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Science and Technology Issues in the 114th Congress

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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 spur 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 directly by 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 114th 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 114th Congress. The selected issues are grouped into 11 categories:

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

Each of these categories includes concise analysis of multiple policy issues. The material 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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Introduction

Science and technology 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 science and technology (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.

This report serves as a brief introduction to many of the science and technology policy issues that may come before the 114th Congress. Each issue section provides 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. Additional sections address issues related to the America Competes Act, tax policy, and public access to federally supported research results and data.

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, policies, regulations, regulatory agencies, and regulatory processes that rely on S&T data and analysis. However, Congress's 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 which have led to scientific breakthroughs and new technologies, from jet aircraft and the Internet to communications satellites and defenses against disease.

Between FY2009 and FY2014, federal R&D funding fell from $147.3 billion to $133.7 billion, a reduction of $13.6 billion (9.3% in current dollars, 15.8% 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 FY2016 appropriations process it faces two overarching issues: (1) the direction in which the federal R&D investment will move in the context of increased pressure on discretionary spending and (2) 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 R43944, *Federal Research and Development Funding: FY2016*, coordinated by (name redacted)

CRS Report R43918, *Overview of FY2016 Appropriations for Commerce, Justice, Science, and Related Agencies (CJS)*, by (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

The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act (P.L. 110-69) was first enacted in 2007. The act, a response to concerns about U.S. competitiveness, authorized certain federal research, education, and innovation-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. Most of the funding authorizations in the 2010 act expired in FY2013. Legislation to reauthorize provisions of the acts was introduced, but not enacted, in the 113th Congress.

Many economists assert that economic, security, and social benefits accrue preferentially to nations that lead in scientific and technological (S&T) advancement and commercialization. Some analysts suggest that historical U.S. leadership in these areas is 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—that is, the targeted "doubling path" accounts at the Department of Energy (Office of Science), National Institute of Standards and Technology (laboratories and construction), and National Science Foundation (total)—and by authorizing certain federal science, technology, engineering, and mathematics (STEM) education activities. The acts also authorized the Advanced Research Projects Agency-Energy (ARPA-E) and prize competitions at federal agencies, among other provisions. Implementation of the COMPETES Acts' provisions has varied, and congressional appropriations have generally been below authorized levels.

Those who oppose the COMPETES Acts do so from several perspectives. Some critics question the existence of such a STEM labor shortage. Other critics agree with the assertion of a shortage, but question whether the federal government should address it. Some analysts prefer alternative approaches to improving U.S. competitiveness, such as research tax credits or reducing regulatory costs. Other analysts object to the cost, given broader concern about the federal budget deficit and debt. Some scholars express concern 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 R43880, *The America COMPETES Acts: An Overview*, by (name redacted)

CRS Report R42779, *America COMPETES Acts: FY2008 to FY2013 Funding Tables*, by (name re dacted)

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)

Public Access to Federal Research Results

"Open access" or "public access" publishing generally refers to when an 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 fees only to authors to fund the costs of journal publication and distribution but 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.

Supporters of federal open-access publishing policies have a variety of motivations, including avoiding rising traditional journal subscription fees; beliefs regarding improved scientific progress through broader dissemination via free information access; and wishes for the public to access the results of research and development funded by their taxes. In contrast, traditional publishers and some scholarly associations object to federal open access policies because they believe they may weaken the publishing industry, erode profits, and consequently restrict the activities of associations whose main source of income is publishing. They 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.

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.

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. In addition, starting in 2014, Congress required such agencies funded through the Labor, Health and Human Services, Education, and Related Agencies appropriations act to develop such plans. The OSTP and Office of Management and Budget have reviewed submitted plans, and agencies have begun releasing them in 2015. The 114th Congress may continue its interest in the implementation of such plans and the effect these plans have on both the publishing industry and the advancement of science.

For Further Information

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

CRS Report R43935, *Office of Science and Technology Policy (OSTP): History and Overview*, by (name redacted) and (name redacted)

CRS Report R43923, *The White House Office of Science and Technology Policy: Issues for the 114th Congress*, by (name redacted) and (name redacted)

Public Access to Data from Federally Funded Research

Federal agencies often use the results of scientific studies when making policy decisions. The interpretation of data from those studies has sometimes been contentious. In the 1990s, Congress reacted to such controversy with legislation to make data from federally funded research more accessible to the public. The change was in an amendment, often called the Shelby Amendment or Data Access Act, to an appropriations act (P.L. 105-277). It directed the Office of Management and Budget (OMB) to mandate that federal agencies allow the public to use procedures under the Freedom of Information Act (FOIA, 5 U.S.C. §552) to access such data.

The Shelby Amendment originated from disputes about data used in developing regulations. A key element was debate over Environmental Protection Agency (EPA) regulations to strengthen air quality standards. Dispute focused especially on data underlying a study funded by the National Institutes of Health that found a link between particulate air pollution and health. Industry groups requested to review the data, but the researchers refused, citing confidentiality agreements. An independent review procedure was developed, but the law's supporters believed that public access was still needed. Among the issues raised by the EPA dispute were *transparency* of publicly funded research, *accountability* of agencies developing regulations and other policy, *privacy* of human subjects of research, and *integrity* of the research process.

Recent Administration activities have focused on increasing public access to data within current authorities. A 2012 report by the National Science and Technology Council indicated broad support for increasing public access and requiring funding proposals to include data management plans. The report also stated that most federal agencies did not have policies on public access to data.

A 2013 OSTP memorandum affirmed the Administration's commitment to ensuring the availability of the direct results of federally funded scientific research to the public, industry, and the scientific community. The memorandum requires federal agencies to develop and implement access plans. Some agencies have released plans, and additional releases are expected in 2015. Bills to extend public access to some federal research data were considered in the 113th Congress. The 114th Congress may continue interest in such measures and in the implementation of agency plans.

For Further Information

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

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

CRS Report R42983, *Public Access to Data from Federally Funded Research: Provisions in OMB Circular A-110*, by (name redacted)

Tax Incentives for Technological Innovation

The 114th Congress may consider federal policies to promote technological innovation. Among the concerns fueling this interest is what some view as sluggish growth in domestic high-paying jobs in a range of industries in recent decades. