

The logo for the IDA (Innovation and Digital Agency) is located in the top left corner. It consists of the letters "IDA" in a bold, black, sans-serif font. A thin red horizontal line is positioned directly beneath the letters "I" and "D".

SCIENCE AND
TECHNOLOGY
POLICY INSTITUTE

REPORT TO THE PRESIDENT FISCAL YEAR 2022



The Institute for Defense Analyses is a nonprofit corporation that operates three Federally Funded Research and Development Centers. Its mission is to answer the most challenging U.S. security and science policy questions with objective analysis, leveraging extraordinary scientific, technical, and analytic expertise.

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**REPORT TO THE PRESIDENT
FISCAL YEAR 2022**

LETTER FROM THE DIRECTOR

Dear Mr. President:

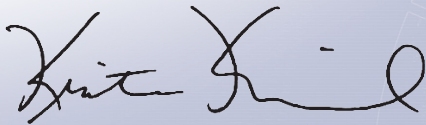
On behalf of the IDA Science and Technology Policy Institute (STPI), I am proud to present our report of activities for fiscal year 2022.

Congress established STPI as a federally funded research and development center in 1991 to inform policy decisions of the Office of Science and Technology Policy (OSTP) in the Executive Office of the President and expanded STPI's mission in 1998 to include:

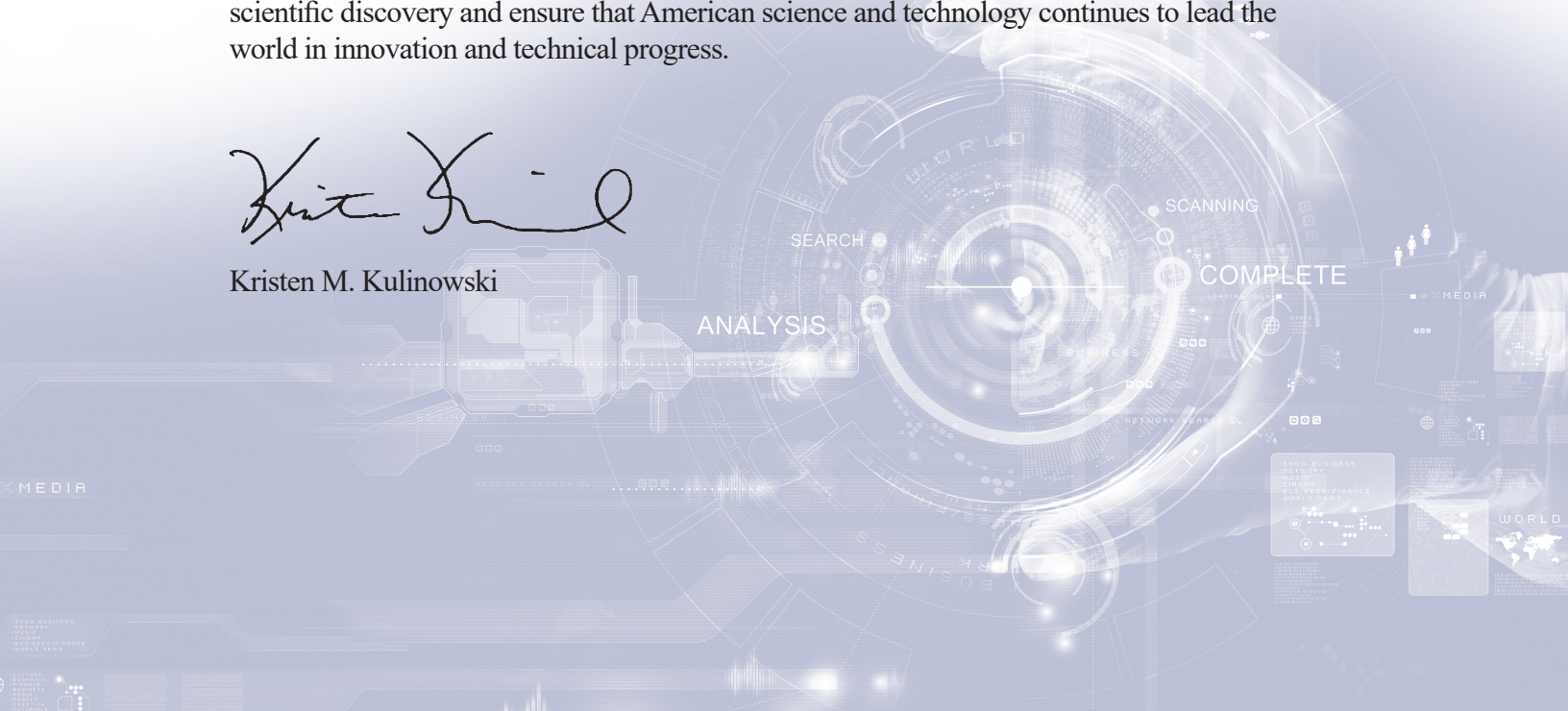
- Reporting on significant trends and developments in science and technology in the United States and abroad;
- Analyzing those trends with attention to the Federal science and technology portfolio; and
- Performing studies that will ensure the long-term strength of American science and technology.

Since 2003, we have been operated by the nonprofit Institute for Defense Analyses with sponsorship through the National Science Foundation. We also work with other Federal agencies to inform science and technology policies and assess their effectiveness, including the National Science Foundation, the National Aeronautics and Space Administration, the National Institutes of Health, the Department of Commerce, the Department of Energy, the Department of Homeland Security, and the Department of Transportation.

It is my pleasure to deliver this report highlighting the depth of knowledge at STPI and the diverse array of issues we have tackled over the past year. Everyone at STPI is deeply committed, both individually and as an institution, to providing OSTP and Federal agencies with in-depth, objective, fact-based analysis on a wide variety of science and technology topics and trends with complete discretion and free of conflicts of interest. On behalf of everyone at STPI, I thank you for the opportunity to help keep America at the forefront of scientific discovery and ensure that American science and technology continues to lead the world in innovation and technical progress.



Kristen M. Kulinowski



ABOUT THE SCIENCE AND TECHNOLOGY POLICY INSTITUTE

The Science and Technology Policy Institute (STPI) was established by Congress in the National Defense Authorization Act for Fiscal Year 1991 (P.L. 101-510) as a federally funded research and development center (FFRDC) under the name Critical Technologies Institute. In 1998, Congress renamed the Institute as part of the National Science Foundation Authorization Act of 1998 (P.L. 105-207), which also assigned STPI the following duties:

- Assembly of timely and authoritative information regarding significant developments and trends in science and technology research and development in the United States and abroad.
- Analysis and interpretation of the information with particular attention to the scope and content of the Federal science and technology research and development portfolio as it affects interagency and national issues.
- Initiation of studies and analyses of alternatives available for ensuring the long-term strength of the United States in the development and application of science and technology.
- Provision, upon the request of the Director of the White House Office of Science and Technology Policy (OSTP), of technical support and assistance
 - to committees and panels of the President’s Council of Advisers on Science and Technology, and
 - to interagency committees and panels of the Federal Government concerned with science and technology.

Consistent with congressional direction, STPI provides analyses of significant science and technology policies and developments in the United States and abroad for OSTP, its primary sponsor, and for other Federal Government organizations with science and technology responsibilities. To ensure the continued relevance of its work, STPI meets frequently with the Director and staff of OSTP. Such close coordination—coupled with a flexible tasking process—ensures that STPI focuses on OSTP’s top priorities and emergent problems.

To address STPI’s broad science and technology charter, STPI researchers possess educational training and professional experience across the spectrum of disciplines and sectors. The majority of degrees among STPI’s research staff are in mathematics, physical and life sciences, and engineering, with law, social science, communication, and history rounding out the staff’s educational background.

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FEDERAL SCIENCE AND TECHNOLOGY POLICY



Scientific Integrity and Evidence-Based Policymaking

In 2021, the President issued the *Memorandum on Restoring Trust in Government through Scientific Integrity and Evidence-Based Policymaking*, which affirmed that it is the policy of the Administration “to make evidence-based decisions guided by the best available science and data” that are not “distorted or influenced by political considerations.” The President asked the Office of Science and Technology Policy (OSTP) to constitute an interagency task force on scientific integrity within the National Science and Technology Council (NSTC) to review the effectiveness of scientific integrity policies across the Federal Government. In 2021, OSTP asked the Science and Technology Policy Institute (STPI) to assist the task force. In 2022, STPI assembled requested information for the Scientific Integrity Fast Track Action Committee for their final report and the accompanying implementation plan.

Diversity, Equity, and Inclusion in Federal Funding Opportunities

In response to a series of Executive Orders and guidance documents issued by the White House and OSTP, the Office of Energy Efficiency and Renewable Energy (EERE) in the Department of Energy (DOE) decided to revise its Funding Opportunity Announcement (FOA) language and criteria to incorporate principles that advance equity, civil rights, racial justice, and equal opportunity. EERE asked STPI to undertake a review of diversity, equity, and inclusion (DEI) plans, funding programs, and FOAs at six agencies with research and development (R&D) missions and to help develop new FOA language that both aligns with Federal DEI priorities and reflects best practices across the U.S. Government. While intended for EERE, the new language will be incorporated in all R&D FOAs issued by DOE. According to EERE staff, this change will have an impact on billions of Federal R&D dollars and is anticipated to produce better equity outcomes. STPI developed a rubric to systematically and consistently evaluate all DEI plans and will interview applicants and reviewers about their experiences.

Diversity, Equity, and Inclusion in Science and Technology

In late 2021, OSTP held the “Time is Now: Advancing Equity in Science and Technology Ideation Challenge,” asking Americans of all walks of life—students, teachers, workers, scientists, and innovators—to respond to the question, “How can we guarantee all Americans can fully participate in, and contribute to, science and technology?” The challenge drew 241 submissions providing ideas and suggestions to address DEI in science, technology, engineering, and math (STEM). STPI analyzed the responses to identify concrete actions for the Federal Government in the areas of education and training, Federal intervention, government strategy and policy, data collection, information dissemination, and strengthening support services and networks.

President's Council of Advisors on Science and Technology

The President's Council of Advisors on Science and Technology (PCAST) is an advisory group composed of “distinguished individuals and representatives” from industry, academia, and nonprofits with “diverse perspectives and expertise in science, technology, and innovation.” PCAST advises the President “on matters involving policy affecting science, technology, and innovation, as well as on matters involving scientific and technological information that is needed to inform public policy relating to the economy, worker empowerment, education, energy, the environment, public health, national and homeland security, racial equity, and other topics.” OSTP asked STPI to provide technical support to PCAST in the form of information gathering and analysis, identification of key issues for PCAST consideration, and technical review and writing support. In 2022, STPI conducted background research for PCAST working groups, delivering more than 20 analytical products. Several STPI analyses served as inputs to the PCAST reports on *Recommendations for Semiconductors R&D* (released in September and August of 2022) and the report on *Recommendations for Strengthening U.S. Biomanufacturing* (released in December 2022). STPI researchers continue to conduct analyses and assist in report development for PCAST and its working groups on topics ranging from public health to wildfires, to extreme weather and financial risk.

STPI supported the PCAST Nano Working Group in its role as the National Nanotechnology Advisory Panel to carry out a quadrennial review of the National Nanotechnology Initiative (NNI). STPI provided analysis and support in the review including a topic modelling analysis of past NNI research topics to inform the working group's recommendations. Additionally, STPI curated and facilitated interviews with experts, industry leaders, and academics in nanotechnology and nanotechnology-related fields to solicit their insights on the basic nanotechnology research needed to keep the United States globally competitive.

The Legal and Policy Context for Information Integrity

The Networking and Information Technology Research and Development (NITRD) Program's Information Integrity Research and Development Interagency Working Group developed its first-ever *Roadmap for Researchers on Priorities Related to Information Integrity Research and Development*, released in December 2022. OSTP asked STPI to develop a primer for information integrity researchers on the legal and policy context around online information integrity. STPI's review focused heavily on Supreme Court rulings related to the First Amendment as well as the role of Section 230 of the Federal Communications Act (the law that allows online platform operators to moderate user speech and content), including recent State laws intended to regulate internet platforms. Comparable information on the European Union's (EU's) legal and policy context indicated that the EU more actively regulates internet content (and encourages greater self-regulation) than the United States. Information regarding the content moderation policies of large social media platforms was also collected.

Use and Governance of Biometric Technologies

As part of the White House’s initiative to define a “Biometric Bill of Rights,” OSTP posted an RFI on *Public and Private Sector Uses of Biometric Technologies* to solicit public comment on “the extent and variety of biometric technologies in past, current, or planned use; the domains in which these technologies are being used; the entities making use of them; current principles, practices, or policies governing their use; and the stakeholders that are, or may be, impacted by their use or regulation.” OSTP also hosted two public listening sessions to solicit oral comments on these subjects. OSTP asked STPI to facilitate the listening sessions and to prepare a written summary of oral comments made during the listening sessions and written comments submitted to the RFI. Public responses addressed many issues from a wide variety of perspectives, but general concerns included the following: privacy and the ability of individuals to control access to and use of their biometric data; discriminatory bias in biometric systems powered by artificial intelligence (AI); chilling of speech and association due to biometric surveillance; the security of sensitive biometric information; and defining clear boundaries on where, when, and how biometric technologies can be used. In addition, respondents universally encouraged OSTP to continue to engage stakeholders as the Federal Government works to develop voluntary standards, ethical guidelines, and best practices for testing, certifying, and approving uses of biometric technologies.

Supporting the National Artificial Intelligence Research Resource Task Force

The National AI Initiative Act of 2020 called for the National Science Foundation (NSF), in coordination with OSTP, to form a National AI Research Resource (NAIRR) Task Force to investigate the feasibility and advisability of establishing and sustaining a NAIRR, which would serve as a means of democratizing access to the cyberinfrastructure resources and tools that fuel AI R&D. In 2022, STPI continued to provide technical and analytical support to the task force, which commenced in 2021. Researchers completed a fourth and final background research paper, on sustainment and partnership models, to help inform task force deliberations. STPI researchers also provided support to working groups of the task force in their information gathering activities, and assisted in research for and compilation of the task force’s interim and final reports. The task force submitted to the President and to Congress its final report, *Strengthening and Democratizing the U.S. Artificial Innovation Ecosystem*, setting forth an implementation roadmap for the NAIRR that would build on existing and future Federal investments; incorporate protections for privacy, civil rights, and civil liberties; and promote diversity and equitable access. It lays out a phased approach to stand up the administration, policies, security framework, and cyberinfrastructure that would support the full spectrum of AI research—from foundational to use-inspired to translational.

Advancing National Resilience through Science and Technology

To strengthen and promote national resilience against threats and hazards that could have catastrophic consequences to essential national functions, the NSTC Committee on Homeland and National Security established the Subcommittee on Resilience Science and Technology (SRST). OSTP asked STPI to provide analysis and support in conceptualizing, planning, and completing numerous SRST deliverables aimed at increasing national resilience through Federal science and technology coordination and innovation. In 2022, STPI developed a framework to investigate the interdependencies among societal dimensions of resilience and to identify the critical gaps that impede resilience. The framework aims to identify mechanisms to align current and future resilience science and technology capabilities across multiple disruptions, resources and enablers, functions, and societal dimensions to help communities advance their own resilience. The framework was piloted by SRST member agencies, and STPI incorporated feedback to guide the document through the OSTP and NSTC clearance and publication process. In addition, STPI helped SRST prepare the annual review and update of the *Electromagnetic Pulse Research and Development Plan*, as required by Executive Order 13865.

International Science and Technology Cooperation

OSTP requested STPI's support for the NSTC Subcommittee on International Science and Technology Coordination as it prepared its second biennial report to Congress on international science and technology cooperation. STPI worked with OSTP and a writing team of agency subject matter experts to develop the structure of the report and assist in preparation of the final version; STPI also conducted background research to ground the report findings and recommendations. The report presented findings on areas of excellence in the U.S. approach to international science and technology; gaps in the U.S. approach to international science and technology; and recommendations moving forward. The report was published in September 2022.

Committee on Foreign Investment in the United States

The Committee on Foreign Investment in the United States (CFIUS) is an interagency committee authorized to review certain transactions involving foreign investment in the United States and certain real estate transactions by foreign persons, in order to determine the effect of such transactions on the national security of the United States. OSTP is a CFIUS member agency. STPI works with OSTP to inform their ongoing review of CFIUS transactions.

SPACE TECHNOLOGY AND POLICY



Advancing National Strategic Objectives in Cislunar Space

U.S. endeavors in space—whether for research, exploration, or commercial purposes—advance the Nation’s strategic interests by signaling that the United States has the capability and will to achieve incredibly difficult, long-term goals and provide an important avenue for developing international partnerships, attracting global talent in STEM, and developing new industries in the U.S. economy. OSTP asked STPI to support the development of the *2022 U.S. Cislunar Science and Technology Strategy* that would advance U.S. national strategic objectives in the regions near and around the Moon. STPI analyzed responses to a Federal RFI and supported writing teams drafting the final strategy. STPI also identified areas of engagement for the international community in cislunar activities conducted by the United States.

Advancing In-Space Servicing, Assembly, and Manufacturing

In recent years, worldwide interest in on-orbit servicing grew such that in 2020 the National Aeronautics and Space Administration (NASA) set up an intra-agency on-orbit servicing initiative to begin interagency discussions on capabilities, technologies, and definitions. Given recent advances in in-space servicing, assembly, and manufacturing (ISAM) technologies and their potential to support many new activities in space across civil, commercial, and military domains—and the need for stronger leadership to coordinate U.S. efforts in R&D as well as policy and regulation of novel on-orbit activities—OSTP asked STPI to support development of a national ISAM strategy and initiative. STPI conducted an academic roundtable to discuss challenges and opportunities as seen by the ISAM community and facilitated an interagency working group convened to develop a national strategy. STPI provided coordination and prepared background information that led to the publication of the *In-Space Servicing, Assembly, and Manufacturing National Strategy* (April 2022) and accompanying implementation plan (December 2022).

Assessment of Global Space Norms and Legal Regimes

Understanding individual countries’ attitudes toward norms of behavior in space is imperative to protect orbital national security operations and enhance space sustainability in a future where there will be a larger number of actors, public and private, in near-Earth and deep space orbits. As the number of countries involved in space increases, the importance of clear definitions on proper behavior increases. Knowledge of how key countries develop policies and actions related to operating in space is vital to understanding how global norms will evolve in the future. OSTP asked STPI to examine the legal, policy, and technical considerations for ISAM and how they may change in the future as space activities become more diverse. STPI found that most countries and companies do not have a common definition of what a norm of behavior in space is, and that new activities, such as ISAM, do not have enough heritage for norms to develop.

Low-Earth Orbit Commercialization of In-Space Production Applications

NASA asked STPI to assess current and potential future foreign competition with the United States for in-space manufacturing of products to be sold on Earth. The report reviewed the in-space manufacturing activities of China, the EU, Japan, and to a lesser extent, Canada, Israel, and Russia. The report concluded that the United States is ahead of all other countries in in-space manufacturing. A core strength of the United States is the existence of dedicated Federal funding for companies endeavoring to develop in-space manufacturing technologies. The EU and the United Kingdom are the only other major space powers that have shown interest in in-space manufacturing. Although China has not yet focused on manufacturing in space, it appears to be particularly interested in the fabrication of microchips and the development of pharmaceuticals in the microgravity environment. A second objective of this study was to identify current and potential new products to be manufactured in low-Earth orbit. Current and potential commercial in-space manufacturing activities for Earth markets include three-dimensional cell cultures and organoids, crystallization of small molecules and membrane proteins, exotic optical fibers, metal-organic frameworks, potassium dihydrogen phosphate crystals, and special semiconductor wafers.

Identifying Federal Civil Satellite Needs

OSTP, through the Satellite Needs Working Group of the NSTC's U.S. Group on Earth Observations Subcommittee, supports a biennial process to collect satellite measurement needs from Federal civil agencies. The objective of this process is to identify, collect, and transmit civil agency measurement requests to NASA for consideration in its systems engineering process. At the request of OSTP, in 2022, STPI helped prepare briefings of the technical and policy analyses of the recently completed third survey and contributed to the development and launch of the fourth satellite needs data collection process.

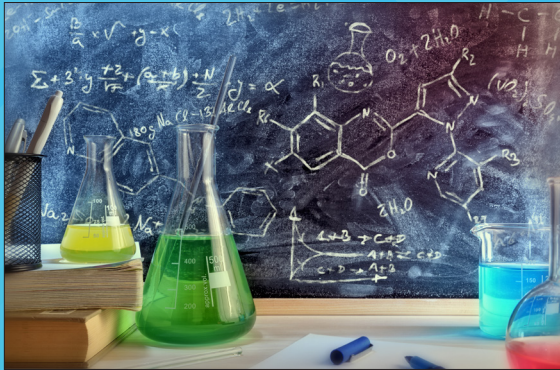
Managing Space Orbital Debris

Due to increased activity in space, the amount of human-made debris in orbit continues to grow, increasing the probability of collisions with active satellites. While the risk of individual collisions is relatively low, each one generates new debris that increases the likelihood of subsequent collisions. The resulting growth of debris reduces the sustainability, safety, stability, and security of the outer space environment, and represents a threat to both human and robotic space flight. At the request of the NSTC, STPI aided the interagency working group in developing an implementation plan in support of the 2021 *Orbital Debris Research and Development Strategic Plan*, which focuses on R&D to minimize the creation of orbital debris, as well as to track, mitigate, and remediate it. STPI convened several activities to gather input from the broader community about orbital debris actions, including a request for comment on the National Strategy, two virtual public listening sessions, and an academic workshop. Based on the information gathered, STPI collated, harmonized, and developed a draft list of implementation actions for agencies to consider to address the challenges of orbital debris. The NSTC's *National Orbital Debris Implementation Plan* was published in July 2022.

Enhancing Space Weather Forecasting and Mitigation

Space weather comprises a wide array of phenomena that can have severe effects on national security assets and the Nation's critical infrastructure, including assets in space. Through coordination across the Federal Government and sustained engagement with academia, the private sector, and international partners, the United States has made significant progress in enhancing preparedness since the release in 2015 of the United States' first *National Space Weather Strategy*. However, even as our society becomes more reliant on technology and interconnected infrastructure, the Nation remains vulnerable to space weather. Recognizing this threat, the Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act was signed into law in October 2020. The PROSWIFT Act assigns roles and responsibilities to agencies involved in space weather research and forecasting and codifies coordination via the NSTC's Space Weather Operations Research and Mitigation (SWORM) working group. STPI provided technical support and assistance to OSTP for a range of issues under SWORM, including progress toward refining the space weather benchmarks. STPI's analysis included interviews with subject matter experts on the current state of space weather research for benchmarking and characterizing extreme space weather events, assessing progress on achieving the near- and long-term recommendations from the *Next Step Space Weather Benchmarks* report, identifying barriers to improving the current Phase 1 Benchmarks, and providing recommendations for a potential revision. STPI also conducted analysis for OSTP and SWORM on the related issue of revising the space weather scales, which included a literature review to understand the history, current use, and limitations of the scales and recommendations for a potential revision.

STEM EDUCATION, WORKFORCE, AND TALENT



Federal Coordination in STEM Education

STEM education lays the foundation for continued U.S. global leadership in discovery and innovation. As part of the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Reauthorization Act of 2010, OSTP was tasked by Congress with the coordination of Federal STEM education programs. In FY2022, STPI provided data collection, analysis, and additional support to OSTP and the NSTC Federal Coordination in STEM Education Subcommittee (FC-STEM) in the preparation of the *2022 Progress Report on the Implementation of the Federal STEM Education Strategic Plan*. The progress report provides an update on ongoing efforts and implementation practices across the Federal Government to advance the goals and objectives of the Federal STEM Education Strategic Plan. In addition, STPI provided support for the development of the next Federal STEM strategic plan.

Charting the Course for STEM Education of the Future

NSF's Directorate for Education and Human Resources seeks to achieve excellence in U.S. STEM education for all ages and in all settings. That excellence includes a well-prepared workforce of scientists, technicians, engineers, mathematicians, and educators in addition to a well-informed citizenry. Scientific and engineering habits of mind and practice enhance the quality of life of all citizens and the health, prosperity, welfare, and security of the Nation. NSF asked STPI to support NSF staff engaging with representatives of the STEM education R&D community and other STEM education stakeholders to explore possible future directions and venues for STEM learning and education. As part of this task, STPI supported five workshops on (1) new and emerging methods in STEM education research, (2) CAREER awardees (two workshops), (3) climate science and communication, and (4) blockchain in education. STPI also supported eight listening sessions addressing mid-scale instrumentation for STEM education research, online STEM learning (two sessions), effects of online STEM education on educational organization, data science education, Hispanic-serving Institutions, community colleges, and low-income STEM students. These sessions provided information for NSF as it manages its STEM education portfolio.

Defense Research at Historically Black Colleges and Universities and Other Minority Institutions

At the request of the National Academies of Sciences, Engineering, and Medicine's Committee on Defense Research at Historically Black Colleges and Universities and Other Minority Institutions, STPI collected, analyzed, and collated data on Department of Defense funding of institutions of higher education, with a specific focus on Historically Black Colleges and Universities and other Minority Institutions. Task findings were incorporated into a 2022 National Academies report: *Defense Research Capacity at Historically Black Colleges and Universities and Other Minority Institutions: Transitioning from Good Intentions to Measurable Outcomes*.

