BER) **Bioenergy Research Centers** (BRCs) seek to provide a fundamental understanding of the biology of plants and microbes as a basis for developing innovative processes for bioenergy and bioproducts production from inedible

cellulosic biomass. The four BRCs develop a range of advanced biofuels and bioproducts from sustainable biomass resources and provide high-payoff technology and early-stage research results that can be adapted for industry adoption and development of transformative commercial products and services. All have strong industry partnerships to facilitate licensing, sponsorship, and other ways to share, partner, and join the research teams.

BER's **Biomolecular Characterization and Imaging Science** supports fundamental bioimaging research and enabling capabilities at the DOE Synchrotron Light and Neutron Sources to develop in situ, dynamic and/or nondestructive approaches to enable multifunctional imaging and integrative analysis of bioenergy-relevant plant and microbial systems relevant to DOE's energy and environmental missions.

Excluding AI, what innovative technologies from industry are being used in the DOE?

User Facilities: Industry plays an important role in the design, construction and operation of the SC scientific user facilities. US national laboratories and universities conduct world leading R&D on the critical technologies needed by the facilities such as accelerators, beamlines, control systems and detectors and the R&D results are transferred to industry. Industry transforms the R&D concepts into high technology products that are incorporated back into the scientific user facilities located at the DOE national laboratories. Industrial capabilities to scale-up, control and refine fabrication processes for complex, technically challenging components are often critical to realizing cutting-edge science facilities.

Fundamental Materials and Chemical Sciences: Examples of use of innovative technologies by DOE include

- Development of leading-edge characterization and synthesis instruments for national laboratory core research programs.
    - Advanced electron microscopes: A cornerstone for analysis of the atomic and molecular structure of materials and their evolution, DOE labs are the home of world-leading instruments, including the development of new techniques and partnering with industry for advances in optics and detectors.
    - Dynamic nuclear polarization-enhanced NMR system: One of the first of these highly sensitive instruments for characterizing molecular chemistry and materials
- Solvents for Extraction of Cesium: Parsons Corporation has implemented the solvents that were developed through innovative separations science to extract cesium from nuclear wastes at the Savannah River DOE Site.

Because ASCR deploys high end computing resources, we are interested in **novel and energy efficient components** such as interconnects, memory, processors and storage from industry. We form research partnerships with the vendors to support the development of the innovative technologies needed to build DOE's supercomputers.

Laser technology: Advances in commercial laser technology leading to shorter, higher power pulses, optical phase locking, and generation of wide range of wavelengths ranging from terahertz to soft x-rays have provided a versatile tool that is used by every branch of the physical sciences, and increasingly by biology. Examples include optical parametric amplifiers that can continuously tune from the far infrared into the near ultraviolet, high harmonic generators that can produce attosecond bursts of soft x-rays, and ultra-stable optical combs that provide extremely precise spectroscopic and time references.

- Because the development frontier is in front of where industry usually draws its line of acceptable risk for innovation, the flow is usually from DOE supported researchers to industry and not the other way around. An exception is the SBIR/STTR program, where NP takes great pains to try to foster innovation that may benefit NP in the long run in areas like macro electronics (some micro) and particle detection technology.

ARM, EMSL and JGI user facilities partner with industry to advance remote sensing for atmospheric parameters including specialized radars and wind sensors; molecular science capabilities such as proteomics analyses, NMR, microscopy techniques, and other instrumentation; genomic sequencing technology and analytic capabilities for complex plant, microbial and fungal genomes, and metagenomic sequencing for Departmental-relevant research.

JGI and EMSL often serve as beta-testers for new technologies or instruments under development by industry; they also are early adopters for these new technologies once they become commercially available.

A private company (General Atomics) operates the DIII-D national tokamak user facility for the FES program. GA has developed several innovative technologies for heating and current drive of fusion plasmas:

- Steerable neutral beam injectors
- Neutral beams with variable voltage/energy during injection
- Inside-launch (high magnetic field side) lower hybrid wave antenna
- Helicon-frequency wave antenna

Several private companies have developed computer codes for simulating fusion plasma behavior, which are used by university and lab scientists.

Several private companies have developed innovative diagnostic technologies for measuring the properties and behavior of fusion plasmas. These diagnostics are installed on FES experimental facilities for use by university and laboratory scientists.

The fusion materials program is making use of additive manufacturing, developed by private companies.

What systems or processes does the DOE employ to foster innovation internally?

DOE national laboratories use Laboratory Directed Research and Development funding to foster innovations. These programs are the "seed" funds for initial research that support the transition of innovative ideas to reach the maturity level required for proposals to DOE.

SC funds a number of high risk, high reward projects as well as Early Career researchers to continue to foster innovation (and new workforce development).

SBIR/STTR is also an engine for supporting innovative tech developments relevant to the NP sphere of research needs. Support of transformative accelerator R&D, detector R&D and isotope production and processing research.

FES funds SBIR/STTR projects, which also foster innovation. In FY 2020, the SBIR topics are:

- Fusion materials--To develop materials needed to design, construct and operate a fusion power plant that meet demanding objectives for safety, performance, economics, and environmental impact.
- Superconducting magnets--To develop new or advanced superconducting magnet concepts needed for plasma fusion confinement systems
- Low-temperature plasmas--Building upon fundamental low temperature plasma science, further developments are sought in plasma sources, plasma surface interactions, and plasma control science that can enable new plasma technologies or marketable product and impact in other areas or disciplines, including microelectronics
- Inertial fusion energy--Research and development activities are sought that address specific technology needs necessary to both assess and advance inertial fusion energy

How do the labs foster innovation?

