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Science and Technology Issues in the 113th Congress

(name redacted), Coordinator
Specialist in Science and Technology Policy

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Summary

Science and technology (S&T) have a pervasive influence over a wide range of issues confronting the nation. Public and private research and development spurs scientific and technological advancement. Such advances can drive economic growth, help address national priorities, and improve health and quality of life. The constantly changing nature and ubiquity of science and technology frequently create public policy issues of congressional interest.

The federal government supports scientific and technological advancement by directly funding research and development and indirectly by creating and maintaining policies that encourage private sector efforts. Additionally, the federal government establishes and enforces regulatory frameworks governing many aspects of S&T activities.

This report briefly outlines an array of science and technology policy issues that may come before the 113th Congress. Given the ubiquity of science and technology and its constantly evolving nature, some science and technology related-issues not discussed in this report may come before the 113th Congress. The selected issues are grouped into 11 categories:

- Overarching S&T issues,
- Workforce and Education,
- Agriculture,
- Biomedical Research and Development,
- Physical Science and Material Sciences
- Defense,
- Space,
- Environment,
- Energy,
- Homeland Security, and
- Information Technology.

Each of these categories includes concise analysis of multiple policy issues. The information and analysis presented in this report should be viewed as introductory rather than comprehensive. Each section identifies available CRS reports and the appropriate CRS experts for further information and analysis.

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Contacts

Introduction

Science and technology (S&T) play an increasingly important role in our society. Advances in science and technology can help drive economic growth, improve human health, increase agricultural productivity, and help meet national priorities.

Federal policies affect scientific and technological advancement on several levels. The federal government directly funds research and development activities to achieve national goals or support national priorities such as funding basic life science research through the National Institutes of Health (NIH) or new weapons of mass destruction detectors through the Department of Homeland Security (DHS). The federal government establishes and maintains the legal and regulatory framework that affects science and technology activities in the private sector. Federal tax, intellectual property, and education policies can have large effects on private sector S&T activity performance. The federal government also directly regulates certain aspects of science and technology such as limiting who is allowed to perform research with certain dangerous biological pathogens through the select agent program or who is allowed to use portions of the radio frequency spectrum for commercial purposes.

Many science and technology policy issues may come before the 113th Congress. This report is designed to serve as a brief introduction to many of these issues. Each issue section provides some background information and outlines the policy issues that may be considered. Each issue includes a heading entitled "For Further Information" that provides the author's contact information and the titles of relevant CRS reports to pursue more detailed policy analysis and information.

Overarching S&T Policy Issues

Several issues of potential congressional interest apply to federal science and technology policy in general. This section begins with a brief introduction to the roles each branch of the federal government plays in S&T policymaking, then discusses overall federal funding of research and development and its effect on innovation. Additional sections address issues in intellectual property, tax policy, and public access to federally supported research results.

The Federal Science and Technology Policymaking Enterprise

The federal science and technology (S&T) policymaking enterprise is composed of an extensive and diverse array of stakeholders in the executive, legislative, and judicial branches. The enterprise fosters, among other things: the advancement of scientific and technical knowledge; science, technology, engineering, and mathematics (STEM) education; the application of S&T to achieve economic, national security, and other societal benefits; and the use of S&T to improve federal decision making.

Federal responsibilities for S&T policymaking are highly decentralized. Congress enacts laws to establish, refine, and eliminate S&T-related programs and policies, as well as regulations, regulatory agencies, and regulatory processes that rely on S&T data and analysis. Congress' authorities related to S&T policymaking are diffuse. While the primary congressional committees for S&T policy are the House Committee on Science, Space, and Technology and the Senate

Committee on Commerce, Science, and Transportation, other House and Senate committees also have jurisdiction over important elements of S&T policy. In addition, there are dozens of informal congressional caucuses in areas of S&T policy such as research and development, specific S&T disciplines, and STEM education.

The President formulates annual budgets, policies, and programs for consideration by Congress; issues executive orders and directives; and directs the executive branch departments and agencies responsible for implementing S&T policies and programs. The Office of Science and Technology Policy, in the Executive Office of the President, advises the President and other Administration officials on S&T issues.

Executive agency responsibilities for S&T policymaking are also diffuse. Some agencies have broad S&T responsibilities (e.g., the National Science Foundation). Others use S&T to meet a specific federal mission (e.g., defense, energy, health, space). Regulatory agencies have S&T responsibilities in areas such as nuclear energy, food and drug safety, and environmental protection.

Federal court decisions often affect U.S. science and technology policy. Decisions can have an impact on the development of science and technology (e.g., decisions regarding the U.S. patent system); S&T-intensive industries (e.g., the break-up of AT&T in the 1980s); and the admissibility of S&T-related evidence (e.g., DNA evidence).

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report RL34736, *The President's Office of Science and Technology Policy (OSTP): Issues for Congress*, by (name redacted) and (name redacted)

Federal Funding for Research and Development

The federal government has long supported the advancement of scientific knowledge and technological development through investments in research and development (R&D). Federal R&D funding seeks to address a broad range of national interests, including national defense, health, safety, the environment, and energy security; advancing knowledge generally; developing the scientific and engineering workforce; and strengthening U.S. innovation and competitiveness. The federal government has played an important role in supporting R&D efforts that have led to scientific breakthroughs and new technologies, from jet aircraft and the Internet to communications satellites and defenses against disease.

Between FY2009 and FY2012, federal R&D funding fell from $147.3 billion to $140.9 billion, a decline of 4.3% in current dollars (8.7% in constant dollars). This decline is a reversal of sustained growth in federal R&D funding for more than half a century, and has stirred debate about the potential long-term effects on U.S. technological leadership, innovation, competitiveness, economic growth, and job creation. Concerns about reductions in federal R&D funding have been exacerbated by increases in the R&D investments of other nations (China, in particular); globalization of R&D and manufacturing activities; and trade deficits in advanced technology products, an area in which the United States previously ran trade surpluses. At the same time, some Members of Congress have expressed concerns about the level of federal funding in light of the current federal fiscal condition, deficit, and debt. In addition, R&D funding

decisions may be affected by differing perspectives on the appropriate role of the federal government in advancing science and technology.

As Congress undertakes the FY2015 appropriations process it faces two overarching issues: the direction in which the federal R&D investment will move in the context of increased pressure on discretionary spending and how available funding will be prioritized and allocated. Low or negative growth in the overall R&D investment may require movement of resources across disciplines, programs, or agencies to address priorities. Congress will play a central role in defining the nation's R&D priorities as it makes decisions with respect to the size and distribution of aggregate, agency, and programmatic R&D funding.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R43086, *Federal Research and Development Funding: FY2014*, coordinated by (name redacted)

CRS Report R43080, *Commerce, Justice, Science, and Related Agencies: FY2014 Appropriations*, coordinated by (name redacted), (name redacted), and (name redacted)

CRS Report R41951, *An Analysis of Efforts to Double Federal Funding for Physical Sciences and Engineering Research*, by (name redacted)

America COMPETES Act

P.L. 110-69, the America "Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science" (COMPETES) Act, was first enacted in 2007. The act, a response to concerns about U.S. competitiveness, authorized certain federal research, education, and related activities. In 2010 Congress passed the America COMPETES Reauthorization Act of 2010 (P.L. 111-358), extending and modifying provisions of the 2007 law. Certain appropriations authorizations in the 2010 act expired in FY2013. In the fall of 2013, House and Senate committees with jurisdiction over the COMPETES acts held hearings designed to help develop one or more bills to reauthorize, amend, establish, or repeal the acts' provisions and closely related policies.

Many economists assert that economic, defense, and social benefits accrue preferentially to nations that lead in scientific and technological (S&T) advancement and commercialization. However, some analysts suggest that historical U.S. leadership in these areas may be slipping. They note that other countries are increasingly able to attract S&T jobs and industry while traditional U.S. strengths appear to be weakening. In particular, some stakeholders have questioned the adequacy of federal funding for physical sciences and engineering research and the domestic production of scientists and engineers.

The COMPETES acts were designed to respond to these challenges by increasing funding authorizations for targeted federal physical science and engineering research activities—i.e., the so-called "doubling path" accounts at the National Science Foundation, Department of Energy's Office of Science, and National Institute of Standards and Technology's laboratories and construction accounts—and by authorizing certain federal science, technology, engineering, and mathematics (STEM) education activities. The acts also authorize the Advanced Research

Projects Agency-Energy (ARPA-E) and prize competitions at federal agencies, among other provisions. Implementation of COMPETES acts' provisions has varied and congressional appropriations have generally been below authorized levels.

Those who express opposition to the COMPETES Acts do so from several perspectives. Some critics question the existence of a STEM labor shortage. Other critics agree with the assertion of a shortage, but question whether the federal government should address it. Some critics of the COMPETES Act prefer alternative approaches to improving U.S. competitiveness such as research tax credits or reducing regulatory costs. Also, some oppose increasing funding for research and development and STEM education given the federal budget deficit, national debt, and U.S. fiscal situation. Yet others express concerns about the use of competitiveness as a rationale for economic and education policy.

For Further Information

(name redacted), Specialist in Science a nd Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42779, *America COMPETES Acts: FY2008-FY2013 Funding Tables*, by (name redac ted)

CRS Report R42642, *Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer*, by (name redacted) and (name redacted)

CRS Report R41951, *An Analysis of Efforts to Double Federal Funding for Physical Sciences and Engineering Research*, by (name redacted)

CRS Report R43061, *The U.S. Science and Engineering Workforce: Recent, Current, and Projected Employment, Wages, and Unemployment*, by (name redacted)

Technological Innovation and the Economy: Impact of Federal R&D Funding

Experts widely accept that technological progress is responsible for up to one-half the growth of the U.S. economy and is one principal driving force for increases in our standard of living. Technology contributes to the creation of new goods and services, new industries, new jobs, and new capital. The application of technologies also can contribute to the resolution of those national problems that are amenable to technological solutions.

Technological progress is achieved through innovation, the process by which industry provides new and improved products, manufacturing processes, and services. Research and development (R&D) contribute to economic growth by their impact on productivity. Some analysts maintain that innovations arising from R&D are the most important ones.

Traditionally, the government funds R&D to meet the mission requirements of the federal departments and agencies. The government also supports work in areas where there is an identified need for research, primarily basic research, not being performed in the private sector. While basic research can be the foundation for important new innovations, the results generally

are long term, may prove to be unmarketable, and the benefits may not accrue solely to the organization funding the work.

Federal funding reflects a consensus that while basic research is important for innovation, the rate of return to society as a whole generated by investments in this activity is significantly larger than the benefits that can be captured by any one firm performing it. It is estimated that the social rate of return on R&D spending is over twice that of the rate of return to the inventor. Because the knowledge associated with an innovation can be dispersed and adapted to other products and processes, experts argue there tends to be private sector underinvestment in research, thus necessitating federal funding.

Economic analysis has shown the importance of federally funded R&D to advancements in innovation. Studies demonstrate that collaboration with publicly funded research organizations increases private sector productivity in many industries, findings that parallel additional work showing the importance of public science to innovation and technological advancement across industrial sectors. Federal R&D can stimulate the additional and often substantial private investment necessary to bring new and improved technologies to the marketplace.

While the development of new products, processes, and services for the marketplace is primarily a private sector activity, government plays a role in structuring the environment in which business decisions are made and thereby influences private sector behavior. Choices made by the 113th Congress related to financing the research endeavor may have immediate impacts on current federal programs as well as long term effects on the nation's technological progress.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report RL33528, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, by (name redacted)

CRS Report RL32324, *Federal R&D, Drug Discovery, and Pricing: Insights from the NIH-University-Industry Relationship*, by (name redacted)

CRS Report RL32076, *The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology*, by (name redacted)

CRS Report 96-402, *Small Business Innovation Research (SBIR) Program*, by (name redacted)

Intellectual Property and Competitiveness Issues

Most experts agree that patent ownership is an incentive to innovation. The award of a patent is intended to stimulate the often substantial investment necessary to develop an idea and bring it to the marketplace embodied in a product or process. Patent title provides the recipient with a limited-time monopoly over the use of his discovery in exchange for the public dissemination of information contained in the patent application.