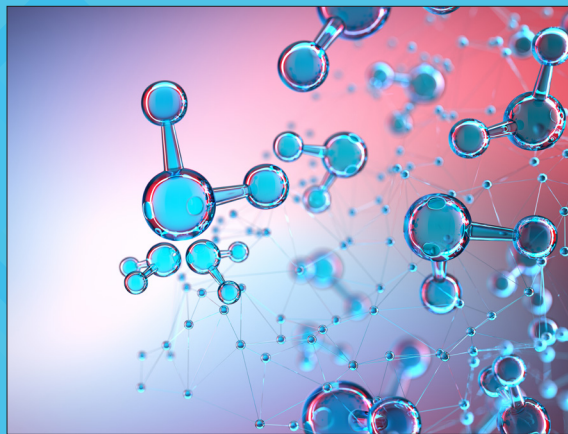
Benefits and Costs of Foreign STEM Talent in the United States

To help inform policy decisions by the U.S. Government concerning the admission of foreign students and workers to the United States, OSTP asked STPI to make a comprehensive, empirically-based comparison of the potential economic benefits and costs to the United States related to foreign STEM talent who visit, work, or study in this country. STPI's report, *Economic Benefits and Losses from Foreign STEM Talent in the United States*, provided quantitative estimates and a net assessment of those economic benefits and costs. STPI concluded that the benefits of foreign STEM talent in the United States far outweigh any potential economic costs. STPI presented the report to two workshops hosted by the National Academies of Sciences, Engineering, and Medicine in 2022. It has been used to support the assessment of policy shifts designed to attract and retain foreign STEM talent in the United States.

How the America COMPETES Act Could Impact Foreign STEM Talent

To understand how many foreign-born STEM degree-holders may be eligible for green cards under the America COMPETES Act of 2022, OSTP asked STPI to determine what portion of the world's STEM doctoral or master's degree recipients received their degrees from institutions with over \$25M in R&D spending per year. STPI used multiple approaches to analyze (1) the degrees awarded to temporary residents at U.S. institutions and (2) degrees awarded by non-U.S. institutions. STPI generated estimates of the annual degree production at these institutions over time and the portion of the total worldwide stock of doctoral and master's degree holders in STEM disciplines currently employed in the United States. In a related concurrent effort, STPI is helping OSTP understand the numbers and percentages of international medical graduates and residency programs in certain fields.

BIOSCIENCES AND PUBLIC HEALTH



Understanding Artificial Intelligence in Health and Human Services

In September 2020, the Office of the Assistant Secretary for Planning and Evaluation and the Administration for Children and Families of the U.S. Department of Health and Human Services (HHS) asked STPI to conduct a study focused on emerging issues and needs associated with AI in the health and human services sectors. The purpose of the study was to help inform HHS about the rapidly emerging standards and policies associated with AI R&D. Results were summarized in four deliverables: (1) a landscape analysis of 10 AI, machine learning, and advanced analytics ethics documents published by Federal departments and agencies and released between 2018 and 2020; (2) a landscape analysis of AI activities across the Federal Government; (3) an analysis of nine case studies with an analytical focus on understanding the existing and potential barriers, facilitators, risks, and benefits when using AI in health and human services; and (4) a final report synthesizing results from STPI's analyses to identify potential options and opportunities to promote the benefits of the responsible development of AI.

Support for Pandemic Preparedness Innovation

OSTP asked STPI for support to implement the *American Pandemic Preparedness Plan*. STPI helped OSTP plan discussion topics, identify speakers, and execute a summit on *Strengthening the Nation's Early Warning System for Public Health Threats* for the launch of the National Center for Forecasting and Outbreak Analytics. STPI summarized event proceedings, which were published on the White House website. STPI also supported the Pandemic Innovation Task Force in their preparation of the *Annual Report on Progress Towards Implementation of the American Pandemic Preparedness Plan*. Specifically, STPI summarized interagency progress towards pandemic preparedness and supported working group deliberations to identify goals for the future. STPI identified potential gaps, helped OSTP develop a plan to prioritize and implement priority goals, and generated schematics to visually represent the pandemic preparedness priorities as communication tools for public engagement.

Biosafety and Biosecurity Analysis

OSTP asked STPI for support to develop a policy framework to govern life science research of concern (i.e., research that could lead to knowledge, information, products, or technologies that could be directly misapplied to pose a significant threat to public health and safety, agriculture, the environment, or national security). STPI evaluated documents governing high-risk research—such as existing policies on Dual-Use Research of Concern, Potential Pandemic Pathogen Care and Oversight (P3CO), Recommended Guidance for the Providers of Synthetic Double-Stranded DNA (Guidance), and the Federal Select Agent and Toxins Program—for gaps and areas where they could be harmonized. STPI leveraged some of its prior work related to this topic, including efforts to assess the impact of P3CO on the conduct of biological research and the effect that potential changes in the Guidance would have on the synthetic DNA industry. STPI used this information to identify policies that would support laboratory biosafety and biosecurity while promoting high-quality research. STPI then worked with OSTP to develop a draft framework for a risk-based Federal policy for life science research of concern and evaluated the framework for its ability to fill existing policy gaps.

Increasing Diversity in the National Cancer Institute's Extramural Clinical Trials Leadership and Programs

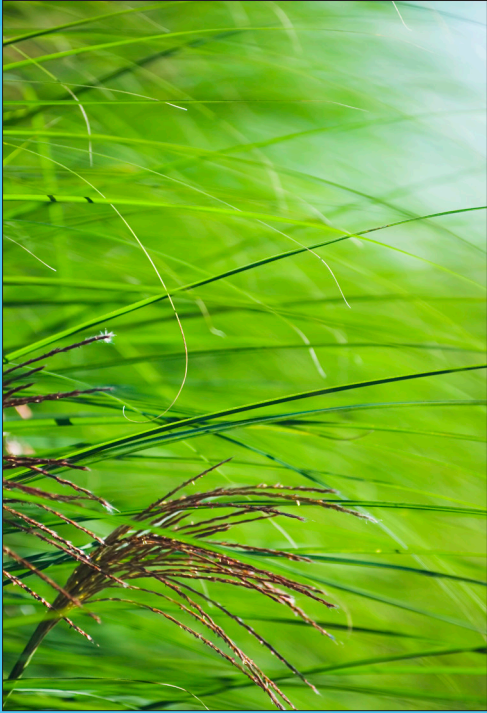
To support its commitment to increase the diversity of the cancer clinical trials workforce and build a more inclusive and equitable community, the National Cancer Institute (NCI) created the NCI Equity and Inclusion Program. The program formed a subcommittee to better understand and make recommendations to improve the inclusion of women and underrepresented groups in leadership positions within the NCI National Clinical Trials Network, the NCI Community Oncology Research Program, and the NCI Scientific Steering Committees. In FY2022, the subcommittee asked STPI to design and conduct a survey to establish a baseline understanding of the diversity of leadership across these entities.