- DOE national laboratories partner with industry to move scientific innovations and software to commercial products.
- Primarily though LDRD investments in new technologies. The labs also foster innovation through workshops and meetings such as the "Big Ideas" and X-lab forums, and through domestic and international research collaboration activities.
- A new public-private partnership program called Innovation Network for Fusion Energy (INFUSE) was initiated in 2019. Through this program, DOE national labs help eligible private-sector companies overcome critical scientific and technological challenges in pursuing fusion energy. In the pilot program, INFUSE accepted basic research applications focused on innovation for fusion energy in enabling technologies, materials science, plasma diagnostics, modeling & simulation, and MFE experimental capabilities. Twelve awards were made to six labs to partner with six private fusion companies. Recently, a workshop (Nov 22-23, Knoxville) brought together private fusion companies and lab scientists to better understand industry needs and lab capabilities.

How has or should the DOE built platforms to help others be innovative?

User Facilities:

- BES operates 12 scientific user facilities (5 light sources, 2 neutron sources & 5 nanoscience centers) that provide state-of-the art tools for the synthesis, fabrication and characterization for biology, chemistry, geoscience and materials sciences. In FY 2019, over 16,000 scientists, engineers and students from universities, national laboratories and industry made use of these facilities. BES ensures that the user facilities maintain cutting edge tools with innovative upgrades to existing facilities. BES also oversees the construction of new facilities to equip the science community with transformative new capabilities.
- HEP operates 3 scientific user facilities (the multi-function proton accelerator complex at Fermilab , and 2 advanced accelerator R&D testbeds) that provide state-of-the art tools for particle physics and advanced technology R&D. In addition there is extensive technology demonstration and testing infrastructure and expertise at the DOE Laboratories outside of the dedicated user facilities. HEP ensures that these facilities maintain cutting edge tools with innovative upgrades to existing facilities. HEP also oversees the construction of new facilities to equip the science community with transformative new capabilities.
- BER operates 3 scientific user facilities – Atmospheric Radiation Measurement (ARM) user facility (exploring the role of clouds and aerosols in Earth system Change), the Joint Genome Institute (JGI) and the Environmental Molecular Sciences Laboratory (EMSL). JGI and EMSL provide state-of-the art tools for genome sequencing and interrogation, and molecular scale characterization of biological and chemical systems of relevance to Earth and environmental sciences. In FY 2019, nearly 3,500 scientists, engineers and students from universities, national laboratories and industry made use of these facilities. BER ensures that the user facilities maintain cutting edge tools for scientific investigation through strategic upgrades of equipment at existing facilities.
- FES has major user facilities, as well as a number of mid-scale collaborative research facilities, which are open to researchers, including those from industry, through a peer review process. A new example, initiated in FY 2019, is LaserNetUS, a national network of high-performance laser facilities, which provides enhanced access for scientists to perform high-energy-density plasma science experiments.

How has or should the DOE build platforms to help others be innovative?

SC SBIR/STTR program: SC topics for the SBIR and STTR program provide opportunities for innovative small businesses to do research on development of new technologies that will support user facilities and advanced research.

Fundamental science for innovative technologies: Examples of innovate platforms to help others in the BES research programs include:

- JCESR has an affiliate program that includes nearly one-hundred stakeholder organizations involved in electrical energy storage, ranging from chemical and material manufacturers to battery system integrators and testers. Affiliates have the opportunity to engage with the research to accelerate innovation.
- Computational Materials and Chemical Sciences programs are a new BES research modality with a specific focus on development of innovative software and the associated databases for use on future generation computer platforms.
- The Materials Project provides community access to data and materials design tools to accelerate materials discovery, including data for tens of thousands of materials.

FES participates in several cross-agency partnerships that are platforms for encouraging innovation:

- NSF-DOE Partnership in Plasma Science and Engineering
- SC-NNSA Joint Program in High Energy Density Plasma Science
- FES partnership with ARPA-E (under development)

How has or should the DOE built platforms to help others be innovative?

Because ASCR's Leadership Computing Facilities are the most advanced systems when deployed and are open to researchers, including industry through a peer review process, they encourage scientific and economic innovation.

DOE can facilitate access to the "hidden" test infrastructure and expertise at the DOE Laboratories:

- DOE operates more than 50 accelerator and detector test facilities and possesses expertise that is unique and generally not well known to the public. Making these capabilities more visible and accessible will help the DOE Laboratories foster U.S. innovation in these high technology areas, and strengthen the domestic vendor base for these key technologies.
- Programs such as EERE's Small Business Vouchers Program, OTT's Technology Commercialization Fund, and SC's Accelerator Stewardship Test Facility Program facilitate connections between laboratories and industry, with the latter specifically aimed at improving access to accelerator R&D infrastructure and expertise.

DOE can simplify the process for enabling collaborative R&D:

- Simplify SPPs, CRADAs, ACTs, NPUAs and streamline the approval process. These agreements typically require months to execute, delaying the start of work and significantly raising the threshold for interested businesses and universities to interact with DOE National Laboratories.

In the context of NP's mission, the current balance is about right. Going a lot further in the direction of helping industry innovate would get into the realm of applied R&D which is outside NP's discovery science mission, which nonetheless does include R&D integration.

Office of Technology Transitions

Excluding AI, what innovative technologies are being developed in your Office?

OTT complements the Department's innovative R&D portfolio by seeding and cultivating innovation around partnership models and working to expand market-informed thinking into the Department's R&D roadmaps. Our customers are the potential end-users of DOE's technology and facilities and we work to amplify their "market voice" and "market pull" inside the Department and across the Lab system

The Innovation-to-Commercialization pathway is not a linear function, and OTT's remit is to think beyond the classic paradigms and to instead enable public-private and public-public partnership collaborations that de-risk technology through a commercialization lens by considering questions such as market-readiness, financial worthiness, manufacturability, workforce availability, regulatory requirements, and supply chain risks.

Excluding AI, what innovative technologies from industry are being used in your Office?

Our Lab Partnering Service (LPS) is the Department of Energy's (DOE) powerful discovery engine for investors to explore the Department's expertise, technical content, research facilities, and patents. By using this powerful multifaceted browsing capability that quickly and efficiently links customers of all types to the answers they are seeking, LPS energizes exploration, quickly connects, and efficiently partners customers with the National Labs.