Congressional interest in patent reform was evidenced by sustained legislative activity that led to enactment of P.L. 112-29, the Leahy-Smith America Invents Act, or AIA. This legislation arguably made the most significant changes to the patent statute since the 19th century. Among

other provisions, the statute introduced into U.S. law a first-inventor-to-file priority rule, an infringement defense based upon prior commercial use, and assignee filing. The legislation prevented patents from claiming or encompassing human organisms, limited the availability of patents claiming tax strategies, and restricted the best mode requirement. The AIA also made notable reforms to administrative patent challenge proceedings at the U.S. Patent and Trademark Office (USPTO) and to the law of patent marking.

While the AIA was the product of years of discussion and debate, some observers believe that the legislation did not reflect all the issues that were the subject of congressional discussion including the assessment of damages during infringement litigation, the publication of all pending patent applications prior to grant, and "fee diversion" during the appropriations process. While the reforms introduced by the legislation, intended to improve, update, and adopt global best practices, will bring immediate changes to patent practice by the USPTO, the private bar, and innovative firms, experience will show whether the legislation meets its intended goals of increasing patent quality, making patent dispute resolution more fair and efficient, improving the environment for innovation, and enhancing the economic growth of the United States.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42014, *The Leahy-Smith America Invents Act: Innovation Issues*, by (name red acted) and (name redacted)

CRS Report RS20906, *U.S. Patent and Trademark Office Appropriations Process: A Brief Explanation*, by (name redacted)

CRS Report R42668, *An Overview of the "Patent Trolls" Debate*, by (name redacted)

CRS Report RL33367, *Patent Reform: Issues in the Biomedical and Software Industries*, by (name redacted)

R&D Partnerships and Intellectual Property

Congressional interest in the value of intellectual property has grown as technology becomes increasingly important to the United States. Similarly, the role of patents has changed as the use of cooperative research and development (R&D) expands to facilitate technological advancement and generate new products, processes, and services for the marketplace. Various laws, including the Stevenson-Wydler National Technology Innovation Act (P.L. 96-418) and the "Bayh-Dole" Act (P.L. 96-517), as amended, have included patent-related incentives to create an environment conducive to joint ventures between government and industry, or between industry and universities, as well as among companies.

Patents are widely believed to encourage innovation by simultaneously protecting the inventor and fostering competition. Patents provide the inventor with a right to exclude others, temporarily, from use of the invention without compensation. They give the owner an exclusive right for 20 years (from date of filing) to further develop the idea, commercialize a product or process, and potentially realize a return on the initial investment. In an academic setting, the possession of title to inventions is expected to provide motivation for the university to license the technology to companies for commercialization in expectation of royalty payments. Concurrently,

the process of obtaining a patent places the concept in the public arena. As a disclosure system, the patent can, and often does, stimulate other firms or individuals to invent "around" existing patents to provide for parallel technical developments or meet similar market needs.

As such cooperative efforts become more widespread, additional issues have emerged. Concerns have been expressed regarding the cost of drugs developed in part with federal funding or in conjunction with federal agencies. Conflicts have surfaced over federal laboratories patenting inventions that collaborating parties believe to be their own. In some agencies, delays continue in negotiating cooperative research and development agreements (CRADAs) because of disagreements over the dispensation of intellectual property. Policymakers have raised questions regarding the effects of patenting early stage discoveries (e.g., research tools) on additional innovation. The National Institutes of Health has encountered difficulties obtaining for government-sponsored research new experimental compounds developed and patented by drug companies because of concerns over diminished effectiveness of the intellectual property if additional applications are discovered. Given these issues, the 113th Congress may make additional decisions regarding the way to maintain a balance between bringing new products and processes to the marketplace and protecting the public investment in R&D.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report RL33526, *Cooperative R&D: Federal Efforts to Promote Industrial Competitiveness*, by (name redacted)

CRS Report RL33527, *Technology Transfer: Use of Federally Funded Research and Development*, by (name redacted)

CRS Report RL32076, *The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology*, by (name redacted)

CRS Report RL32324, *Federal R&D, Drug Discovery, and Pricing: Insights from the NIH-University-Industry Relationship*, by (name redacted)

Tax Incentives for Technological Innovation

The 113th Congress is considering ways to improve the domestic climate for technological innovation. Among the concerns fueling this interest is the sluggish growth in domestic high-paying jobs in a range of industries in recent decades. Two pathways to accelerating growth in these jobs are faster rates of entrepreneurial business formation and increased business investment in domestic research and development (R&D) and domestic production of products and services derived from that research.

One way Congress can influence those sources of high-wage job creation is tax incentives. Under current federal tax law, three provisions directly affect new business formation and business investment in R&D. They are: (1) an expensing allowance for qualified research expenditures under Section 174 of the tax code, (2) a non-refundable tax credit for increases in qualified research expenditures above a base amount under Section 41, and (3) a partial exclusion for capital gains from the sale or exchange of qualified small business stock held for five or more years under Section 1202.

The credit and expensing allowance encourage companies to invest more in qualified research than they otherwise would by lowering their after-tax cost. R&D serves as the lifeblood of innovation. Some argue that the current credit's incentive effect is weaker than it should be, mainly because of several problems with the credit's design, including a lack of permanence and refundability. The credit expired at the end of 2013, while the expensing allowance is a permanent tax provision.

The Section 1202 gains exclusion is 100% for eligible stock acquired in 2013 and 50% for stock acquired in 2014 and thereafter. It is intended to boost equity investment in qualified small startup firms by reducing the tax burden on the returns to that investment.

Recent research indicates that young startup firms account for most net U.S. job growth over time but that access to capital remains a significant barrier to the formation of small startup companies. Congress may wish to examine the need for new tax incentives intended to increase the rate of growth in domestic high-paying jobs.

For Further Information

(name redacted), Analyst in Public Finance ([redacted]@crs.loc.gov, 7-....)

CRS Report RL31181, *Research Tax Credit: Current Law and Policy Issues for the 113th Congress*, by (name redacted)

Public Access to Federal Research Results

"Open access" or "public access" publishing generally refers to when the entity that holds the copyright to an article grants all users unlimited, free access to the article. In traditional scientific publishing, authors and readers pay fees to fund the costs of journal publication and distribution. This contrasts with open access publishers, which typically charge only authors fees to fund the costs of journal publication and distribution and give readers free online access to the full text of articles. Some traditional publishers have implemented a hybrid model where authors may choose to provide their articles free to readers in exchange for increased author fees.

Since 2008, Congress has authorized the National Institutes of Health (NIH) to require recipients of NIH grants to submit an electronic version of their final, peer-reviewed articles to NIH. The NIH places these articles in a public repository no later than 12 months after publication. This congressionally authorized policy has raised issues regarding protection of intellectual property and government competition with the private sector.

Supporters of federal open-access publishing policies have a variety of motivations, including avoiding rising traditional journal subscription fees; beliefs regarding improved scientific collaboration and utilization from free information access; and wishes for the public to access the results of research and development funded by their taxes. These supporters urge increased federal support for open access publishing.

In contrast, traditional publishers and some scholarly associations object to federal open access policies because they believe it may weaken the publishing industry, erode profits, and consequently restrict the activities of associations whose main source of income is publishing. Opponents of federal open-access publishing policies cite issues such as long-term maintenance of electronic archives, increased publication costs for researchers, and the perceptions of the

academic community and the academic reward system which appear to give more status to articles published in traditional journals.

The America Competes Reauthorization Act of 2010 (P.L. 111-358) required the OSTP Director to establish a working group to coordinate agency policies on public access to the results of federally funded R&D. The OSTP Director convened such a group and solicited public comment on the issue. Respondents generally stated support for increasing public access to such research results.

In February 2013, the OSTP Director directed federal agencies annually funding over $100 million of research and development to develop plans to make the published results of federally funded research freely available to the public within one year of publication. The OSTP has identified 20 agencies from which it expects draft public access plans and OSTP and Office of Management and Budget review of submitted plans is ongoing.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

Workforce and Education

Maintaining a rapid pace of scientific and technological advancement requires a sufficient workforce of scientists and engineers. This section discusses some workforce-related issues that may come before the 113th Congress, including the adequacy of the current workforce and efforts to develop the future workforce.

Adequacy of the U.S. Science and Engineering Workforce

The adequacy of the U.S. science and engineering (S&E) workforce has been an ongoing concern of Congress for more than 60 years. Scientists and engineers are widely believed to be essential to U.S. technological leadership, innovation, manufacturing, and services, and thus vital to U.S. economic strength, national defense, and other societal needs. Congress has enacted many programs to support the education and development of scientists and engineers. Congress has also undertaken broad efforts to improve science, technology, engineering, and math (STEM) skills to prepare a greater number of students to pursue S&E degrees. In addition, some policymakers have sought to increase the number of foreign scientists and engineers working in the United States through changes in visa and immigration policies.

Most experts agree that there is no authoritative definition of which occupations comprise the S&E workforce. Rather, the selection of occupations included in any particular analysis of the S&E workforce may vary. The policy debate about the adequacy of the U.S. S&E workforce has focused largely on professional-level computer occupations, mathematical occupations, engineers, and physical scientists. Accordingly, much of the analytical focus has been on these occupations. However, some analyses may use a definition that includes some or all of these occupations, as well as life scientists, S&E managers, S&E technicians, social scientists, and related occupations.

Many policymakers, business leaders, academicians, S&E professional society analysts, economists, and others hold diverse views with respect to the adequacy of the S&E workforce and related policy issues. These issues include the question of the existence of a shortage of scientists and engineers in the United States, what the nature of any such shortage might be (e.g., too few people with S&E degrees, mismatches between skills and needs), and whether the federal government should undertake policy interventions to address such a putative shortage or to allow market forces to work in this labor market. Among the key indicators used by labor economists to assess occupational labor shortages are employment growth, wage growth, and unemployment rates.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

Science, Technology, Engineering, and Mathematics (STEM) Education

The term "STEM education" refers to teaching and learning in the fields of science, technology, engineering, and mathematics. Policymakers have an enduring interest in STEM education and raise the topic in a variety of national policy debates. Popular opinion generally holds that U.S. students perform poorly in STEM education—especially when compared to students in certain foreign education systems—however the data paint a complicated picture. Over time U.S. students appear to have made gains in some areas but may be perceived as falling behind in others. Estimates of the federal STEM education effort vary. Various analyses have identified between 105 and 252 STEM education activities at 13 to 15 federal agencies, with annual federal appropriations totaling around $3.0 billion.

The national conversation about STEM education frequently develops from concerns about the U.S. science and engineering workforce. Some advocates assert that the United States faces a shortage of STEM workers; others dispute this claim. Although opinions about whether such shortages exist vary, most observers agree that a *general* increase in STEM abilities among the U.S. workforce would benefit the nation's economy, defense, and health and welfare.

Analysts differ, however, in their conclusions about the scope, scale, and emphasis of federal STEM education policy. Many analysts prefer comprehensive policies aimed at lifting the STEM achievement of all students—such as STEM content education for K-12 teachers or changes in the teaching of STEM subjects across all grade levels (e.g., more hands-on learning). Other advocates emphasize targeted policies designed to meet specific needs—such as scholarships for the "best and brightest," training for the federal workforce, or programs for underrepresented groups. However, some scholars oppose using education policy to increase the supply of STEM workers, either because they perceive such policies as corporatizing education at the expense of other values (e.g., personal development) or because they perceive the market as the more efficient lever in signaling demand for STEM skills.

Federal STEM education activities are closely watched—due in part to perceived duplication and incoherence in the portfolio. Concerns about the dissemination of STEM education research and best practices also recur periodically. The Obama Administration proposed a reorganization of the federal STEM education effort as part of the FY2014 budget request. The stated goal of the reorganization was to target federal resources towards certain STEM education priorities while

reducing perceived fragmentation in the federal STEM education effort. The Administration's proposal received a mixed response in Congress. Many legislators expressed general support for reorganization as a means to reduce perceived duplication. However, some critics expressed concern about the perceived dearth of stakeholder input in the development of the proposal. Others questioned the degree to which the reorganization aligned with a congressionally mandated federal STEM education strategy. (That strategy was not yet published when the FY2014 budget request was released.) Some congressional appropriations and authorizations committees have moved to prohibit implementation of the Administration's FY2014 STEM education reorganization plan in whole or part. Other committees appear to have endorsed changes or remained silent.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42642, *Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer*, by (name redacted) and (name redacted)

CRS Report R42470, *An Analysis of STEM Education Funding at the NSF: Trends and Policy Discussion*, by (name redacted)

CRS Report R43061, *The U.S. Science and Engineering Workforce: Recent, Current, and Projected Employment, Wages, and Unemployment*, by (name redacted)

CRS Report R42530, *Immigration of Foreign Nationals with Science, Technology, Engineering, and Mathematics (STEM) Degrees*, by (name redacted)

Agriculture

The federal government supports billions of dollars of agricultural research annually. The 113th Congress is likely to face issues related to the budget for this research and specific issues arising from advances in agricultural biotechnology.