In November 2019, NCI convened a Strategic Planning Working Group to develop recommendations for realizing its vision for cancer clinical trials in 2030 and beyond as well as improving the operational efficiency and reducing the cost of cancer clinical trials today and in the future. NCI asked STPI to provide strategic and analytical support for this working group including drafting the final report. In FY2022, STPI assisted NCI with implementation of the report's recommendations, including (1) design, conduct, and analysis of a Cancer Centers survey concerning impact of the COVID pandemic on clinical trials procedures and workforce; (2) analysis of data collection burden for NCI late phase trials; (3) analysis of survey findings on use and value of telemedicine in clinical trials; (4) current status of the integration of clinical trial activities with electronic medical record (EMR) systems, and (5) facilitating deliberations of the Streamlining Clinical Trials Working Group convened to advise on reducing data collection burden and promoting the integration of clinical trial activities with EMR systems.

Assessing Biotechnology Skillsets in Synthetic Biology

OSTP asked STPI to assess the skillsets and technology required to conduct synthetic biology experiments. STPI delivered a classified briefing and final report summarizing findings.

ENVIRONMENT



Contaminants of Emerging Concern in Drinking Water

Contaminants of emerging concern (CEC) are newly identified or reemerging manufactured or naturally occurring physical, chemical, biological, radiological, or nuclear materials that may cause adverse effects to human health or the environment and do not have a national primary drinking water regulation. In the FY2020 National Defense Authorization Act, Congress directed OSTP to develop a National Emerging Contaminants Research Initiative that would guide a CEC Interagency Working Group in coordinating Federal research programs operating in this arena. In FY2022, OSTP asked for STPI's assistance to summarize the results from three workshops on Federal CEC research and incorporate those findings and the results from STPI's analysis of the CEC RFI into the National Emerging Contaminants Research Initiative (NECRI). STPI supported OSTP during the CEC agency review of the NECRI, and the NECRI was published in July 2022. STPI also assisted OSTP in the transition of the congressionally directed CEC working group to a Strategy Team under the auspices of the NSTC Joint Subcommittee on Environment, Innovation, and Public Health.

Environment, Innovation, and Public Health Analysis

OSTP requested that STPI provide technical assistance to the NSTC Joint Subcommittee on Environment, Innovation, and Public Health and their Working Group on Polyfluoroalkyl Substances (PFAS): manufactured chemicals that are used to keep food from sticking to packaging or cookware, make clothes and carpets resistant to stains, and increase the effectiveness of firefighting foam, among many other common uses. PFAS are used in many industries, including aerospace, automotive, construction, and electronics. Exposure to PFAS has been related to negative health effects including altered metabolism, altered fertility, reduced fetal growth, increased risk of some cancers, and reduced ability of the immune system to fight infections. STPI was asked to analyze an RFI on *Identifying Critical Data Gaps and Needs to Inform Federal Strategic Plan for PFAS Research and Development*. STPI identified themes in the RFI responses and organized the analysis by the type of organization that responded. STPI produced an informal report for NSTC summarizing the responses to the RFI to inform the subcommittee's ongoing work on PFAS.

Federal Flood Risk Management Standard

The Federal Flood Risk Management Standard (FFRMS) is intended to ensure that Federal taxpayer-funded investments are sited, designed, and maintained to be resilient against current and future flooding. In October 2021, the National Climate Task Force's Flood Resilience Interagency Working Group convened an FFRMS Science Subgroup co-led by OSTP and charged it to review and update science underpinning the FFRMS using a climate-informed science approach. OSTP requested STPI's support in completing this state of the science report. STPI worked with OSTP and a writing team of agency subject matter experts to draft the report, which focuses on four types of flooding (coastal, riverine, pluvial, and compound) and offers guidance on how the current science around these flood types can be applied and understood. In addition to supporting the preparation of this report, STPI also developed a short proposal for a Federal Future Flooding Community of Practice as requested by OSTP.

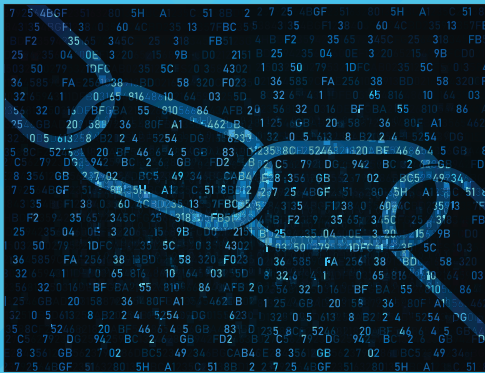
Arctic Research Implementation Plan

The Arctic Research and Policy Act of 1984 called for a comprehensive national policy focused on research needs and objectives in the Arctic, and established both the Interagency Arctic Research Policy Committee (IARPC) and the Arctic Research Commission. OSTP asked STPI to support the development of the IARPC Biennial Implementation Plan for the execution of its Arctic Research Plan (ARP) 2022–2026 and, in particular, examine how previous efforts (ARP 2017–2021) might already align with the ARP 2022–2026 priority areas and foundational activities. In 2022, STPI delivered its written summary report and presented its findings to the IARPC Staff Group and the U.S. Arctic Observing Network’s Board. Briefing the latter group contributed to its continuing development of a value tree analysis for Arctic-focused observing networks and systems.

National Net-Zero Innovation Priorities

In February 2021, the White House stood up the Climate Innovation Working Group (CIWG), whose mission is to develop a whole-of-government climate innovation strategy to achieve net-zero emissions by 2050 and protect the American people from the worsening impacts of climate change. A sub-group of the CIWG is the Net-Zero Game Changers Working Group, which is charged with identifying, evaluating, and prioritizing a portfolio of transformative technologies that are needed to meet the Administration’s net-zero goals. In support of the CIWG, OSTP asked STPI to document FY2021 budget and legislative appropriations for each of 37 net-zero innovation areas. STPI analyzed the status of R&D in each innovation area, including Federal investment and outstanding projects, and grouped them into five priority areas: (1) efficient building heating and cooling; (2) net-zero aviation; (3) net-zero power grid and electrification; (4) fusion energy at scale; and (5) industrial products and fuels for a net-zero, circular economy.