What systems or processes does your Office employ to foster innovation internally?

OTT serves as a clearinghouse and curator of business model innovation across the Department and National Lab system. We take a rigorous approach to inventorying existing programs and practices, conducting analysis of gaps/white spaces and proposing new programs and mechanisms to enhance impact of DOE investments.

The Technology Transfer Policy Board (TTPB) meets regularly to discuss key issues related to technology transfer activities conducted at laboratories and facilities under their cognizance. TTPB develops policy recommendations for the Technology Transfer Coordinator and monitors the overall technology transfer activities of the laboratories and facilities authorized to conduct technology transfer activities.

How does your Office leverage the labs to foster innovation?

OTT manages several programs to foster dynamic, active innovation.

The Technology Transfer Working Group (TTWG) was established with the passing of the Energy Policy Act of 2005, Title X, Sec. 1001 by the Department to improve technology transfer activities of DOE National Laboratories, single purpose research facilities, production facilities and DOE/NNSA field elements. The TTWG primarily includes technology transfer professionals from the National Laboratories, single purpose research facilities and production facilities, and DOE/NNSA field elements. This group works together to improve the technology transfer activities of the laboratories/facilities and the Department. The members promote the implementation of DOE Laboratory technology transfer policy in a mutually beneficial, supportive, and non-adversarial working environment that encourages open communication, teamwork, and professional development.

In 2019, through the Practices to Accelerate the Commercialization of Technology (PACT) Laboratory Call, OTT aimed to improve, expand, and develop commercialization capabilities across the National Laboratories and ultimately selected 12 projects to receive about $2.5 million in awards, combined with over $1 million in cost share. Selected projects encompassed all 17 National Labs, one National Nuclear Security Administration (NNSA) Facility, and six external partners.

Another successful program is Energy I-Corps. Recently concluding its tenth cohort, Energy I-Corps is a two-month entrepreneurship program that helps train lab researchers to better understand and address industry engagement and market awareness to find more viable pathways for their technologies.

The office has worked closely with labs and local business organizations and governments to develop connections and partnerships to target local needs -- finding ways to catalyze lab resources and technology to foster regional innovation hubs meant to drive economic growth and technology ecosystems.

Lastly, OTT seeks proposals annually for the Technology Commercialization Fund (TCF). Through the TCF, DOE increases the commercial impact of its National Laboratories, plants, and sites and their engagement with industry, and fulfills statutory direction in the Energy Policy Act of 2005 (EPAct 2005). The TCF facilitates the commercialization of energy technologies with promising potential that are developed at DOE Facilities.

How has or should your Office built platforms to help others be innovative?

OTT has successfully coordinated four Innovation*X*Lab Summits to date. The Innovation*X*Lab series is a showcase of the remarkable assets and capabilities of the Department's National Labs facilitates that provides a two-way exchange of information and ideas between industry, universities, investors, and end-use customers with Lab innovators and experts. The summit series enables commercialization opportunities at the decision-maker level by highlighting promising technologies and user facilities from across the 17 DOE National Labs. These events have proven to be very successful, and OTT looks forward to many more in 2020.

S5 – Under Secretary for Nuclear Security

Excluding AI, what innovative technologies are being developed in the DOE?

The National Nuclear Security Administration (NNSA) Labs, Plants and Sites (thereafter collectively referred to as "labs") are developing many innovative technologies in diverse areas including biotechnology, threat detection, magnetic levitation, additive manufacturing, human genome mapping, military applications, high voltage conduction, block-chain, human-machine interfaces, quantum information and sensing systems, and high performance computing and other emerging computing paradigms.

Excluding AI, what innovative technologies from industry are being used in the DOE?

NNSA Labs seek to import business processes and best practices from industry via programs such as the "technologist in residence." Many technologies are advanced collaboratively via CRADAs and other mechanisms that allow the labs to leverage the unique capabilities and expertise of the industry partners. Recent examples include virtual reality and additive manufacturing. Further, the labs often utilize the latest innovative technologies from industry in the form of equipment (e.g. imaging and fabrication tools) that enable advance experimentation and research and development.

What systems or processes does the DOE employ to foster innovation internally?

The NNSA labs have numerous programs that foster internal innovation. These programs can be grouped in the following categories:

- Commercializing Laboratory Technologies
- Developing Entrepreneurial Workforce and Recruiting and Retaining the Best and Brightest
- Accelerator and Incubator Models
- Technology Maturation Funding
- Investor Connections and Energy Investment Center Programs
- Commercialization Campuses and Technology Parks

How do the labs foster innovation?

The labs comprise a preeminent federal research system that develops and maintains unique resources to provide the nation with strategic scientific and technological capabilities. These capabilities are often beyond the scope of academic and industrial institutions but are made available externally to foster innovation and benefit the nation's researchers and national strategic priorities. Technology partnerships and technology transfer provide a mechanism for facilitating the use of these resources or enhancing and enabling the economic, energy, and national security interests of the United States. Technology transfer also serves as a mission-enabling activity as these efforts also contribute back to the knowledge and skills present within the national labs by

keeping them and their cutting-edge equipment productive, intellectually cross-trained, and continually discovering innovative technologies and processes.

How has or should the DOE build platforms to help others be innovative?

Scientific advancements made, and capabilities maintained, on behalf of DOE's missions are shared with the public sector through a process of patent licensing, cooperative research and development agreements, user facility agreements, intellectual exchanges, and entrepreneurial programs. The various offices within DOE have also initiated programs and activities to facilitate internal and external innovation. For example, NNSA has participated in regulatory reforms and sponsored lab teams for workforce development and technology maturation programs, and the Office of Technology Transitions (OTT) has established programs including the Technology Commercialization Fund and Lab Partnering Service.

The DOE could augment existing innovation platforms by providing additional support for existing programs (e.g. SBIR/STTR) and increasing outward facing interactions (e.g. innovation hubs and open campuses).

DOE Management

Office of Congressional and Intergovernmental Affairs

Excluding AI, what innovative technologies are being developed in your Office?