Agricultural Research

Public investment in agricultural research has been linked to productivity gains, and subsequently to increased agricultural and economic growth. The U.S. Department of Agriculture (USDA) is authorized under various laws to conduct agricultural research at the federal level, and provides support for cooperative research, extension, and post-secondary agricultural education programs in the states. USDA's research program is funded with about $2.5 billion per year of discretionary funding. Congress traditionally considers reauthorization of agricultural research in periodic omnibus farm bills that cover virtually all USDA programs and policies. The 2008 farm bill (P.L. 110-246) authorized agricultural research (and many other provisions) through September 30, 2012, and the American Taxpayer Relief Act of 2012 (P.L. 112-240) extended the 2008 farm bill for one additional year, through September 30, 2013. While discretionary research funding continues under the FY2014 continuing resolution, ATRA did not provide funding for mandatory programs that were authorized in the 2008 farm bill but did not have a budget baseline beyond the

original end of the 2008 farm bill. For agricultural research, these include initiatives for specialty crops and organic agriculture that provided about $70 million per year.

The 113th Congress has been working on a 2013 farm bill to reauthorize agricultural research and many other farm bill provisions. The Senate approved its version of an omnibus 2013 farm bill (S. 954) on June 10, 2013. The House approved its version of the farm bill (H.R. 2642) on July 11, 2013, and a nutrition title for the farm bill (H.R. 3102) on September 19, 2013. Conference committee proceedings on the farm bill began in October 2013. Both bills would reauthorize funding for agricultural research and related activities through FY2018, subject to annual appropriations, and amended authority so that only competitive grants can be awarded under certain programs. Also in both bills, mandatory funding would increase for the Specialty Crop Research Initiative and the Organic Agricultural Research and Extension Initiative. To supplement USDA's basic and applied research activities, S. 954 would provide mandatory funding of $200 million to establish the Foundation for Food and Agriculture Research, a nonprofit corporation. The entity would solicit and accept private donations (matching federal funds) to award grants for collaborative public/private partnerships with scientists at USDA and in academia, nonprofits, and the private sector.

For Further Information

(name redacted), Specialist in Agricultural Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R40819, *USDA's Research, Education, and Economics (REE) Mission Area: Issues and Background*, by (name redacted)

CRS Report R43076, *The 2013 Farm Bill: A Comparison of the Senate-Passed (S. 954) and House-Passed (H.R. 2642, H.R. 3102) Bills with Current Law*, coordinated by (name redacted)

Agricultural Biotechnology

The second session of the 113th Congress may address issues regarding the commercialization of bioengineered animals for human consumption, and the issue of labeling bioengineered foods, or foods containing bioengineered ingredients. The Food and Drug Administration (FDA) is considering approving the first bioengineered animal for human consumption. Two bills addressing bioengineered fish were introduced in the first session of the 113th Congress, and three bills were introduced that would require mandatory labeling of genetically engineered foods.

The FDA's review of an application by a Massachusetts biotechnology firm for approval of a bioengineered salmon is nearing completion. The salmon is engineered to grow to market size in half the time as non-bioengineered salmon. If approved, the salmon would be the first bioengineered animal approved for human consumption. The agency had previously determined that the bioengineered salmon is safe for human consumption, and is nearing completion of its Environmental Assessment (EA) on potential ecological impacts of commercially producing the salmon. The EA was made available to the public in December 2012. The comment period on the EA ended on April 26, 2013. The agency is addressing these comments, and plans to issue a final decision.

Potential approval of the bioengineered salmon has been widely covered in the popular press, and has been strongly opposed by environmental groups and food safety advocates. FDA is considering approval under its New Animal Drug Application (NADA) regulatory process.

Opponents of the bioengineered fish regard the NADA structure as inadequate to support the precedent-setting approval of the first bioengineered animal for human consumption. Senator Begich of Alaska introduced a bill (S. 246) in February 2013 to prevent the escape of bioengineered salmon into the wild. Senator Begich and Representative Young also introduced bills (S. 248 and H.R. 584) that would amend the Food, Drug, and Cosmetic Act to require labeling of bioengineered fish. Representative DeFazio introduced a labeling bill in April 2013 (H.R. 1699) that would require that any bioengineered food or food containing bioengineered ingredients be labeled accordingly. An amendment that would permit states to require labeling of bioengineered foods was introduced in the Senate farm bill (S. 954), but defeated. Consideration of the FDA regulatory process and food labeling for bioengineered animals could also lead to further legislative action in the second session of the 113th Congress.

For Further Information

(name redacted), Analyst in Natural Resources and Rural Development ([redacted]@crs.loc.gov, 7-....)

CRS Report RL32809, *Agricultural Biotechnology: Background, Regulation, and Policy Issues*, by (name redacted)

CRS Report RL33334, *Biotechnology in Animal Agriculture: Status and Current Issues*, by (name redacted)

CRS Report R41395, *Deregulating Genetically Engineered Alfalfa and Sugar Beets: Legal and Administrative Responses*, by (name redacted) and (name redacted) and Sugar Beets: Legal and Administrative Responses, by (name redacted) and (name redacted)

CRS Report R43100, *Unapproved Genetically Modified Wheat Discovered in Oregon: Status and Implications*, by (name redacted)

Biomedical Research and Development

Congress has long supported biomedical research and development. Some of the biomedical research and development issues that the 113th Congress may face include the budget and oversight of the National Institutes of Health and the relationship of federal R&D to the cost and availability of prescription drugs.

National Institutes of Health (NIH): Budget and Oversight Issues

NIH is the lead federal agency conducting and supporting biomedical research. Its FY2013 budget of $29.3 billion funds basic, clinical, and translational research in NIH's laboratories and in universities and research institutions nationwide. The extramural research program (83% of the NIH budget) provides grants, contracts, and training awards to support over 300,000 scientists and research personnel affiliated with 2,500 universities, academic health centers, hospitals, and independent research institutions.

In constant dollars, NIH funding was 22% lower in FY2013 than it was at its peak in FY2003 (not counting FY2009 stimulus funding). The NIH budget doubled over five years (FY1999-

FY2003), but since FY2004, constraints on discretionary spending have decreased budget growth below the rate of inflation. Between FY2010 and FY2013, nominal program levels for NIH have been reduced from $30.9 billion to $29.3 billion. As access to grant funding tightens, NIH is working to improve research training, including assisting young scientists with career paths outside academia. Another goal is greater diversity in the biomedical research workforce and improved career advancement for minorities. Budget constraints have caused reevaluations of programs like the Institutional Development Awards (IDeA), which supports grants at institutions in 23 states with a historically low success rate in competing for NIH grants. NIH contends that funds targeted for IDeA could be better spent on other research needs.

In FY2012, Congress approved an NIH reorganization focused on translational medicine, the science of converting basic research discoveries into clinical applications that benefit patients. The new National Center for Advancing Translational Sciences (NCATS) works on more rapid and reliable ways to test promising therapeutic products and fosters partnerships between researchers, industry, and health care entities to speed commercialization. Some in Congress may have concerns about government overlap with private sector product development activities and whether NIH is expanding its mission beyond basic and applied research into drug development. Additional oversight topics include rules for financial conflict of interest, the Physician Payments Sunshine Act, and human research subject protection.

For Further Information

(name redacted), Specialist in Biomedical Policy ([redacted]@crs.loc.gov , 7-....)

CRS Report R43086, *Federal Research and Development Funding: FY2014*, coordinated by (name redacted)

CRS Report R43304, *Public Health Service Agencies: Overview and Funding*, coordinated by (name redacted) and (name redacted)

Prescription Drugs: Costs, Availability, and Federal R&D

Congress has exhibited a strong and ongoing interest in facilitating the development of new, innovative pharmaceuticals for the marketplace while reducing the cost of drugs to consumers. Policies pertaining to funding for R&D, intellectual property protection, and cooperative ventures have played an important role in the economic success of the pharmaceutical sector. Industry-specific legislation also works to encourage innovation in the pharmaceutical sector while facilitating the entry of lower cost generic competition.

A critical component of many of these federal efforts concerns patents. Patent ownership can provide an economic incentive for companies to take the results of research and make the often substantial investment necessary to bring new goods and services to the marketplace. In the pharmaceutical industry, patents are perceived as particularly important to innovation due, in part, to the ease of duplicating the invention.

Many factors contribute to innovation in the pharmaceutical industry and its ability to bring new and inventive products to the marketplace. However, this sector is facing issues associated with the loss of revenue available for additional R&D due to generic competition and patent expirations. While generic versions of brand pharmaceuticals benefit the public due to their lower

cost, some observers assert that without the research, development, and testing performed by the brand name pharmaceutical companies, generic drugs would not exist.

Recently, patents on a significant number of "blockbuster" drugs have expired. Brand firms often use funds from these sales to invest in additional R&D. The effect of blockbuster patent expirations on pharmaceutical companies can be significant, particularly when there are insufficient products in the development pipeline to replace these drugs. Some experts point to indications that productivity is declining in this sector as revenues available for additional investment appear to be decreasing.

Some Members of Congress have expressed concern over whether the current legislative approach to encouraging innovation, particularly with respect to drug discovery, is appropriate. Other experts argue that the government's financial, scientific, or clinical support of biomedical research entitles the public to commensurate considerations in the prices charged for any resulting drugs. Critics of the current situation maintain that the need for incentives in the pharmaceutical and biotechnology sectors is mitigated by industry access to government-supported work, monopoly power through patent protection, as well as regulatory and tax advantages.

However, other commentators view government intervention in price decisions as contrary to a long-term trend of government promotion of innovation in the private sector. Supporters of existing incentives for technology development argue that they have given rise to robust domestic pharmaceutical and biotechnology industries. At issue is what initiative, if any, can effectively reduce the cost of safe and effective prescription drugs and what may be the long-term impact of these efforts on innovation in the pharmaceutical industry.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42399, *Drug Patent Expirations: Potential Effects on Pharmaceutical Innovation*, by (name redacted)

CRS Report RL33605, *Authorized Generic Pharmaceuticals: Effects on Innovation*, by (name re dacted)

CRS Report RL33717, *Pharmaceutical Patent Litigation Settlements: Implications for Competition and Innovation*, by (name redacted)

CRS Report R41483, *Follow-On Biologics: The Law and Intellectual Property Issues*, by (name redacted) and (name redacted)

CRS Report R42815, *Mayo v. Prometheus: Implications for Patents, Biotechnology, and Personalized Medicine*, by (name redacted)

Physical and Material Sciences

This section focuses on policy issues relating to federal efforts supporting research and development in the physical and material sciences. Some of the policy issues in this area that the 113th Congress may address include funding and oversight of the National Science Foundation

and the multiagency initiative supporting the research and development in the emerging field of nanotechnology. Issues relating to the Department of Energy Office of Science and ARPA-E, both of which support science and technology in physical and material sciences, are discussed in the "Energy" section of this report.

National Science Foundation

The National Science Foundation (NSF) supports basic research and education in the non-medical sciences and engineering. Congress established the foundation as an independent federal agency in 1950 and directed it to "promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." The NSF is a primary source of federal support for U.S. university research, especially in certain fields such as mathematics and computer science. It is also responsible for significant shares of the federal science, technology, engineering, and mathematics (STEM) education program portfolio and federal STEM student aid and support.

Arguably, the foremost NSF policy concern for the 113th Congress centers on the foundation's funding levels and the so-called "doubling path" policy. (This issue is also discussed in the section on the "America COMPETES Act".) The central question for the NSF is whether Congress wishes to continue to pursue a policy of authorizing large increases in the NSF budget over a short period of time (e.g., 100% increase over seven years). Advocates of the doubling path policy assert that steep and fast increases in funding are necessary to ensure U.S. competitiveness; while other analysts argue that steady, reliable funding increases, over longer periods of time, would be less disruptive to the U.S. scientific and technological enterprise and easier to manage. Some observers prefer to direct any increases in federal funding for research to more purpose- or mission-oriented research than that which is typically funded at NSF; while others favor increasing research tax credits for private industry. Some policymakers seek a reduction in NSF funding in light of the federal fiscal condition, deficit, and debt.