EMERGING TECHNOLOGIES AND TECHNOLOGY TRANSITION



Ecosystem of Critical and Emerging Technologies

As part of its participation in the fast-track action committee developing the *National Security Science and Technology Strategy* under the coordination of the National Security Council and OSTP, NSF asked STPI to develop an ecosystem-based framework and use it to analyze the challenges, opportunities, and risks associated with select critical and emerging technologies: microelectronics, biotechnology, and AI. In 2022, STPI delivered a final report that summarized work on this task. In the final report, STPI described a generalized framework, showing how five general elements (knowledge, workforce, research and development [R&D] infrastructure, organizational support structures, and building blocks) serve as inputs, outputs, and mechanisms in the process of technology maturation. STPI provided examples of how to use the critical and emerging technology ecosystem analysis workflow we developed to help inform whether policy intervention should be considered to target particular elements of the ecosystem. Examples were provided of the application of the generalized framework and analysis workforce to three CET areas. Observations were made about how similarities and differences in the nature of the R&D infrastructure across the three test cases impact the industry structure and the associated risks to the U.S.

Critical and Emerging Technologies under the American COMPETE Act

The Consolidated Appropriations Act of 2021 incorporated the American COMPETE Act, which directed the National Institute of Standards and Technology (NIST) to prepare studies on several critical and emerging technologies: AI, the Internet of Things, quantum computing, blockchain technology, new and advanced materials, unmanned delivery services, and three-dimensional printing. For each of these technology areas, NIST asked STPI to summarize which industry sectors implement and promote the use of the technology; the public-private partnerships focused on promoting the adoption of the technology; the state of regulations, standards, and guidelines affecting the technology; Federal agencies with expertise and jurisdiction relevant to the technology; risks to the supply chains and marketplace of the technology; risks from foreign actors to national security concerning the technology; and future trends for the technology. Five broad areas for continued Federal support were identified in response to the request in the American COMPETE Act to make recommendations for policy and legislation: (1) research infrastructure to advance the technology areas, (2) public-private partnerships as a means of transitioning technologies from lab-to-market, (3) developing clear standards relevant to the technology areas, (4) investing in workforce training for emerging technologies, and (5) addressing cyber-vulnerabilities associated with most of the technology areas.

Advanced Biomanufacturing

OSTP asked STPI to assist PCAST in drafting the Biomanufacturing Working Group's report to the President. STPI provided memos on biomanufacturing apprenticeships, academic programs, partnerships, and relevant provisions in the CHIPS and Science Act and Executive Orders. STPI also attended the working group's meetings, developed the final report's concepts

in collaboration with the working group and PCAST staff, drafted language and graphics, created shadowbox vignettes, assembled references, and provided formatting and editing assistance. The final PCAST report, *Biomanufacturing to Advance the Bioeconomy*, was published in December 2022.

Blockchain Technology in Economic and Energy Transitions

STPI was asked by OSTP to analyze the contributions and drawbacks of blockchain technology in the energy sector. One of the primary uses of blockchain technology has been as the basis for cryptocurrencies—some of which consume substantial amounts of electricity for their operations—which generate large amounts of greenhouse gases and other pollutants. Blockchains could be used to track and trade greenhouse gas emissions, although it was noted that these trading systems have been beset by a large degree of fraud. Blockchains also could be used to track the provenance of critical minerals (including those needed for the clean energy transition) and to manage distributed energy resources. STPI’s findings were presented to OSTP in a series of briefings and a written report, which were used by the interagency working group addressing this issue.

Design Choices for Central Bank Digital Currency

The Executive Order on *Ensuring Responsible Development of Digital Assets* requires the Director of OSTP and the Chief Technology Officer of the United States to conduct a technical evaluation of one particular form of digital asset, a Central Bank Digital Currency (CBDC). A CBDC design is composed of a collection of technical elements and choices—e.g., methods for user access, mechanisms for authenticating transactions, and decisions on the means of distribution. STPI worked with OSTP to develop a list of technical elements to be analyzed, define the design choices for each, and evaluate the pros and cons of each choice. STPI provided a background report to OSTP entitled *Analysis of Central Bank Digital Currency Technical Design Choices*, which helped inform OSTP’s response to the President, *Technical Evaluation for a U.S. Central Bank Digital Currency System*.

The Energy Use and Climate Impact of Digital Assets

To better understand the protocols, hardware, resources, economics, and other factors that shape the energy use and climate impacts of all types of digital assets, OSTP issued an RFI on the *Energy and Climate Implications of Digital Assets*. It sought comment on attempts to mitigate climate harms and reduce energy use associated with digital assets, potential energy or climate benefits from digital assets and opportunities for natural asset or emissions accounting, likely future developments or industry trajectories related to digital assets, and implications of digital assets for U.S. policy (including electricity grid reliability and greenhouse gas emissions). OSTP asked STPI to prepare a report summarizing and synthesizing the RFI submissions and identify recommendations for government action suggested by respondents. STPI found that public sentiment ranged from substantial enthusiasm for the future of cryptocurrency to grave concern about the environmental and climatic impacts of crypto mining data centers.

Lab-to-Market Technology Transfer

The NSTC's Subcommittee on Lab-to-Market Commercialization of Federally Funded R&D (L2M) aims to coordinate interagency efforts to transfer federally funded technology into the commercial marketplace. In FY2022, it oversaw the activities of five strategy teams focused on: (1) Regulatory and Administrative Improvements, (2) Innovation Ecosystem Engagement, (3) Strategic Communications, (4) Tools and Services, and (5) the Research, Development, Demonstration, and Deployment Continuum. At the request of OSTP and NIST, STPI supported the activities of the strategy teams by analyzing submissions to an RFI to *Make Access to the Innovation Ecosystem More Inclusive and Equitable*, facilitating ideation sessions to set strategic goals, providing summaries of published literature, implementing and managing surveys of Federal agencies, and compiling agency social media accounts to post and disseminate information on technology transfer. STPI will continue to help the L2M Subcommittee and the strategy teams develop resources for prospective innovators; ethics guidelines for Federal agencies to avoid conflicts of interest when transferring technology to the commercial marketplace; metrics to evaluate DEI in innovation ecosystems; and prepare a strategic communications guide for Federal agencies to reach the broader public.