CI constantly strives to identify process improvements that can bring greater effectiveness to our workflow and work processes. Over the course of the past year, CI has continually sought staff feedback to determine new systems that can be implemented to increase efficiencies in our work product. To that end:

CI is partnering with Microsoft to use a video indexing tool (which utilizes AI) to help us more efficiently and effectively monitor congressional hearings and public feedback on DOE policy proposals. This tool helps identify critical stakeholders, categorize their response to DOE policies (acutely and over time) and can monitor public chatter on social media channels, among many other benefits. CI use of this tool will begin in calendar year 2020.

CI coordinated with GC to create a better system for managing and tracking requests for technical assistance and views letters. The previous process relied on decentralized information sharing, feedback accrual, and dissemination. The new model, developed from CI staff feedback, creates a single repository where GC and CI store incoming requests and the responses to those requests. This will help CI and GC better organize these requests, leverage them for additional needs, and create an easy to use historical record of incoming TA and views letter requests.

CI works with MA to develop notifications by zip code. A large portion of CI staff time is spent developing notification lists when DOE announces winning recipients of FOA's and other

financial assistance. Working with MA, CI has developed a tool that uses CI's access to CQ to develop notification lists by entering in zip codes for recipients of the DOE award. This enables CI staff to quickly and accurately develop notification lists taking into account the representation of the area where the funding is being sent. Previously, CI staff would have to manually develop these lists and then double-check them to ensure each Member's district actually included the locality where the award is being sent.

Excluding AI, what innovative technologies from industry are being used in your Office?

Innovation in the government affairs industry typically centers on the use of software systems designed to increase the effectiveness of customer relationship management (CRM). An example of a widely used CRM system is SalesForce. Other software suites, like Quorum, enable users to track congressional bills, monitor social media, Dear Colleague letters, public statements by Members of Congress, and include additional tools to help advance grassroots advocacy initiatives.

What systems or processes does your Office employ to foster innovation internally?

We work to build a culture of empowerment purposefully as part of our managerial responsibilities for the office. We end each collective meeting with an opportunity for staff to provide thoughtful recommendations on process improvements. In addition, we include this topic on all meeting agenda's to ensure staff has the opportunity to offer thoughtful feedback that will lead to improved operations. In addition, CI contacted an organizational culture consultant in FY 2019 to help us develop a better understanding of our strengths and weaknesses as well as to provide an avenue for staff to offer thoughtful suggestions in improving our shared work environment. Collectively, these activities have created a more empowered, and happy, staff as noted by a significant increase in positive feedback on CI's FY19 FEVS results.

How does your Office leverage the labs to foster innovation?

Given the nature of our work, CI often times doesn't directly interact with the labs to help foster innovation. We do, however, maintain open and ongoing communications with the labs and their federal affairs representatives.

How has or should your Office built platforms to help others be innovative?

All of the systems improvements CI has initiated primarily benefit CI and the other organizations with whom CI works on a fairly routine basis.

Office of Small and Disadvantaged Business Utilization

How does your Office leverage the labs to foster innovation?

OSDBU hosts a monthly Small Business Program Manager (SBPM) meeting which serves as a platform for innovation where labs and DOE headquarters exchange best practices and ideas. OSDBU also hosts an annual SB Forum & Expo where labs and small business innovators interact personally.

How has or should your Office built platforms to help others be innovative?

OSDBU has created a Forecast Improvement Working Group to better market DOE acquisition opportunities across the program offices, sites, and labs to further help small business innovators find ways to engage with the Agency.

Office of Enterprise Assessments

Excluding AI, what innovative technologies are being developed in your Office?

The Office of Enterprise Assessments (EA) utilizes Engagement Simulation Systems (ESS) to maximize realism when conducting performance testing of DOE site protective force capabilities. ESS' are non-lethal systems that permit protective forces and adversary role players to simulate combat conditions and provide for an accurate assessment of the effects of firearms during security exercises. EA has developed and customized various ESS-related and other equipment used in performance testing that has enhanced realism, improved safety, reduced costs, and expanded the capability to evaluate security response strategies specific to DOE. Examples of these enhancements include:

- Installing engineered safety controls on firearms and ammunition magazines to ensure only blank ammunition can be introduced,
- Modifying firearm barrels to divert a portion of the expelled gasses, thereby increasing user safety,
- Designing and deploying a securely mounted ESS vehicle detection system to provide for its use in all environments and minimize vehicle damage,
- Designing and testing remote and motion-activated simulated explosive devices using ESS laser transmitters,
- Developing grenade simulators to reduce blast effects and risk of injuries, and
- Customizing a shoulder fired rocket simulator by developing a cartridge that uses less explosive material and costs less.

EA's National Training Center (NTC) is collaborating with the DOE Office of Human Capital and the National Nuclear Security Administration to develop and launch the DOE Learning Nucleus. Learning Nucleus is the Department's new learning management system, a software application for the administration, documentation, tracking, reporting, and delivery of educational courses and training programs to federal and contractor employees. The system provides enhanced searching capabilities for online content, automated assignment and notification of mandatory training, and personalized employee dashboards to help manage development goals, thereby streamlining the Department's training operations and improving the employee experience.

EA's National Training Center has also collaborated with the contractor training community to develop the Course and Related Data System (CARDS). CARDS is an electronic system for sharing government-

owned training materials across the DOE enterprise. CARDS is available to any DOE federal or contractor training professional to search for or share training materials. CARDS allows training professionals to use existing DOE content to develop courses or supplement existing site courses with new materials. Training materials may include the entire courses, short videos, or other instructional materials.

Excluding AI, what innovative technologies from industry are being used in your Office?

EA uses 3-D scanners and printers, computer-aided design software, and in-house electronics expertise to develop ammunition prototypes (e.g., grenades, rocket cartridges) and customize other equipment and materials used in security performance testing that are otherwise unavailable or difficult to procure "off the shelf."