Other enduring federal policy issues for the NSF focus on the balance between scientific independence and accountability to taxpayers at the foundation; funding for behavioral and social sciences; the geographic distribution of grants; the selection, funding, and management of instruments, construction projects, and facilities; the foundation's grant-making process; its role in broadening participation in STEM fields; the shape and scope of the foundation's investments in STEM education research and programs, as well as its support for various STEM scholarships and fellowships; and the production of data about the U.S. scientific and technological enterprise.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42470, *An Analysis of STEM Education Funding at the NSF: Trends and Policy Discussion*, by (name redacted)

Nanotechnology and the National Nanotechnology Initiative

Nanoscale science, engineering, and technology—commonly referred to collectively as nanotechnology—is believed by many to offer extraordinary economic and societal benefits.

Nanotechnology R&D is directed toward the understanding and control of matter at dimensions of roughly 1 to 100 nanometers (a nanometer is one-billionth of a meter). At this size, the properties of matter can differ in fundamental and potentially useful ways from the properties of individual atoms and molecules and of bulk matter.

Most current applications of nanotechnology are evolutionary in nature, offering incremental improvements in existing products and generally modest economic and societal benefits. For example, nanotechnology is being used in automobile bumpers, cargo beds, and step-assists to reduce weight, increase resistance to dents and scratches, and eliminate rust; in clothes to increase stain- and wrinkle-resistance; and in sporting goods to improve performance. In the longer term, some believe that nanotechnology may deliver revolutionary advances with profound economic and societal implications, such as detection and treatment of cancer and other diseases; clean, inexpensive, renewable power through energy creation, storage, and transmission technologies; affordable, scalable, and portable water filtration systems; self-healing materials; and high-density memory devices.

The development of this emerging field has been fostered by significant and sustained public investments in nanotechnology R&D. In 2001, President Clinton launched the multi-agency National Nanotechnology Initiative (NNI) to accelerate and focus nanotechnology R&D to achieve scientific breakthroughs and to enable the development of new materials, tools, and products. More than 60 nations subsequently established programs similar to the NNI.

Through FY2012, Congress has appropriated approximately $16.1 billion for nanotechnology R&D; FY2013 funding is estimated to be $1.7 billion. In 2003, Congress enacted the 21st Century Nanotechnology Research and Development Act (P.L. 108-153), providing a legislative foundation for some of the activities of the NNI, establishing programs, assigning agency responsibilities, and setting authorization levels through FY2008. Legislation has been introduced in successive Congresses to amend and reauthorize the act though none has been enacted into law. Congress has directed its attention primarily to three topics that may affect the realization of nanotechnology's hoped-for potential: R&D funding; U.S. competitiveness; and environmental, health, and safety (EHS) concerns.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report RL34511, *Nanotechnology: A Policy Primer*, by (name redacted)

CRS Report RL34401, *The National Nanotechnology Initiative: Overview, Reauthorization, and Appropriations Issues*, by (name redacted)

CRS Report RL34614, *Nanotechnology and Environmental, Health, and Safety: Issues for Consideration*, by (name redacted)

Defense

Science and technology play an important role in national defense. The Department of Defense relies on a robust research and development effort to develop new military systems and improve existing systems. Issues that may come before the 113th Congress regarding the Department of

Defense's science and technology include budgetary concerns and the effectiveness of programs to transition S&T findings into fielded products.

Department of Defense Research, Development, Test, and Evaluation

At roughly $68 billion ($67.520 billion requested for FY2014), the Research, Development, Test, and Evaluation program at the Department of Defense is the single largest research and development program in the federal government. A majority share of the program, in dollar terms (>80%), is devoted to the development of new and the improvement of existing military systems. The remainder, $11 billion to $12 billion per year, goes toward basic research, applied research, and the development of a technology base with potential application to future military systems. This latter investment is referred to as the Department's Science and Technology (S&T) program.

One area of concern for some in the science and technology community is maintaining the S&T portion of the budget as the Department's overall spending is expected to decline. Some experts contend that maintaining a robust S&T program now is necessary to maintain or improve the country's military advantage in the future. However, advances in knowledge and technology supported by the S&T budget may take years to develop. The immediate value may be low and the future value unknown. The FY2014 budget request for S&T was $11.983 billion. This represents a slight increase of $316 million (<3%) above the actual amount available in FY2012. The request is $610 million below what was provided in the FY2013 continuing resolution, before factoring in the sequestration.

While there is concern about the overall S&T budget, there is also concern among some experts regarding the level of funding for the Department's basic research activities. The Department is not the largest federal supporter of basic research ($2.165 billion requested in FY2014). However, it is a major supporter in certain fields (e.g., mathematics, materials). Much of this support goes to universities and supports the development of graduate and undergraduate students.

Another area of concern is the efficient and effective transition of technology from the laboratory to the field. While many new military systems can trace the origins of their fundamental technologies back to earlier S&T programs, the transition is not automatic. In some cases well developed technologies are not utilized. In other cases, systems being developed for acquisition try to incorporate technologies that are not yet fully developed. In the first case, the technologies may reside in small companies not able or willing to manage the complexities of the military acquisition process, or the acquisition community may find the new technologies unfamiliar or that they require changes in operations. In the second case, system developers may be overly optimistic about what can be accomplished in a given amount of time and with a given amount of funds. Congress has established a number of programs over the last few years to address these concerns (e.g., Rapid Reaction Fund, the Rapid Innovation Fund, the Defense Acquisition Challenge). Congress may choose to examine how effectively these programs achieve their objectives.

For Further Information

John Moteff, Specialist in Science and Technology Policy, ([redacted]@crs.loc.gov, 7-....)

Space

Congress has historically had a strong interest in space policy issues. Two space topics that may come before the 113th Congress include the reauthorization of the National Aeronautics and Space Administration (NASA) and issues related to earth observing satellites.

NASA

Spaceflight has been an issue of strong congressional interest since the establishment of NASA in 1958. The 113th Congress is expected to consider legislation to reauthorize NASA. Issues include the direction of NASA's human spaceflight program and the impact of constrained budgets on NASA's other missions, such as unmanned science satellites.

With the last flight of the space shuttle in July 2011, the United States lost the capability to launch astronauts into space and to deliver cargo to the International Space Station (ISS). Since that time, NASA has relied on Russian spacecraft for ISS crew transport. For ISS cargo transport, NASA regained a U.S. capability in October 2012, when a NASA-contracted commercial flight successfully delivered a payload of supplies and equipment.

As directed by the NASA Authorization Act of 2010 (P.L. 111-267), NASA is pursuing a two-track strategy for human spaceflight. First, for transport to low Earth orbit (including the ISS) NASA is supporting commercial development of a crew capability like the commercial cargo capability achieved in 2012. NASA expects commercial crew transportation services to be available by 2017.

Second, for human exploration beyond Earth orbit, NASA is developing a new crew capsule (Orion) and a new heavy-lift rocket to launch it. NASA expects the first crewed test flight of this system in 2021. Under current plans, an asteroid will be Orion's first destination for human exploration, but many details of the first mission remain to be determined.

The 2010 authorization act projected funding increases for NASA that have not occurred. In considering reauthorization, the 113th Congress may examine whether reduced budget expectations require corresponding changes to planned programs. One common concern is that the cost of planned human spaceflight activities may mean less funding for other NASA missions, such as science, aeronautics research, and technology development. Some of those other missions have their own issues, however, such as the cost and schedule of the James Webb Space Telescope, future plans for unmanned Mars exploration following the landing of the Curiosity rover in August 2012, and the establishment in February 2013 of a new NASA directorate for space technology.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R43144, *NASA: Issues for Authorization, Appropriations, and Oversight in the 113th Congress*, by (name redacted)

Earth Observing Satellites

The constellation of earth-observing satellites launched and operated by the United States government performs a wide range of observational and data collecting activities, such as measuring the change in mass of polar ice sheets, wind speeds over the oceans, land cover change, as well as the more familiar daily measurements of key atmospheric parameters that enable modern weather forecasts and storm prediction. Satellite observations of the Earth's oceans and land surface help with short-term seasonal forecasts of El Nino and La Nina conditions, which are valuable to U.S. agriculture and commodity interests, identification of the location and size of wildfires which can assist firefighting crews and mitigation activities, as well as long-term observational data of the global climate which are used in predictive models that help assess the degree and magnitude of current and future climate change.

Congress continues to be interested in the performance of NASA, NOAA, and the U.S. Geological Survey in building and operating U.S. earth-observing satellites. Congress has been particularly interested in the agencies meeting budgets and time schedules so that critical space-based observations are not missed due to delays and cost overruns. Congressional scrutiny has focused recently on one specific satellite—the Joint Polar Satellite System (JPSS)—designed to provide daily measurements from polar orbit that inform weather forecasts and storm predictions. JPSS was formerly known as NPOESS (National Polar-orbiting Operational Environmental Satellite). It has experienced delays and higher costs than originally projected by the administration. Originally expected to have been launched into orbit by now, JPSS is currently scheduled to launch in 2017. A potential problem resulting from a 2017 launch of the JPSS satellite is the possibility of a gap in coverage from the polar-orbiting weather satellite system. The current system of polar-orbiting weather satellites includes the Suomi NPP (formerly known as the NPOESS Preparatory Project); its mission life extends to 2016. The Suomi-NPP satellite is now filling the operational gap until the JPSS spacecraft is launched and operational. If the Suomi-NPP instruments fail prior to the end of its five-year mission life there is a risk of a gap in polar-orbiting weather satellite coverage.

For Further Information

(name redacted), Specialist in Energy and Natural Resources Policy ([redacted]@crs.loc.gov, 7-....)

Environment

Science and technology play an increasingly large role in environmental issues. Science- and technology-related environmental issues that may come before the 113th Congress include climate change science, carbon sequestration, and national ocean policy.

Climate Change Science

Climate change, including the policy questions of whether and how the federal government might address it, will be on the agenda of the 113th Congress. Science and technology considerations will underpin virtually all congressional deliberations on the topic. Most notable among them may be the feasibility and costs of new greenhouse gas (GHG) regulations of the Environmental Protection Agency (EPA), which may largely depend on the commercial availability of Carbon Capture and Sequestration (CCS) technology for power plants.

For FY2014, the President requested $7.9 billion for clean energy programs and $2.7 billion for the U.S. Global Change Research Program, the federal program that coordinates and integrates global change research across 13 government agencies. Additionally, the federal government provides tax and other incentives to deploy technologies in the United States that variously lead to GHG emissions (e.g., fossil fuel extraction and utilization technologies) or would lower GHG emissions (e.g., more efficient and renewable energy technologies). The magnitude of federal expenditures for climate change, their effectiveness, and priorities may be topics for Congress, particularly in light of budget pressures.

In 2013, several bills have been introduced in Congress. They variously would: prohibit the Administration from regulating greenhouse gas (GHG) emissions; establish new federal programs to reduce GHG emissions; tax carbon in fossil fuels; reduce existing incentives for production of fossil fuels; or support planning for and adaptation to expected climate change. In addition, sector- or technology-specific issues are likely to come before Congress, such as control of GHG emissions from international aviation; incentives for biofuel production, or abatement from existing power plants and refineries; and the value of investments to lessen damages from future extreme weather events.

Debate on appropriate federal policies is fueled by differing levels of confidence in climate change science among Members and the public, as well as views about the prospects and costs of technologies to address climate change. Few scientists dispute that the climate is changing. Increasingly, private and public decision-makers recognize that the Earth's climate is not fixed, but shifts in ways both predictable and unpredictable, on multiple time scales. Over the long run, not addressing human contributions to the causes of climate fluctuations and their consequences could set up costly, even catastrophic risks and challenges. Most experts conclude from evidence and computer modeling that human activities have driven most of the global warming observed since the1970s, although solar variations and other natural oscillations contribute on some time scales. The most important human contribution to climate change is carbon dioxide, along with other so-called "greenhouse gases" and black carbon aerosols. They are emitted by fossil fuel combustion, land clearing and degradation, and some industrial activities. Effectively reducing GHG emissions to levels that could stabilize climate change would require, over the long run, radical technological change in the United States and in rapidly growing economies.

Technologies to support adaptation to future climate change have also been proposed in legislation. Because it is virtually certain that the climate will continue to change, due to both natural and human-related causes, Congress may address the federal role in facilitating effective private decision-making to anticipate and be resilient to changes. It may also consider incorporation of climate change projections into agency management of federal resources and infrastructure, and requirements and incentives in federal programs that may encourage or impede adaptation. Effective decisions would all depend on the adequacy and appropriate use of scientific information and available technologies.