Artificial Intelligence and Nanotechnology from Lab-to-Market

NIST has set a goal of improving technology transfer and commercialization of the Nation's \$150 billion annual investment in R&D. As part of this initiative, NIST asked STPI to provide research as well as technical and analytical support to assess—quantitatively and qualitatively—the role and impacts of Federal R&D and technology transfer investments in the development of AI and nanotechnology. To achieve these goals, STPI gathered data and metrics on Federal R&D investments, R&D activities, and technology transfer activities—including publications, patents, licenses, collaborative agreements, workshops, and conferences—focusing on historical and downstream outcomes of R&D investments in AI and nanotechnology. STPI collected information and data using a historical approach in which AI and nanotechnologies already on the market were analyzed to identify those that have had significant impacts in science and industry and to understand the Federal role in their development.

AGENCY PROGRAM AND PORTFOLIO EVALUATIONS



National Cancer Institute

The Center for Research Strategy (CRS) within the Office of the Director of the NCI is charged with analysis, assessment, and reporting on the results of NCI research programs as well as the use of analyses to guide future research efforts and inform research policies. NCI requires that all new program proposals include performance or evaluation measures, and all program renewal requests include information on program evaluation results. The center asked STPI to carry out technical analyses and evaluation studies for planning, developing, coordinating, presenting, and managing cancer research programs.

During winter 2021–2022, STPI staff assisted CRS in conducting a needs assessment regarding future activities. Participants in NCI focus groups were asked about their current understanding of evaluation, previous training, what tools they used for such evaluations, what barriers existed to current evaluation efforts, and suggestions on how to improve current evaluation infrastructure. A final memorandum summarized the discussions of the focus groups around the current landscape, barriers, and suggestions regarding future NCI activities to promote and enhance evaluation activities. As a result of that effort, in 2022 STPI staff assisted CRS in developing two sets of training materials and leading four interactive webinars for program staff. The purpose of these efforts was to provide information regarding how program evaluations can be designed and conducted.

National Science Foundation Engineering Research Experience and Mentoring Program

NSF's Emerging Frontiers in Research and Innovation (EFRI) program and Engineering Research Center (ERC) program are funded by the NSF Directorate for Engineering to support multi- or interdisciplinary collaborations focused on transformational engineering research and technological innovations. Teams with active EFRI or ERC awards are eligible to apply for Research Experience and Mentoring (REM) supplements, which provide summer research opportunities and mentorship for high school and undergraduate students as well as high school teachers. NSF asked STPI to evaluate impacts of the REM supplement program on research participants, mentors, and research projects conducted by EFRI and ERC awardees. In 2022, STPI analyzed data from a survey fielded in FY2021. The survey involved students who had participated in REM from 2017 to 2021 to learn how the program had been received and the impact of the program on participants' careers. STPI found that survey respondents reported the program to have a positive impact on their persistence in STEM and their careers. STPI developed a framework to understand the types of partnerships REM supplements built with local community colleges and secondary institutions. STPI also delivered the final report to the sponsor.

National Science Foundation Science and Technology Centers

Science and Technology Centers (STC) are one of NSF's flagship initiatives to support innovative, complex, and potentially transformative research and education projects that require large-scale, long-term awards. NSF asked STPI to help design and facilitate a series of virtual workshops to help each of the newest STCs (Class of 2021) develop their strategic plans, which will determine the basis for their evaluation and funding renewal after 5 years. STPI first engaged with the NSF technical coordinators responsible for overseeing each STC to ensure the planning process met the expectations for each center. After working closely with each STC to tailor STPI's support for the development of their strategic plans, STPI prepared a report documenting lessons learned from working with each center and prepared a guide to help NSF and STCs develop strategic plans in the future.

Department of Homeland Security Research and Development

The Department of Homeland Security (DHS) asked STPI to prepare a review addressing three questions: (1) Is DHS's R&D organizational structure optimal? (2) Are DHS Components harnessing other R&D efforts across DHS, in Federal agencies, and with industry? (3) Are DHS's R&D resources optimal? The first phase of this project focused on technology scouting at the DHS Science and Technology Directorate and the agency's other components as well as the characterization of DHS R&D processes and personnel. The second phase analyzed the DHS R&D portfolio and DHS-wide prioritization, acquisition, and research gap identification processes. The final phase analyzed non-DHS homeland security-relevant R&D and synthesized information collected throughout the project to develop recommendations. Results and recommendations were briefed to the Secretary of Homeland Security.

USAID Energy Division Evidence and Learning Framework

STPI was asked by U.S. Agency for International Development (USAID) to support its Energy Division in developing and implementing an Evidence and Learning Framework for understanding what makes energy sector programming effective and transformational. The framework will reflect a flexible approach that can lend itself to iterative refinement as programmatic priorities are adjusted and new evidence (such as evaluations and targeted studies) is gathered. To develop the framework, STPI conducted targeted evaluations and studies intended to provide key insights into energy programming, while also providing the opportunity to reflect on the framework and identify opportunities for additional impactful research and evaluation efforts. The Evidence and Learning Framework will provide a structure for organizing relevant information produced throughout program implementation and using it to support learning. To this end, STPI is supporting USAID in setting up systems and processes around collecting routine program data and management information and developing methods for extracting and organizing insights. The written guidance that is being prepared by STPI will help USAID's Energy Division determine the means by which energy tasks can be effectively monitored and identify the most effective activities.

Department of Energy Strategic Policy

DOE's Office of Technology Transitions (OTT) provides coordination, oversight, and organizational structure to support the development and implementation of policies and procedures related to the commercialization and deployment of technology and capabilities funded by DOE. DOE asked STPI to help analyze current DOE and other U.S. Government policies governing commercialization and technology transfer, examine relevant governmental contracting procedures and commercialization practices and processes, support OTT strategic planning and implementation efforts, and provide input and make recommendations on legislation, regulations, and Federal agency policies and practices to facilitate technology commercialization and enhance DOE partnering mechanisms. In FY2022, STPI provided support to OTT's Innovative Funding Mechanisms Working Group, including preparing reports and providing recommendations to teams looking into the potential for DOE to use Other Transaction Authorities and Partnership Intermediary Agreements. In addition, STPI provided support for OTT in their congressionally mandated effort to establish a nonprofit foundation to support energy security and innovation. Based on a series of interviews with relevant organizations, literature reviews, and analysis of relevant legislation, STPI provided a document and multiple briefings on things to consider and best practices when standing up an agency-related nonprofit foundation. STPI also prepared a memorandum on appropriations and funding mechanisms used to support foundations at other Federal agencies.





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