EA employs Microsoft OneDrive technology to disseminate controlled unclassified information electronically to assessment team members located throughout the country. This digital distribution results in less time and effort to prepare and disseminate information in hard copy or on disk while also providing a greater degree of information security.

EA has initiated a project to employ data analytics in assessing information currently available within the Department to better identify trends, problem areas, and best practices, which will aid in risk based planning and sharing information across DOE. The approach to developing this project will be collaborative with other offices who are undertaking similar endeavors.

What systems or processes does your Office employ to foster innovation internally?

EA operates two cyber security testing facilities where state-of-the-art tools, tactics and procedures are developed to emulate the actions of an adversary attempting to gain access to DOE-specific information.

How does your Office leverage the labs to foster innovation?

EA is conducting a study in collaboration with the Argonne Public Affairs Science and Technology Fusion Cell on the use of social media to communicate critical information during emergencies at DOE sites. An expected outcome of the study will be to identify and share best practices for improving communications during emergencies within the DOE complex.

How has or should your Office built platforms to help others be innovative?

EA documents and shares lessons learned and best practices that are identified during its assessments conducted throughout the DOE complex. Information from security-related assessments is maintained in a classified electronic database, which categorizes assessment results to enable a quick comparison of performance across multiple sites and supports the identification of positive and adverse trends. Information from safety-related assessments is highlighted in assessment reports, presented at workshops, and entered into DOE's operational experience database to share with other organizations. EA has also developed applications for sharing best practices related to training and improving collaboration among subject matter experts.

Office of Management

Excluding AI, what innovative technologies are being developed in your Office?

The Office of Management (MA) is currently seeking ways to update and innovate the business operations it provides to the Department. Currently MA is working with the Office of the Chief Financial Officer to upgrade the PRISM suite that makes up the Department's contract writing system STRIPES. With this upgrade, MA hopes to broaden the system's capabilities to increase its effectiveness and compliance in the acquisition process. With this upgrade, MA could also utilize software applications known as "bots" that will carry out some of the more repetitive tasks associate with contracting such as market research and verifying data integrity.

MA is also working to develop technology to assist with parking and conference room services offered at Headquarters. Other areas of focus include real property, asset management, and operations pertaining to facilities and building support.

Excluding AI, what innovative technologies from industry are being used in your Office?

As a part of its review, MA will evaluate the current systems used to determine where upgrades and innovative solutions from industry can be made. Some processes where MA has used industry tools at the Department include the INVESTOR tool, built on the Service-Now platform and used to collect and display data regarding planned financial assistance. MA also uses STRIPES, the system-of-record for procurement and contracts management information for the Department and supports actions performed by multiple Procurement offices and encompasses both acquisition and financial assistance. Additionally, MA uses a system known as RevCom for the simultaneous review and comment of Departmental directives from 113 organizations and sub-organizations.

What systems or processes does your Office employ to foster innovation internally?

Internally, MA hosts frequent round table discussions with employees and managers seeking feedback on how we can improve and modernize our processes.

How does your Office leverage the labs to foster innovation?

Expertise at the Labs is a valuable asset to the country and the Department. MA recently approached the Laboratory Operations Board regarding the use of the Labs' expertise to perform a review of current processes. MA would use the outcome of the review and any recommendations to update and tackle some of its biggest challenges.

How has or should your Office built platforms to help others be innovative?

Most processes established by MA are used to support customers. The information found in the INVESTOR tool is used in the decision making process, as well as to foster a collaborative and transparent culture. Additionally, use of the RevCom system allows for an expeditious review, while providing each organization the opportunity to contribute.

Office of Chief Information Officer

Excluding AI, what innovative technologies are being developed in your Office?

Office of Deputy CIO for Architecture, Engineering, Technology and Innovation (IM-50):

We are communicating all innovation activity under the umbrella of the Innovation Community Center (ICC).

We are developing Innovation Exchange and Project Portals to establish DOE enterprise reach by community. Our first communities we are building with online presence and automated workflows include the RTIC SubCommittee's Funding Announcements, Artificial Intelligence, DOE on-premise data center optimization, GeoSpatial, DOE Directives Tracking, and IDEA Act-driven website development and forms automation.

Several innovation sandbox environments are being stood up to allow testing, proof of concepts and pilot activity of emerging technologies on different cloud platforms such as Google, Azure, and AWS. Technologies being tested include PowerBI, Tableau, UIPath, Google BiqQuery, MS RPA, etc.

Developing a CDM interface from Splunk into our ServiceNow Asset Management and Application Portfolios to assess viability in providing us enterprise business data inventories as the CDM project for DOE is expanded to the enterprise. We are also conducting discussions on how CDM can ensure capture of more system and application level data and possibly expand the attributes they collect to support agency compliance with the GSA/OMB Application Rationalization and MEGABYTE Act goals.

Developing an Investment Review Board (IRB) capability with metrics, assessments, actionable bubble charts, and dashboards.

Developing a new Product and Service Catalog with a list of products and services available to the enterprise with Enterprise Architecture Assessment metrics, product "white lists", and providing access to enterprise-negotiated pricing when possible.

Incorporating a new Scaled Agile (SAFe) Framework for managing projects with agile principles of quick to value and quick to fail using SCRUM and Stories for developing products and services.

Incorporating Think Tank software into our Customer Feedback meetings.

We are conducting a prototype with Adobe for scanning paper forms into a ServiceNow database and adding electronic signature capability.

In a new ServiceNow instance that will be available to users outside of the DOE enterprise including the public, we are incorporating login.gov integration to ensure users are properly authenticated.

Building out a new architecture system on a tool called Alfabet to provide system-to-system mapping and dependencies to make architectural diagrams available to the enterprise with transparent impact analysis for planned architectural changes.

IM50 conduct Proof of Concepts for enterprise application usefulness. A recent request from a Customer Meeting with OE was for an enterprise Newsletter and outreach communication tool for their use in reaching DOE and external parties in the event of a power incident. We are considering whether our in-house eDARS or DOE-Aware tools could be leveraged as a good fit or whether Constant Contact or Granicus or a similar tool should be introduced to help meet the need with a standard offering.