In 2013, two major scientific assessments regarding climate change were released sparking heightened public and policy discussion. First was the fifth scientific assessment of climate change (Working Group 1 of the AR5) under the Intergovernmental Panel on Climate Change (IPCC). Second was the National Climate Assessment (NCA), required under the Global Change Research Act of 1990 (P.L. 101-606), was released for public comment, will be reviewed by the National Academy of Sciences, and is be due for finalization in 2013. According to the U.S. Global Change Research Project, it "present[s] a comprehensive picture of the changes in regions and sectors that occur in response to climate variability and change, including effects on public

health and human well-being, the economy, infrastructure, and the environment." Looking forward in 2014, the IPCC will release two additional reports—one on climate change impacts, vulnerabilities, and adaptation; and one on GHG control and policy options.

For Further Information

(name redacted), Specialist in Energy and Environmental Policy ([redacted]@crs.loc.gov, 7-....)

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CRS Report R43227, *Federal Climate Change Funding from FY2008 to FY2014*, by (name re dacted), (name redacted), and (name redacted)

CRS Report R41153, *Changes in the Arctic: Background and Issues for Congress*, coordinated by (name redacted)

Water Research

Reliable water quantity and quality is essential for the U.S. population, ecosystems, and economy, including agriculture and energy production (both traditional and alternative sources). Recent droughts and flood disasters and their significant social and economic impacts, as well as climate change impacts and adaptation concerns, also have increased attention to the quality and quantity of water science that is available to inform decision-making and to improve water technologies.

Water science and R&D is spread across more than twenty agencies. No single water research strategy or formal coordination or prioritization mechanism exists. The most recent estimate of federal water R&D and science spending was $700 million in FY2004, which was less than 0.5% of federal R&D in that year. The National Research Council in its 2004 report, *Confronting the Nation's Water Problems: The Role of Research*, found the distribution of water research funding inconsistent with the nation's priority water research needs and favoring short-term research. For example, it found that some legacy monitoring systems had been cutback or eliminated, and that much of the funding was directed at supporting federal regulatory activities. The report supported renewed funding of research on water use, water institutions, conservation, and augmentation (e.g., desalination, reuse). A 2012 GAO report, *Energy-Water Nexus: Coordinated Federal Approach Needed to Better Manage Energy and Water Tradeoffs,* found that effective energy and water policies will continue to be a challenge without more comprehensive data and research.

In recent Congresses, water research, its coordination, and federal funding have received attention in hearings and in legislation. This attention in part has been driven by concerns that current research is insufficient to prepare the United States to confront domestic and international water challenges. At issue for the 113th Congress are several topics, including whether to provide additional direction and funding for the federal water research portfolio, to support specific research topics (e.g., energy-water research), and/or to reauthorize appropriations for existing efforts (e.g., S. 376 for the National Integrated Drought Information System, H.R. 745 for federal desalination research, and S. 970 for federal support of state water resources research institutes).

For Further Information

(name redacted), Specialist in Natural Resources Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R40477, *Desalination and Membrane Technologies: Federal Research and Adoption Issues*, by (name redacted)

CRS Report RL34580, *Drought in the United States: Causes and Issues for Congress*, by (name redacted), (name redacted), and (name redacted)

CRS Report R42653, *Selected Federal Water Activities: Agencies, Authorities, and Congressional Committees*, by (name redacted) et al.

Carbon Capture and Sequestration

Carbon capture and sequestration (or storage)—known as CCS—has attracted congressional interest as a measure for mitigating global climate change because large amounts of carbon dioxide (CO_2) emitted from fossil fuel use in the United States are potentially available to be captured and stored underground and prevented from reaching the atmosphere. Large, industrial sources of CO_2, such as electric power plants, are likely initial candidates for CCS because they are predominantly stationary, single-point sources. On September 20, 2013, the U.S. Environmental Protection Agency (EPA) re-proposed standards for carbon dioxide (CO_2) from new fossil-fueled power plants. As re-proposed, the standards would limit emissions of CO_2 from new coal-fired power plants to no more than 1,100 pounds per megawatt-hour of production and between 1,000 and 1,100 for new natural gas-fired plants. As a reference point, existing coal-fired plants currently emit over 2,000 pounds of CO_2 per megawatt-hour. According to EPA, new natural gas-fired stationary power plants should be able to meet the proposed standards without the development of new control technologies. However, new coal-fired plants only would be able to meet the standards by installing CCS technology. Given the pending EPA rule, congressional interest in the future of coal as a domestic energy source appears directly linked to the future of CCS.

Currently, U.S. power plants do not capture large volumes of CO_2 for CCS. Several projects in the United States and abroad—typically associated with oil and gas production—are successfully capturing, injecting, and storing CO_2 underground, albeit at relatively small scales. According to the U.S. Department of Energy (DOE), the United States has the potential to store billions of tons of CO_2 underground and keep the gas trapped there indefinitely. Capturing and storing the equivalent of decades or even centuries of CO_2 emissions from power plants (at current levels of emissions) suggests that CCS has the potential to reduce U.S. greenhouse gas emissions substantially while allowing the continued use of fossil fuels. However, the additional cost of installing CCS on CO_2-emitting facilities is a primary challenge to the adoption and deployment of CCS in the United States. In addition, liability, ownership, and long-term stewardship for CO_2 sequestered underground are issues that would need to be resolved before CCS is deployed commercially.

In 2009, Congress appropriated $3.4 billion from the American Recovery and Reinvestment Act (Recovery Act) for CCS RD&D at DOE's Office of Fossil Energy in addition to annual appropriations for CCS. To date, there are no commercial ventures in the United States that capture, transport, and inject industrial-scale quantities of CO_2 solely for the purposes of carbon sequestration. However, CCS RD&D has embarked on commercial-scale demonstration projects for CO_2 capture, injection, and storage. The success of these projects will likely influence the future outlook for widespread deployment of CCS technologies as a strategy for preventing large quantities of CO_2 from reaching the atmosphere while U.S. power plants continue to burn fossil fuels, mainly coal.

For Further Information

(name redacted), Specialist in Energy and Natural Resources Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42532, *Carbon Capture and Sequestration (CCS): A Primer*, by (name redacted)

CRS Report R43127, *EPA Standards for Greenhouse Gas Emissions from Power Plants: Many Questions, Some Answers*, by (name redacted)

Geoengineering Technologies

"Geoengineering" refers to a suite of technologies and/or activities that have been offered by some as a potential response to global climate change. Unlike mitigation activities, which seek to reduce man-made emissions of greenhouse gases, or adaptation activities, which look to improve an individual's or institution's ability to cope with the impacts of climate change, geoengineering aims to achieve a deliberate and large-scale modification to the Earth's energy balance in order to reduce global mean temperatures (e.g., by blocking incoming solar radiation or removing greenhouse gases from the atmosphere). To date, little research has been done on most geoengineering methods, and deployment of the technologies—either through controlled field tests or commercial enterprises—has been minimal. A few foreign governments, including the United Kingdom's, as well as scientists from Germany and India, have engaged in some research. Many have expressed reservations about the effectiveness and appropriateness of geoengineering as a tool to address climate change. Others see the need for continued research due to concerns over the slow progress of emissions reductions, the uncertainties of climate sensitivity, the possible existence of climate thresholds (or "tipping points"), and the political, social, and economic impact of pursuing aggressive mitigation strategies. Further, some warn that the method's perceived advantages (e.g., low cost, low technology requirements, quick results) may provoke hasty deployment by an individual or country, which could result in an array of unanticipated consequences.

Despite several hearings held by the House Committee on Science and Technology in the 111th Congress, there has been limited federal involvement in, or oversight of, geoengineering. Congressional interest has focused primarily on whether the activity is a realistic, effective, and appropriate strategy for the United States and whether funding may be required for potential research and development. With the possibility that climate change will remain an issue of global concern, Congress may determine whether geoengineering warrants attention at either the federal or international level. If so, policymakers may need to consider whether geoengineering can be addressed effectively by existing laws and international agreements or, alternatively, whether new laws and treaties would need to be developed.

For Further Information

(name redacted), Specialist in AgriculturalConservation and Natural Resources Policy ([redacted]@crs.loc.gov, 7-....)

(name redacted), Analyst in Environmental Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R41371, *Geoengineering: Governance and Technology Policy*, by (name redacted) and (name redacted)

National Ocean Policy

In August 2000, legislation to create a U.S. Commission on Ocean Policy was enacted, and in September 2004, the commission published *An Ocean Blueprint for the 21st Century*. This report included 212 recommendations for a coordinated and comprehensive national ocean policy spanning a broad range of topics including ocean science and technology. Earlier in 2000, the Pew Oceans Commission, an independent group, was established to develop policies to restore and protect living marine resources, and in June 2003, it published *America's Living Oceans: Charting a Course for Sea Change*. In 2005, the commissions identified complementary recommendations for a number of areas and established the Joint Ocean Commission Initiative (JOCI).

Both the George W. Bush and Obama administrations responded to the U.S. Commission's recommendations with executive actions which focused on improving coordination across federal agencies. The Obama Administration also established an Interagency Ocean Policy Task Force, which published recommendations that focused on coordination of federal activities, stewardship of marine resources, and coastal and marine spatial planning. In response, in July 2010, President Obama signed Executive Order 13547 which adopted the task force's recommendations and established a National Ocean Council. The administration has stressed that the national ocean policy as stated in E.O. 13547 is a planning framework that will operate within existing authorities. Some in Congress have questioned whether the administration's national ocean policy, especially marine spatial planning, is a new regulatory program and whether the administration has the statutory authority to implement the policy. During the 113th Congress, several bills have included provisions to prohibit actions based on the national ocean policy or to prohibit the use of funding to implement, administer, or enforce the national ocean policy.

Since the release of the U.S. Commission's recommendations in 2004, legislation has focused on specific activities or environmental issues such as marine debris, coral reef conservation, marine fisheries, ocean exploration, and ocean observation systems. Although these efforts have addressed specific recommendations of the commissions, comprehensive approaches to federal organization and administrative structure, regional ecosystem management, and marine spatial planning have not been introduced during the 113th Congress. Furthermore, under current budgetary constraints some investments in ocean-related technology and research have been reduced. See "Ocean Energy Technologies" for additional ocean-related policy issues.

For Further Information

(name redacted), Analyst in Natural Resources Policy ([redacted]@crs.loc.gov, 7-....)

Energy

The science and technology related-energy issues that may come before the 113th Congress include the funding and role of the Advanced Research Projects Agency-Energy and the Department of Energy Office of Science, reprocessing of spent nuclear fuel, and the development of biofuels and of ocean energy technology.

Advanced Research Projects Agency-Energy (ARPA-E)

The Advanced Research Projects Agency-Energy, or ARPA-E, was established to "over-come the long-term and high-risk technological barriers in the development of energy technologies" (P.L. 110-69, Sec. 5012). ARPA-E is patterned after the widely lauded Defense Advanced Research Projects Agency (DARPA), which played a key role in the development of critical technologies like satellite navigation and the Internet. ARPA-E has supported over 285 energy technology research projects since Congress first funded it in FY2009. ARPA-E's appropriations authorization expired at the end of FY2013.

Critical questions for the 113th Congress include whether (and at what level) to continue providing specific funding and policy authorizations for ARPA-E. For FY2014, there was a $329 million gap between House ($50 million) and Senate ($379 million) appropriations committee recommendations for ARPA-E. House members later added another $20 million to the ARPA-E account during floor debate over passage of H.R. 2609 (Energy and Water Development and Related Agencies Appropriations Act, 2014). However, two minority members of the House Appropriations Committee asserted that the initially passed $50 million funding level would "effectively end" ARPA-E (H.Rept. 113-135).

It can be difficult for congressional policymakers to assess the optimal level of funding for agencies like ARPA-E. There is no firm consensus among policymakers regarding the optimal level of federal funding for R&D in general; or in regards to the balance of federal investments in various types of research (e.g., transformative and incremental, basic and applied). ARPA-E seeks to fund research that is transformative, but this type of research is typically associated with a higher failure rate. Some analysts may consider the higher failure rate (and therefore greater risk) as an argument for increasing the energy agency's budget because the private sector is widely perceived as unwilling to fund high-risk research. Others question the assumption that the private sector is unwilling to support ARPA-E-type projects, noting that some early ARPA-E grantees had received previous private sector funding. A 2012 Government Accountability Office report on this question concluded, "most ARPA-E projects could not have been funded solely by private investors" (GAO-12-112). Given the long-term nature of the type of research ARPA-E funds, it may be many more years before policy analysts can confidently assess the agency's impact.