Excluding AI, what innovative technologies from industry are being used in your Office?

IM-50:

ServiceNow PaaS to build one centralized database for enterprise business data with mapped inter-relationships and workflows.

Think Tank software to collect feedback in meaningful ways from customers.

DHS Continuous Diagnostic and Mitigation (CDM) (see below in IM60 for Description) for feeding a Business Data Analytics database.

Our ServiceNow PaaS instance is fully integrated with DOE's OneID to provide Single Sign On capability to the enterprise.

Office of the Deputy CIO for Enterprise Operations and Shared Services (IM-60)

Next Generation (application layer) firewalls.

Enhanced Endpoint Protection (Tychon - behavior based, analysis).

Amazon AWS and Microsoft Azure Cloud IaaS and Cloud-native tools for implementation and security monitoring.

DHS Continuous Diagnostic and Mitigation (CDM) - Utilizing tools specialized in the areas of Whitelisting, Threat Detection, and Hardware & Asset Management to canvas our network environment and provide reports. The reports are then normalized through Splunk to provide centralized dashboard capabilities, which are consumed by the Department and DHS. This data allows us to take a proactive approach to harden our posture in vulnerable areas, while allowing for quicker response time against perceived threats.

We are evaluating commercial solutions from zScaler, Proofpoint, and FireEye; and Microsoft O365 G5 suite capabilities to meet TIC 3.0 requirements support the use of the Microsoft Office 365 TIC Overlay, and replace DOE's on-premises TIC service to deliver a scalable TIC capability with improved performance and a better mobile/remote access experience for DOE users. The commercial tools being evaluated include capabilities for behavior analytics, machine learning, and zero-day threat detection.

What systems or processes does your Office employ to foster innovation internally?

IM-50:

We developed and are using the Opportunity Management app for all projects requesting resources and agile development for managing ideas and funded initiatives. We are offering the app for use across DOE as an outcome of our Innovation Community Center and Business Architecture Modeling.

IM-60:

Agile Methodology for project management, project reporting, project implementation. We leverage the Confluence platform as the primary knowledge base for our project portfolio. This knowledge is consumed in several formats ranging from utilizing past lessons learned as input into current planning cycles to utilizing the data for parametric estimating exercises. Also, we have established cloud virtual data centers in both Amazon AWS and Microsoft Azure. Both of these cloud platforms rapidly introduce new and innovative services and solutions regularly that DOE will be able to more quickly deploy and use. In addition, the AWS and Azure environments will provide DOE with the ability to more quickly execute proof-of-concepts and pilots of new technologies and solutions.

How does your Office leverage the labs to foster innovation?

IM-50:

IM50 has conducted numerous Customer Business Architecture meetings to solicit needs from the customer organizations that they would like the OCIO assistance with. We have tracked these needs as Opportunities in our Backlog and are working to assign Use Cases from this list to the Sandbox testing we will be conducting.

In our Sandbox test labs for emerging technologies, we are working closely with the Labs to fully understand their Use Cases, their datasets, their desired results, and things they have already tried.

In our new Innovation Community Center (ICC) our Innovation Exchange will pull in the Labs to communities where they can work with their peers, exchange lessons learned and best practices, and leverage each other's innovation models to build iteratively on top yielding even more value to DOE and to ensure DOE stays competitive in the world of innovation.

IM-60:

We are partnering with Office of Science ESnet team from LBNL on the IT Modernization initiative to leverage ESnet as a primary enterprise transport service supporting the Department's DOEnet corporate network enhancing DOE's wide area network architecture to enable more secure and interoperable federal enterprise collaboration and accelerated cloud service adoption.

Attending CISO meetings and roundtable discussions; quarterly meetings that provide the environment to share ideas, capabilities, testing/innovation from across the DOE.
Canvas labs for tools utilized in their environment that could be leveraged to meet the same types of requirements on an enterprise scale (i.e. standing up BOX as a cloud service to meet enterprise collaboration requirements.

We hold quarterly or semi-annual meetings with the Labs on Unified Communications and collaboration system and tools (Instant Messaging, Cisco Webex, Microsoft Teams, etc.), Messaging (mobile, Email, etc.), Wide Area, Local Area, and Cloud Networking (WAN, LAN, SDN, etc.) technologies, and Cybersecurity (IDS, IPS, SDP, etc.) to foster communication, information sharing, and innovation.

We seek lab Powerpedia editors input along with others who are part of the Powerpedia Working Group.

How has or should your Office build platforms to help others be innovative?

IM-50:

Our Innovation Community Center is where innovations will be categorized and maps provided for efficient agency wide sharing. We plan to facilitate or conduct Community meetings to encourage sharing including innovative successes in the labs and offices. Management will have read-only access to all dashboards to encourage knowledge sharing and metrics analytics. Our development of innovation Sandbox testing, co-creation and pilot platforms will inspire the agency as we communicate experiences and jointly develop business solutions. We are opening up the environments to a wider section of DOE including the labs.

We participate in an intra-DOE ServiceNow group of Labs and Program Offices and the OCIO who use the tool and we understand fully the value of the platform. The innovations we have developed can be offered to the rest of DOE in our ServiceNow eDARS Product and Service Catalog but also we can do more to bring out the innovations and creativity from the field. By end of year in December we are moving to a new version of our ServiceNow platform that has enhanced capability for us to train and allow other DOE Sites and Labs to use a new Guided Development module in our platform and create custom automation for their own use. We see an IM50 role of providing the offering and pricing to the enterprise, training users, setting up the appropriate access restrictions and user roles, and enabling de-centralized development of reports and dashboards.