For Further Information

(name redacted), Specialist in Science a nd Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42779, *America COMPETES Acts: FY2008-FY2013 Funding Tables*, by (name redac ted)

CRS Report R42430, *America COMPETES 2010 and the FY2013 Budget*, by (name redac ted)

DOE Office of Science

The Department of Energy's Office of Science, whose origins trace to the Manhattan Project, conducts basic research in six program areas: basic energy sciences, high-energy physics, biological and environmental research, nuclear physics, advanced scientific computing research,

and fusion energy sciences. Through these programs, DOE is the third-largest federal funder of basic research and the largest federal funder of research in the physical sciences. The Office of Science also stewards 10 of DOE's 17 national laboratories, including the Oak Ridge National Laboratory in Tennessee and Lawrence Berkeley National Laboratory in California. Typically, about 70% of the office's budget supports the national laboratories while about 15% is granted to university researchers. The remainder goes to industry, nonprofit, and other recipients.

As with many other federal research agencies, funding levels are a perennial policy concern for the Office of Science. In recent years, authorized increases in appropriations for the Office of Science have been driven, at least in part, by a broader effort to increase federal funding for federal physical sciences and engineering research. However, actual appropriations have not increased at the authorized rates, and provisions that allowed for increased appropriations to the Office of Science expired in FY2013. One policy question before the 113th Congress, therefore, is whether (and at what level) to reauthorize funding for the Office of Science. (For more information, see section on the "America COMPETES Act.")

A second Office of Science policy question centers on the ITER project. ITER (formerly known as the "International Thermonuclear Experimental Reactor") is an international project to design and build a fusion reactor. Advocates assert that the ITER project is a reasonable next step toward the design of a demonstration fusion power plant. However, funding for the project has increased budget pressure on the domestic fusion activities of the Office of Science. Some analysts assert that grants for U.S. fusion researchers have been cut in order to maintain funding for ITER. Others question the reliability of ITER's cost and schedule, which have changed significantly since the ITER agreement was established in 2006. The U.S. ITER program notes that "over 80% of U.S. ITER project funding is spent in the [United States]," and that for this investment, "the United States has access to all ITER technology and scientific data, the right to propose/conduct experiments, and the opportunity for U.S. universities, laboratories and industries to design and construct parts." (U.S. ITER web page at https://www.usiter.org/index.shtml).

Other Office of Science topics that the 113th Congress may consider relate to technology transfer, laboratory management, and exascale computing.

For More Information

(name redacted), Specialist in Science a nd Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R43121, *Energy and Water Development: FY2014 Appropriations*, coordinated by (name redacted)

Biofuels

Biofuels—liquid transportation fuels produced from biomass feedstock—are often touted as an alternative to conventional fuels. Some see promise in producing liquid fuels from a domestic feedstock that may reduce dependence on foreign sources of oil, contribute to improving rural economies, and lower greenhouse gas emissions. Others regard biofuels as potentially causing more harm to the environment (e.g., air and water quality concerns), encouraging land owners to put more land into production, and being prohibitively expensive to produce. The debate about the feasibility of biofuels is complex, as policymakers consider a multitude of factors. These factors (e.g., feedstock costs) sometimes overlap with the needs of other industries (e.g.,

livestock). The debate can be even more complicated when one considers that biofuels may be produced using numerous biomass feedstocks and conversion technologies. Thus, for each specific biofuel, a thorough assessment of the costs and benefits requires specific knowledge of the various factors involved. Further, certain aspects of U.S. energy policy (e.g., infrastructure, increased use of natural gas, and the role of alternatives) may impact the level of investment in biofuel research, development, and commercial-scale production.

Congress has expressed interest in biofuels for decades, with most of its attention on the production of "first-generation" biofuels (e.g., cornstarch ethanol). Farm bills have had a significant effect on biofuel research and development. Starting in 2002, the farm bills have contained an energy title with several programs focused on assisting biofuel production (see "Agriculture" for additional farm bill related research). While commercial-scale production of "first-generation" biofuels is well established, commercial scale production of advanced biofuels (e.g., cellulosic ethanol) is in its infancy. In 2007, Congress expanded one policy that may increase advanced biofuel production—the Renewable Fuel Standard (RFS). The RFS requires U.S. transportation fuel to contain a minimum volume of biofuel, a significant percentage of which will gradually come from advanced biofuels. However, the RFS has been under scrutiny for various reasons, including some of the advanced biofuel targets not being met, a compliance system that some view as not being transparent, and the possibility that the policy may require more biofuel to be produced than can actually be used. Lastly, Congress may continue to debate if a domestic biofuel industry is necessary for national defense, and what, if any, role the military might take regarding biofuel production. Going forward, Congress may consider whether to modify various biofuel efforts, or to maintain the status quo.

For Further Information

(name redacted), Specialist in AgriculturalConservation and Natural Resources Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R41282, *Agriculture-Based Biofuels: Overview and Emerging Issues*, by (name redacted)

Reprocessing of Spent Nuclear Fuel

Spent fuel from commercial nuclear reactors contains most of the original uranium that was used to make the fuel, along with plutonium and highly radioactive lighter isotopes produced during reactor operations. A fundamental issue in nuclear policy is whether spent fuel should be "reprocessed" to extract plutonium and uranium for new reactor fuel, or directly disposed of without reprocessing. Proponents of nuclear power point out that spent fuel still contains substantial energy that reprocessing could recover. However, reprocessed plutonium can also be used in nuclear weapons, so critics of reprocessing contend that federal support for the technology could undermine U.S. nuclear weapons nonproliferation policies.

In the 1950s and 1960s, the federal government expected that all commercial spent fuel would be reprocessed, using "breeder reactors" that would convert uranium into enough plutonium to fuel additional commercial breeder reactors.

Increased concern about weapons proliferation in the 1970s and the slower-than-projected growth of nuclear power prompted President Carter to halt commercial reprocessing efforts in 1977, along with a federal demonstration breeder project. President Reagan restarted the breeder

demonstration project, but Congress halted project funding in 1983 while continuing to fund breeder-related research and development. Under President Clinton, research on producing nuclear energy through reprocessing was largely halted, although some work on the technology continued for waste management purposes.

The George W. Bush Administration renewed federal support for reprocessing, adopting an aggressive development schedule for a different technology, called UREX+, with a pilot plant to have begun operating by the early 2020s.

Under the Obama Administration, the Fuel Cycle Research and Development Program has been redirected toward development of technology options for a wide range of nuclear fuel cycle approaches, including direct disposal of spent fuel (the "once through" cycle) and partial and full recycling, according to the FY2014 DOE budget justification. The program "will research and develop a suite of technology options that will enable future decision-makers to make informed decisions about how best to manage nuclear waste and used fuel from reactors," the FY2014 justification says. The total FY2014 funding request for this program was $165.1 million, down from the FY2013 level of $185.0 million. The House approved $91.1 million (H.R. 2609, H.Rept. 113-135), while the Senate Appropriations Committee recommended $175.1 million (S. 1245, S.Rept. 113-47).

For Further Information

(name redacted), Specialist in Energy Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report RL33558, *Nuclear Energy Policy*, by (name redacted)

CRS Report RL34234, *Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power*, coordinated by (name redacted)

Ocean Energy Technologies

New and improved technology is widely recognized as necessary if growth is to occur in domestic ocean energy production. Prompted by concerns about diversifying the U.S. ocean energy portfolio (geographically and technologically), many in Congress seek to encourage deploying renewable ocean energy resources: generating electricity from wind blowing above the ocean; harnessing thermal power from the sun's heat on the sea, and capturing kinetic forces of ocean tides and waves. Of these technologies, offshore wind projects offer the only near-term options for commercial application in U.S. waters.

According to the Energy Information Administration (EIA), 200 megawatts (MW) of offshore wind capacity producing about 750 million kilowatt hours (kWh) per year of electricity is anticipated to come online by 2015. The first site proposed for an offshore wind farm in U.S. waters is off the coast of Massachusetts— the so-called "Cape Wind" project. This project, comprising approximately 46 square miles in Nantucket Sound, has been highly controversial. While some local residents voice concern that operating wind turbines might pose environmental risks, supporters claim generating "clean" electricity is long overdue. Delays stemming from litigation have placed further permitting for Cape Wind on hold; no schedule has been announced for commencing operations.

In addition to litigation hurdles, financing poses challenges for deploying renewable energy projects. At issue for Congress is whether statutory changes might be needed to facilitate financing options for Cape Wind and other renewable energy projects. Options for addressing financing hurdles might include extending federal tax credits designed to spur renewable energy projects. On October 24, 2012, as part of an effort to streamline permitting for renewable energy projects, DOI announced the first lease granted under the "Smart from the Start" initiative. (No schedule has been established for this lease. For more details see http://www.boem.gov/Renewable-Energy-Program/Smart-from-the-Start/Index.aspx.)

Recent concerns of policymakers about ocean drilling safety have prompted a renewed focus on research to address challenges accompanying deepwater drilling operations. Specifically to help prevent subsea blowouts, the Marine Well Containment Company — a consortium of ExxonMobil, Chevron, ConocoPhillips and Shell —developed a subsea containment system that was recently tested by the Bureau of Safety and Environmental Enforcement (BSEE). According to BSEE, this new system is engineered to shut off flow from an underwater well and to activate subsea dispersant injection equipment. This system is among other technologies being examined for blowout prevention at ocean depths of up to 10,000 feet. Congress will likely monitor this development to ensure ocean drilling safety.

For Further Information

(name redacted), Specialist in Energy and Natural Resources Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42942, *Deepwater Horizon Oil Spill: Recent Activities and Ongoing Developments*, by (name redacted) and (name redacted)

CRS Report R40175, *Wind Energy: Offshore Permitting*, by (name redacted)

Homeland Security

The federal government spends billions of dollars supporting research and development to protect the homeland. Some of the issues that the 113th Congress may consider include how the Department of Homeland Security performs research and development and issues regarding its programs to detect smuggled nuclear material and biological terrorism. This section also includes issues regarding the development of medical countermeasures against chemical, biological, radiological, and nuclear agents; oversight of who is permitted to perform research on certain dangerous biological pathogens; and how to communicate scientific results that may pose a security risk.

R&D in the Department of Homeland Security

The Department of Homeland Security (DHS) has identified five core missions: to prevent terrorism and enhance security, to secure and manage the borders, to enforce and administer immigration laws, to safeguard and secure cyberspace, and to ensure resilience to disasters. New technology resulting from research and development (R&D) can contribute to all these goals.

Coordination of DHS R&D is a long-standing congressional concern. The Directorate of Science and Technology (S&T) has primary responsibility for establishing, administering, and coordinating DHS R&D activities. The Domestic Nuclear Detection Office (DNDO) is responsible for R&D relating to nuclear and radiological threats. The S&T Directorate, DNDO, and the Coast Guard are the only DHS components that report R&D expenditures to the Office of Management and Budget. In September 2012, however, the Government Accountability Office (GAO) found that at least ten DHS components fund R&D and R&D-related activities. GAO concluded that "as a result, it is difficult for DHS to oversee components' R&D efforts." (GAO-12-837).

The S&T Directorate oversees a system of federal laboratories, federally funded R&D centers, and university centers of excellence. In recent years, maintaining this infrastructure has consumed a growing share of the directorate's budget. This trend has constrained the funding available for R&D projects. Construction of the planned National Bio- and Agro-defense Facility may further increase infrastructure costs.

Initially envisioned as mainly an R&D organization, the S&T Directorate has expanded its role in technology acquisition and operational support of other components. It oversees operational test and evaluation for major acquisitions and provides other scientific and technical assistance throughout DHS. The focus of its R&D activities is increasingly short-term and incremental, with reduced emphasis on basic research and high-risk, high-reward projects.

DHS has reorganized its R&D-related activities several times. DNDO and the Office of Health Affairs (OHA) were both created largely from elements of the S&T Directorate. In the explanatory statement for the Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6), Congress directed DHS to evaluate the option of merging DNDO and OHA and realigning some of their functions, possibly including R&D, into other components.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

Detection of Smuggled Nuclear Material

Congress has emphasized the need to detect and interdict smuggled nuclear and radiological material before it enters the United States, funding investment in nuclear detection domestically and abroad. The U.S. Government has adopted a layered strategy of engaging internationally through threat reduction programs and provision of detection equipment to foreign governments; increasing supply-chain security efforts to track cargo approaching the U.S. border; securing the border through emplacement of radiation portal monitors and non-intrusive imaging equipment; and developing fixed and mobile detection capabilities within the United States. Experts have criticized this combined system as being insufficient to detect all smuggled special nuclear material.

Research and development activities supporting detection of nuclear smuggling span multiple agencies, including DHS and the National Nuclear Security Administration (NNSA). The DHS and NNSA have spent several years developing, testing, and evaluating next-generation detection equipment. The development of these next-generation systems has not yet met performance and timeline expectations. In addition, a shortfall of a key neutron detection material, helium-3, may

force reconsideration of the current nuclear detection approach and require deployment of new neutron-detection materials.

Congressional policymakers may continue their oversight over the interagency coordination in nuclear detection activities; development, testing, and procurement of current and next-generation nuclear detection equipment; and the sufficiency of the global nuclear detection architecture that links these efforts together.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

Chemical, Biological, Radiological, and Nuclear Medical Countermeasures

The anthrax attacks of 2001 highlighted the nation's vulnerability to biological terrorism. The federal government responded to these attacks by increasing efforts to protect civilians against chemical, biological, radiological, and nuclear (CBRN) terrorism. Effective medical countermeasures, such as drugs or vaccines, could reduce the impact of a CBRN attack. Policymakers identified a lack of such countermeasures as a challenge to responding to the CBRN threat. To address this gap, the federal government created several programs over the last decade to encourage private sector development of new CBRN medical countermeasures. Despite these efforts, the federal government still lacks medical countermeasures for many CBRN threats.

The Biomedical Advanced Research and Development Authority (BARDA) and Project BioShield are two key pieces of the federal efforts supporting the development and procurement of new CBRN medical countermeasures. The BARDA directly funds the advanced development of countermeasures through contracts with private sector developers. Project BioShield provides a procurement mechanism to remove market uncertainty for countermeasure developers. It allows the federal government to guarantee companies that if they successfully develop a countermeasure, then the government will purchase a specified amount of it. The 113th Congress enacted Pandemic and All-Hazards Preparedness Reauthorization Act of 2013 (P.L. 113-5), which reauthorized and modified BARDA and Project BioShield. However, some key issues remain unresolved, including the form and magnitude of appropriations. In FY2004, Congress advance appropriated $5.6 billion to Project BioShield for a ten year period. Congress funded BARDA through annual transfers from the unobligated balance of the Project BioShield advance appropriation. However, as of FY2014, HHS had obligated all of this advance appropriation. Congressional policymakers may consider whether providing appropriations to BARDA and Project BioShield individually on an annual basis rather than through a combined, multiyear advance appropriation would improve efficiency or performance. Additionally, congressional policymakers may consider deviating from the previous funding amounts for BARDA and Project BioShield to account for perceived countermeasure needs or the current fiscal environment.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

The Select Agent Rule: Bioagent Lab Registration and Security

The National Select Agent Registry Program (NSAR, http://www.selectagents.gov/) oversees the possession of "select agents"—i.e., biological agents and toxins with the potential to pose a severe threat to public, animal, or plant health, or to animal or plant products. The select agent list is developed and periodically updated by the HHS Centers for Disease Control and Prevention (CDC) and the USDA Animal and Plant Health Inspection Service (APHIS). Congress mandated the program in 1996, and expanded and strengthened it through subsequent reauthorizations. NSAR requires registration and specified security practices by U.S. laboratory facilities—including those at government agencies, universities, research institutions, and commercial entities—that possess, use, or transfer biological agents and toxins. Individuals given access to select agents must undergo background investigations conducted by the Federal Bureau of Investigation. Federal law bars access by certain groups of individuals, based on criminal history, immigration status, and other factors.

CDC regulates laboratory facilities that possess human pathogens and toxins (42 CFR 73), and APHIS regulates laboratory facilities that possess animal and plant pathogens and toxins (7 CFR 331 and 9 CFR 121). The two agencies share oversight of so-called "overlap agents" (such as the pathogen that causes anthrax), which affect both human and non-human animals.

While NSAR emphasizes the prevention of the intentional use of these agents, there have also been concerns about the accidental release of these agents from registered facilities. Such releases can result from the failure of environmental controls, or from improper laboratory practices. NSAR regulations require registered facilities to have, in addition to the biosecurity provisions discussed above, biosafety plans that address good laboratory practices, worker safety, and related matters, to mitigate the possibility of an accidental release.

NSAR has imposed significant constraints on those who choose to work with select agents. Skeptics point out, however, that it may not prevent intentional acts by individuals who have been granted access, or by others who have gained access to these agents in countries that lack comparable regulatory controls. In a 2012 final rule, pursuant to an executive order, CDC designated a subset of select agents that "present the greatest risk of deliberate misuse with the most significant potential for mass casualties or devastating effects to the economy, critical infrastructure; or public confidence" as "Tier 1" agents. The rule established new security requirements for entities that possess Tier 1 agents, including ongoing monitoring of personnel who have been granted access to them (77 Fed. Reg. 61084, October 5, 2012).

For Further Information

(name redacted), Specialist in Public Health and Epidemiology ([redacted]@crs.loc.gov, 7-....)

BioWatch: Detection of Aerosol Release of Biological Agents

The BioWatch program—begun in 2003—deploys pathogen sensors in more than 30 large U.S. cities to detect the possible aerosol release of a bioterrorism pathogen, in order that medications can be distributed before exposed individuals become ill. The DHS Office of Health Affairs (OHA) manages the system. The CDC oversees some aspects of laboratory testing. Local jurisdictions would manage the public health response to a bioterrorism incident.

Timely treatment will reduce casualties during a bioterrorism incident. Federal officials have sought to improve the responsiveness of the BioWatch system by replacing the current practice of daily sensor filter collection and analysis with so-called autonomous sensors, which would transmit pathogen detection findings in near-real time. OHA has pursued procurement of this type of sensor, which it terms Generation 3, or Gen-3, since 2007. However, GAO has noted that Gen-3 has a history of technical and management challenges, and a sizeable $5.8 billion life-cycle cost through FY2028. GAO recommends that DHS reevaluate the mission need and alternatives before continuing acquisition of these sensors. (GAO-12-810, September, 2012.) DHS later announced that further Gen-3 procurement was on hold pending an analysis of alternatives.

BioWatch has not detected a bioterrorism incident since its inception, although it has detected pathogens of interest; scientists believe that natural airborne "background" levels of these pathogens, or close relatives of them, exist in certain regions. In July 2012, the Los Angeles Times published the first in a series of investigative articles criticizing the performance of BioWatch, echoing in part the concerns of GAO (above), as well as the National Academy of Sciences. The articles claimed that the system is prone to false alarms and is also insufficiently sensitive to detect an actual incident. DHS disputed these claims. In addition, some state and local health officials defended the program, saying, among other things, that it has fostered collaboration among federal, state, and local officials, who would be called upon to work together in response to an actual incident.

The performance of BioWatch has attracted the attention of Members of Congress since its inception. Congressional appropriators have at times sought to limit funding for program expansion and/or called for program reviews. Authorizing committees in each Congress since the 108th have held hearings on the program. In addition, Members of the House Committee on Energy and Commerce began an investigation of the program in the 112th Congress, which has continued in the 113th Congress.

For Further Information

(name redacted), Specialist in Public Health and Epidemiology ([redacted]@crs.loc.gov, 7-....)

"Office of Health Affairs," in CRS Report R43147, *Department of Homeland Security: FY2014 Appropriations*, coordinated by (name redacted)

Publishing Scientific Results with Potential Security Risks

The federal government generally supports the publication of federally funded research results because wide dissemination may drive innovation, job creation, technology development, and scientific advances. However, a series of scientific articles describing how to make influenza more transmissible have highlighted the possibility that publication of some research results could threaten national security. Congress, the Administration, and other stakeholders are considering whether current research publishing policies sufficiently balance potential benefits with potential harms. The current issues under debate cut across traditional policy areas, involving simultaneous consideration of security, science, health, export, and international policy. Because of the complexity of these issues, analysis according to one set of policy priorities may adversely affect other policy priorities. For example, maximizing security may lead to detriments in public health and scientific advancement, while maximizing scientific advancement may lead to security risks. Accounting for such trade-offs may allow policymakers to establish regulatory frameworks that more effectively maximize the benefits from such research while mitigating its potential risks.

The Administration has begun developing policy frameworks for funding agencies and researchers to consider when sponsoring or performing specific sets of life science experiments that might produce results that could have beneficial and malicious uses. Stakeholders have not reached consensus on the effectiveness or appropriateness of these nascent policies. Congressional policymakers could decide to allow full implementation of the new policies before evaluating whether they sufficiently address the policy issues. Alternatively, Congress could require agencies to implement new, different processes to identify potential research of concern prior to funding; require federal prepublication review of all potential research of concern to establish appropriate limits on the distribution of the research results; require federal licensing of researchers permitted to conduct such experiments and access results; and limit such research to the most safe and secure laboratories.

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42606, *Publishing Scientific Papers with Potential Security Risks: Issues for Congress*, by (name redacted) and (name redacted)

Information Technology

The rapid pace of advancements in information technology presents several issues for congressional policymakers, including cybersecurity, potential changes to how the Internet is governed, issues related to broadband access, and issues related to the allocation of spectrum to support wireless services.

Cybersecurity

For more than a decade, experts have expressed concerns about the security of information and communications systems—often referred to as *cybersecurity*—in the United States and abroad. The frequency, impact, and sophistication of attacks on those systems have added urgency to the concerns.

The federal role in cybersecurity is complex, involving both securing federal systems and fulfilling the appropriate federal role in protecting nonfederal systems. No overarching framework legislation is in place, but many enacted statutes address various aspects of cybersecurity.

Consensus has grown that the federal policy framework take into account the diversity and continuing evolution of the technology and threats, and the increasing role of the Internet in the U.S. economy and the lives of citizens. Among the issues Congress continues to confront are

- cybersecurity for critical infrastructure, given that most of it is owned by the private sector;
- prevention of and response to cybercrime, especially given its international character;
- the relationship between cyberspace and national security; and

- how federal funding should be invested to protect information systems.

Proposed legislation has focused largely on issues in 10 broad areas:

- national strategy and the role of government,
- reform of the Federal Information Security Management Act (FISMA),
- protection of critical infrastructure (especially the electricity grid and the chemical industry),
- information sharing and cross-sector coordination,
- breaches resulting in theft or exposure of personal data such as financial information,
- cybercrime offenses and penalties,
- privacy in the context of electronic commerce,
- international efforts,
- research and development (R&D), and
- the cybersecurity workforce.

Several bills addressing those issues were considered in the 112th Congress, but none were enacted. Some have been reintroduced, and additional proposals are expected.

The White House issued an executive order in February 2013 designed to improve the cybersecurity of U.S. critical infrastructure. Citing repeated cyber-intrusions into critical infrastructure and growing cyberthreats, Executive Order 13636, *Improving Critical Infrastructure Cybersecurity,* attempts to enhance security and resiliency of critical infrastructure through voluntary, collaborative efforts involving federal agencies and owners and operators of privately owned critical infrastructure, as well as use of existing federal regulatory authorities. Several bills have been introduced in the 113th Congress, and additional proposals are expected.

For Further Information

(name redacted), Senior Specialist in Science and Technology ([redacted]@crs.loc.gov, 7-....)

(name redacted), Analyst in National Security Policy and Information Operations ([redacted]@crs.loc.gov, 7-....)

CRS Report R42114, *Federal Laws Relating to Cybersecurity: Overview and Discussion of Proposed Revisions*, by (name redacted)

CRS Report R42984, *The 2013 Cybersecurity Executive Order: Overview and Considerations for Congress*, by (name redacted) et al.

Internet Governance and the Domain Name System

The Internet is comprised of international and decentralized networks largely owned and operated by private sector entities. As the Internet becomes more pervasive in all aspects of modern society, the question of how it should be governed becomes more pressing. Currently, an

important aspect of the Internet is governed by a private sector, international organization called the Internet Corporation for Assigned Names and Numbers (ICANN), which manages the domain name system and Internet addressing. ICANN makes its decisions using a multistakeholder model of governance, in which a collaborative policy development process is open to all Internet stakeholders.