IM-60:

We have established cloud virtual data centers in both Amazon AWS and Microsoft Azure. Both of these cloud platforms rapidly introduce new and innovative services and solutions regularly that DOE will be able to more quickly deploy and use. In addition, the AWS and Azure environments will provide DOE with the ability to more quickly execute proof-of-concepts and pilots of new technologies and solutions. As we transition to a Service Broker we will test, discover, develop Cloud-centric technologies and toolsets for improved security, flexible applications and services, and greater return on investment compared to legacy datacenters. Being positioned as a Service Broker allows us to present the best end state solution to meet customer requirements while capitalizing on economies of scale (i.e. licensing) while driving towards standardization. Agile methodologies will facilitate more rapid access to new solutions and adoption of new technologies.

Office of Human Capital

Excluding AI, what innovative technologies are being developed in your Office?

The Office of the Chief Human Capital Officer (HC) does not receive program direction money to invest in the development of new technology. Our investments are primarily targeted towards commercial off-the-shelf (COTS) IT systems in support of business operations.

Excluding AI, what innovative technologies from industry are being used in your Office?

HC utilizes systems that are primarily owned by the Office of the Chief Financial Officer (CFO). There are also specific federal requirements that not all commercial solutions can meet. HC is working with CFO to identify better technology solutions for some of our outdated software applications to support operational efficiency through increased automation of core business processes

What systems or processes does your Office employ to foster innovation internally?

Leadership within the Office of the Chief Human Capital Officer are encouraged to participate in communities of practice and attend Industry Day events to keep apprised of best practices and emerging technologies that can be adopted with the Department to help drive improvements in HR service delivery. DOE's HC and CFO are participating in a group of five agencies invited by the Office of Personnel Management to help define the requirements for a future end-to-end software as a service solution to all aspect of human capital management. HC also has established an internal working group to look at artificial intelligence and other system improvements that could be adopted with additional resources.

How does your Office leverage the labs to foster innovation?

HC does not have funding to engage the National Laboratories. Additionally, the business process systems utilized by HC do not need the specific expertise of DOE's National Laboratories. There are significant improvement that could be realized by deploying more advanced COTS technologies.

How has or should your Office built platforms to help others be innovative?

HC is focused on technologies that improve service. In April of 2018, the Office of the Chief Human Capital Officer implemented a new Learning Management System, the Learning Nucleus, to support employee learning and development. The Learning Nucleus includes modules that facilitate mentoring and support online learning communities. There are many processes that could be automated to ensure greater efficiency and to minimize the amount of time our customers devote to HR basic functions, thus enabling them to utilize that time in helping develop and engage their employees and focus on DOE's core missions.

International Affairs

How does your Office leverage the labs to foster innovation?

- International Affairs (IA) will lead DoE efforts to promote U.S. energy dominance internationally, and, leverage energy technologies, policies and services to address U.S. national security objectives worldwide. The International Affairs Office provides a keystone reference for execution of critical executive branch policy and goals. Formulate better cross-agency/national laboratory coordination to fully vet the national security implications of all foreign investments that potentially affect DOE's strategic goals to maintain U.S energy dominance in the markets, including both energy resources and related technologies. DOE IA is committed to supporting energy initiatives that will attract investments, safeguard the environment, strengthen our energy security, and realize our potential as a strong and prosperous America.
- Recognizing POTUS Space Policy Directives and their ambitious goals, and, that DoE invests more than $500-$1billion annually on critical space technologies (e.g., nuclear propulsion systems and astrophysics), IA led the development of the DoE Space Coordination Group (SCG) with the aim of focusing and uniting DoE space technology programs and activities on cogent Space Policy Directives. The DoE SCG is a platform, for the 14 participating DoE Program Offices, to foster space technology innovation and cooperation. IA also led effort to have DoE re-instated to the EOP National Space Council enabling DoE leadership to have a voice in cogent space policy, regulatory and technology investment decisions.

How does your Office leverage the labs to foster innovation?

We utilize labs to develop new pathways to meet mutual goals with partner countries.
The labs are very helpful when answers to questions are unclear and require best practice frameworks, training, or systems to demonstrate a partner's need to rethink their stated requirements, such as:

- What are the priority areas to explore as we reduce vulnerability of partner countries to energy supply disruption?
- How can we motivate other countries to ideate solutions to complex problems?
- When developing solutions to protect critical energy infrastructure, how do we get partner countries to understand that they need to thing bigger and include fellow departments and agencies in the development of solutions?

How has or should your Office built platforms to help others be innovative?

Utilize Strategic Energy Dialogues and high level interactions to produce measurable increases in opening of LNG markets, increased energy interconnections, increased resource development and open markets for gas, nuclear, renewables and efficiency.

Our office could build a platform that helps us distinguish priority projects based on the 2017 NSS and Administration Priorities.

As a growing energy exporter, we could leverage a cross-department system, accessible to DOE attaches, that takes in commercial export and FDI opportunities, prioritizes them based on the

aforementioned guidance, dollar amount, and DOC status, and then tracks actions from 'potential opportunity' through 'notice to proceed' (NTP).

Recognizing that the US is an Arctic nation and the malign actions of competitor nations are damaging US Arctic equities and interests, IA led the development of the DoE Arctic Energy Strategy and contributed to the development and launch of the DoE Arctic Energy Office (AEO). The Strategy and the AEO are platforms to foster innovative technologies and policies to advance US strategic circumpolar interests across the Arctic Region. The DoE Arctic Energy Strategy is now emerging as a major pillar in the US Arctic Strategy now be re-instituted and revised at the EOP National Security Council.

Public Affairs

What systems or processes does your Office employ to foster innovation internally?

Public Affairs brings best practices from the private sector to overcome typical bureaucratic barriers. In addition to maintaining a competent, motivated workforce of skilled leaders with a dedicated work ethic, you've been able to foster the innovative capabilities of PA staff by clearly defining roles and responsibilities, empowering people to make prompt decisions and respond quickly, and instituting enterprise-wide commitment to collaborative internal communications to advance the strategic objectives of externally explaining and selling the capabilities and impact of the department.

Office of Chief Financial Officer

Excluding AI, what innovative technologies from industry are being used in your Office?