National governments have increasingly recognized the importance of ICANN policy decisions, especially in cases where Internet policy intersects with national laws addressing such issues as intellectual property, privacy, law enforcement, Internet freedom, and cybersecurity. Some governments are advocating greater intergovernmental influence over the way the Internet is governed, while other governments (such as the United States and the European Union) oppose intergovernmental jurisdiction over the Internet. This debate surfaced during consideration of the revised International Telecommunication Regulations (ITR) treaty held by the International Telecommunication Union (a United Nations agency) during the December 2012 World Conference on International Telecommunications (WCIT) in Dubai. Ultimately, the United States (and 54 other nations) chose not to sign the final treaty, citing an unacceptable expansion of ITR jurisdiction over the Internet.

As part of its input into the WCIT debate, the 112th Congress unanimously passed S.Con.Res. 50, which expressed the sense of Congress that the Administration should promote a global Internet free from intergovernmental control, and should preserve and advance the successful multistakeholder model of Internet governance. On May 14, 2013, the House unanimously passed H.R. 1580, which states that it is "the policy of the United States to preserve and advance the successful multistakeholder model that governs the Internet."

A key issue for the 113th Congress is whether and how the U.S. government should continue to maximize its influence over ICANN's multistakeholder Internet governance process, while at the same time effectively resisting proposals for an increased role by international governmental institutions such as the United Nations. An ongoing concern is: to what extent will future international telecommunications and Internet conferences constitute an opportunity for some nations to increase intergovernmental control over the Internet, and how effectively will the Administration work to counteract that threat?

For Further Information

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42351, *Internet Governance and the Domain Name System: Issues for Congress*, by (name redacted)

CRS Report 97-868, *Internet Domain Names: Background and Policy Issues*, by (name redacted)

Broadband Deployment

Broadband—whether delivered via fiber, cable modem, copper wire, satellite, or wirelessly—is increasingly the technology underlying telecommunications services such as voice, video, and data. Since the initial deployment of broadband in the late 1990s, Congress has viewed broadband infrastructure deployment as a means towards improving regional economic development, and in the long term, to create jobs. According to the Federal Communications Commission's (FCC's)

National Broadband Plan, the lack of adequate broadband availability is most pressing in rural America, where the costs of serving large geographical areas, coupled with low population densities, often reduce economic incentives for telecommunications providers to invest in and maintain broadband infrastructure and service. The National Broadband Plan also identified broadband adoption as a problem, whereby 1 in 3 Americans have broadband available but choose not to subscribe. Populations continuing to lag behind in broadband adoption include people with low incomes, seniors, minorities, the less-educated, non-family households, and the non-employed.

The 113th Congress is addressing a range of broadband-related issues. These include the transition of the telephone-era Universal Service Fund to the broadband-focused Connect America Fund, reauthorization of broadband loan programs in the 2013 farm bill, and the development of new wireless spectrum policies. Additionally, the 113th Congress may choose to examine our existing regulatory structure and consider possible revision of the 1996 Telecommunications Act and its underlying statute, the Communications Act of 1934. Both the convergence of telecommunications providers and markets and the transition to an Internet Protocol (IP) based network have, according to a growing number of policymakers, made it necessary to consider revising the current regulatory framework. How a possible revision might create additional incentives for investment in, deployment of, and subscribership to, our broadband infrastructure is likely to be just one of many issues under consideration.

To the extent that Congress may consider various options for further enhancing broadband deployment, a key issue is how to develop and implement federal policies intended to increase the nation's broadband availability and adoption, while at the same time minimizing any deleterious effects that government intervention in the marketplace may have on competition and private sector investment.

For Further Information

(name redacted), Specialist in Telecommunications Policy ([redacted]@crs.loc.gov, 7-....)

(name redacted), Specialist in Science and Technology Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R42524, *Rural Broadband: The Roles of the Rural Utilities Service and the Universal Service Fund*, by (name redacted) and (name redacted)

CRS Report RL30719, *Broadband Internet Access and the Digital Divide: Federal Assistance Programs*, by (name redacted) and (name redacted)

CRS Report RL33816, *Broadband Loan and Grant Programs in the USDA's Rural Utilities Service*, by (name redacted)

CRS Report R40616, *Access to Broadband Networks: The Net Neutrality Debate*, by (name redacted)

The Federal Networking and Information Technology Research and Development Program

Congress passed the High-Performance Computing and Communications Program (HPCC) Act of 1991 (P.L. 102-194) to enhance the effectiveness of federally-funded information technology (IT) research and development (R&D) programs, as well as encourage coordination among agencies conducting such research.

Proponents of federal support of IT R&D assert that it has produced positive outcomes for the country and played a crucial role in supporting long-term research into fundamental aspects of computing. Such fundamentals may provide broad practical benefits, but generally take years to realize. Additionally, the unanticipated results of research are often as important as the anticipated results. Another aspect of government-funded IT research is that it often leads to open standards, something that many perceive as beneficial, encouraging deployment and further investment. Industry, on the other hand, is more inclined to invest in proprietary products and will diverge from a common standard when there is a potential competitive or financial advantage to do so. Supporters believe that the outcomes achieved through the various funding programs create a synergistic environment in which both fundamental and application-driven research are conducted, benefitting government, industry, academia, and the public. Critics, however, assert that the government, through its funding mechanisms, may be picking "winners and losers" in technological development, a role more properly residing with the private sector. For example, the size of the NITRD Program may encourage industry to follow the government's lead on research directions rather than selecting those directions itself.

The NITRD Program is funded through appropriations to its individual agencies, so support for it will likely be part of the Federal budget debate in Congress.

For Further Information

(name redacted), Specialist in Internet and Telecommunications Policy
([redacted]@crs.loc.gov, 7-....)

CRS Report RL33586, *The Federal Networking and Information Technology Research and Development Program: Background, Funding, and Activities*, by (name redacted)

Using Technology to Manage Spectrum Resources

The rapid growth in mobile voice and data technologies has created new demands for advanced communications infrastructure and radio frequency spectrum capacity that can support high-speed, content-rich uses. Forging new policies for managing radio frequency spectrum may be the subject of far-reaching debates during the 113th Congress. By statute, spectrum is treated as a natural resource, but it is considered by many as a form of property, through the assignment of licenses. Electro-magnetic, or radio frequency, spectrum is segmented into bands of radio frequencies and typically measured in cycles per second, or hertz. Spectrum allocations and license assignments are described in hertz. Standard abbreviations for measuring frequencies include kHz—kilohertz or thousands of hertz; MHz—megahertz, or millions of hertz; and GHz—gigahertz, or billions of hertz.

The emerging debate over spectrum policy centers on how best to apply technology to maximize the societal and economic value of the airwaves to support popular and essential wireless services. Immediate policy concerns tend to focus on providing new spectrum capacity to fuel the building of networks using IP-enabled technologies to meet immediate consumer demand. Still to be fully addressed – by Congress and by most policy-makers – is how to bring the wireless network technology to the next level of accomplishment, assuring American leadership in a wireless, mobile economy for decades to come.

The "Spectrum Act," Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (P.L. 112-96)—signed into law on February 22, 2012—addresses present and future needs to provide adequate spectrum. The act authorizes the Federal Communications Commission (FCC) to establish an "incentive auction" process. The incentive auction is intended to release airwaves, now used for television broadcasting, to be licensed and auctioned to commercial wireless companies for broadband networks. The act also seeks to expand the amount of spectrum available for unlicensed use and stipulates conditions under which federal agencies may share their spectrum holdings with commercial users.

The technologies for next-generation networks built using licensed spectrum are well-established. Technologies that rely on databases to manage spectrum availability are being deployed and tested for next-generation unlicensed use. More advanced technologies, such as Dynamic Spectrum Access, that many believe will be the base for future spectrum policy, are in early stages of testing and development.

For Further Information

(name redacted), Specialist in Telecommunications Policy ([redacted]@crs.loc.gov, 7-....)

CRS Report R43256, *Spectrum Policy: Provisions in the 2012 Spectrum Act*, by (name redacted)

Author Contact Information

(name redacted), Coordinator
Specialist in Science and Technology Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Agricultural Conservation and Natural Resources Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Natural Resources Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Analyst in Natural Resources and Rural Development
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Internet and Telecommunications Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Senior Specialist in Science and Technology
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Telecommunications Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Science and Technology Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Analyst in Public Finance
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Energy and Natural Resources Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Energy Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Biomedical Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Science and Technology Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Analyst in Environmental Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Energy and Environmental Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Public Health and Epidemiology
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Telecommunications Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Science and Technology Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Science and Technology Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Science and Technology Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Science and Technology Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Science and Technology Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Agricultural Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Analyst in Natural Resources Policy
[redacted]@crs.loc.gov, 7-....

Key Policy Staff

Area of Expertise	Name	Phone	E-mail
Agricultural research, general	(name redacted)	7-....	/redacted/@crs.loc.gov
Agricultural research, biotechnology	(name redacted)	7-....	/redacted/@crs.loc.gov
America COMPETES Act	(name redacted)	7-....	/redacted/@crs.loc.gov
ARPA-E	(name redacted)	7-....	/redacted/@crs.loc.gov
Biofuels	(name redacted)	7-....	/redacted/@crs.loc.gov
BioWatch	(name redacted)	7-....	/redacted/@crs.loc.gov
Broadband deployment	(name redacted) (name redacted)	7-.... 7-....	/redacted/@crs.loc.gov /redacted/@crs.loc.gov
Carbon capture	(name redacted)	7-....	/redacted/@crs.loc.gov
Chemical, biological, radiological, and nuclear (CBRN) medical countermeasures	(name redacted)	7-....	/redacted/@crs.loc.gov
Climate change	(name redacted)	7-....	/redacted/@crs.loc.gov
Cybersecurity	(name redacted) (name redacted)	7-.... 7-....	/redacted/@crs.loc.gov /redacted/@crs.loc.gov
Defense	John Moteff	7-....	/redacted/@crs.loc.gov
DHS R&D	(name redacted)	7-....	/redacted/@crs.loc.gov
DOE Office of Science	(name redacted)	7-....	/redacted/@crs.loc.gov
Earth observing satellites	(name redacted)	7-....	/redacted/@crs.loc.gov
Federal research results, public access	(name redacted)	7-....	/redacted/@crs.loc.gov
Federal research results, publishing potential security risks	(name redacted)	7-....	/redacted/@crs.loc.gov
Federal S&T funding & policymaking	John F. Sargent, Jr.	7-....	/redacted/@crs.loc.gov
Geoengineering	(name redacted) (name redacted)	7-.... 7-....	/redacted/@crs.loc.gov /redacted/@crs.loc.gov
Intellectual property/ patents	(name redacted)	7-....	/redacted/@crs.loc.gov
Internet and domain name system	(name redacted)	7-....	/redacted/@crs.loc.gov
Nanotechnology	John F. Sargent, Jr.	7-....	/redacted/@crs.loc.gov
NASA	(name edacted)	7-....	/redacted/@crs.loc.gov
National Institutes of Health	(name redacted)	7-....	/redacted/@crs.loc.gov
Networking and Information Technology Research and Development Program	(name redacted)	7-....	/redacted/@crs.loc.gov
NSF	(name redacted)	7-....	/redacted/@crs.loc.gov
Nuclear energy	(name redacted)	7-....	/redacted/@crs.loc.gov
Nuclear material detection	(name redacted)	7-....	/redacted/@crs.loc.gov
Prescription drug costs	(name redacted)	7-....	/redacted/@crs.loc.gov
Public private partnerships	(name redacted)	7-....	/redacted/@crs.loc.gov

Area of Expertise	Name	Phone	E-mail
Ocean energy	(name redacted)	7-....	/redacted/@crs.loc.gov
Ocean policy	(name redacted)	7-....	/redacted/@crs.loc.gov
Select agent program	(name redacted)	7-....	/redacted/@crs.loc.gov
Science, technology, engineering, and mathematics (STEM) education	(name redacted)	7-....	/redacted/@crs.loc.gov
Spectrum	(name redacted)	7-....	/redacted/@crs.loc.gov
Tax policy (S&T-related)	(name redacted)	7-....	/redacted/@crs.loc.gov
Water	(name redacted)	7-....	/redacted/@crs.loc.gov
Workforce	John F. Sargent, Jr.	7-....	/redacted/@crs.loc.gov

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