The Office of Chief Financial Officer (OCFO) is exploring the usage of Robotics Process Automation tools to improve and automate various business processes conducted in the Finance and Accounting and Budget directorates. We have created a working group and invited other DOE support offices to participate in exploring adoption of this technology. We have also began an effort to migrate core DOE-wide data and business systems maintained onsite by OCFO to cloud-based solutions.

What systems or processes does your Office employ to foster innovation internally?

OCFO is leading a working group, with participation from other DOE support offices, to explore the adoption of Robotics Process Automation for various business processes in order to help transition workforce efforts from low to higher value outputs where possible. OCFO is also undergoing a staff realignment to create a Strategic Analysis Group that will provide improved financial analysis, risk assessment and mitigation, program management oversight, and performance reviews for medium to long-term Department objectives and major projects. OCFO recently established a Data Governance Board to help the Department ensure policies are in place to promote open data access, quality, security, interoperability, and data usage in key decision making.

How does your Office leverage the labs to foster innovation?

OCFO senior management meets with all national lab CFO's on a quarterly basis to discuss the status of joint objectives, maintain an open dialogue on challenges and opportunities, and to discuss adoption of

best practices for financial management. Recent focus has centered on data analytics and robotic process automation.

How has or should your Office built platforms to help others be innovative?

OCFO is responsible for building and maintaining several of the Department's key corporate business systems. We continuously provide software and hardware upgrades to systems to improve performance both for internal DOE program & support offices as well as external stakeholders. We are also improving data security, reliability, and lowering operating costs by transitioning key systems to cloud-based solutions. OCFO systems include:

- A new public database to track research grants, contracts, and cooperative agreements per the requirements of the Research and Innovation Act
- STARS – DOE-wide accounting system
- STRIPES – procurement system
- AMERICA – automates/validates internal controls process
- FAST, VIPERS, DOEPAC – invoicing and payment processing tools
- A new public database to track research grants, contracts, cooperative agreements, and task orders per requirements of Research and Innovation Act
- A Do Not Pay pilot with Treasury to help alleviate fraud and improper payments

ARPA-E Advanced Research Projects Agency – Energy

Excluding AI, what innovative technologies are being developed in the DOE?

The Advanced Research Projects Agency-Energy (ARPA-E) funds technologies that have the potential to change the way to get, store, and use energy. ARPA-E's mission is to advance energy innovations that will create a more secure, affordable, and sustainable American energy future. ARPA-E focuses on early-stage energy technologies that can be meaningfully advanced with modest funding over a defined period of time.

Although ARPA-E looks at a wide range of technologies, for example, during Fiscal Year (FY) 2018. ARPA-E selected projects for four programs covering a broad array of energy technologies:

- $20 million to build a new class of sensor systems to enable significant energy savings via reduced demand for heating and cooling in residential and commercial buildings (SENSOR);
- $16 million to develop distributed, natural gas fueled devices that can generate electricity at greater than 70 percent efficiency (INTEGRATE);
- $24 million to create innovative technologies that enable designs for lower cost, safer, advanced nuclear reactors (MEITNER);
- $28 million for developing energy storage systems that provide power to the electric grid for durations of up to approximately 100 hours (DAYS).

Further, ARPA-E released three additional funding opportunities in FY 2018 with project selections that were ultimately announced in FY 2019:

- $98 million for the agency's fourth open solicitation (OPEN 2018);
- $29 million to develop new approaches and technologies for the design and manufacture of high temperature, high pressure, and highly compact heat exchangers (HITEMMP);

- $21 million to develop designs for medium voltage, direct current (MVDC) circuit breakers for a variety of applications (BREAKERS).

In addition to these new programs, ARPA-E hosted the ninth annual Energy Innovation Summit from March 13-15, 2018. The Summit brought together leaders from academia, government, and business to discuss the foremost energy issues, showcase the latest technology innovations, and cultivate relationships to help advance cutting-edge technologies towards deployment. The event drew nearly 1,800 attendees and featured over 100 speakers and keynote addresses.

Finally, ARPA-E announced that as of March 2019, 76 project teams have formed new companies, 131 projects have partnered with other government agencies for further development and an ever increasing number of technologies have already been incorporated into products that are being sold in the market. Additionally, 145 ARPA-E project teams have attracted more than $2.9 billion in private-sector follow-on funding.

Excluding AI, what innovative technologies from industry are being used in the DOE?
N/A- ARPA-E is a granting organization and has not labs or facilities that use technology.

What systems or processes does the DOE employ to foster innovation internally?
ARPA-E technical staff serve for limited terms, which extends to each program and project as well, of approximately 3 to 4 years, which ensures a constant infusion of fresh thinking and new perspectives.

How do the labs foster innovation?

National Labs are treated like other applicants for ARPA-E programs and must compete for awards through the application process along with the private sector and Universities. The labs currently constitute approximately 9% of active ARPA-E projects.

How has or should the DOE built platforms to help others be innovative?
ARPA-E does not build facilities, however, ARPA-E's has launched the Grid Optimization (GO) Competition which is a type of platform that comprises a series of prize challenges to accelerate the development and comprehensive evaluation of new software solutions for tomorrow's electric grid. Key areas for development include but are not limited to optimal utilization of conventional and emerging technologies, management of dynamic grid operations (including extreme event response and restoration), and management of millions of emerging distributed energy resources (DER).Challenge 1The first challenge of the GO Competition is an algorithm competition to develop solutions to the electric power sector's security-constrained optimal power flow (SCOPF) problem. Optimal power flow requires determining generator settings that best enable power to be routed to customers across a complex grid in a reliable and cost-effective manner. Algorithms will be tested on complex, realistic power system models, and participants will be scored on how well their algorithms perform relative to other competitors'. Winning teams will efficiently find a minimum-cost solution to the SCOPF problem. Additional challenges are planned beginning for 2020 in topics including DERs, intermittent resources, storage, grid resilience, grid restoration, grid dynamics, and cyber threats.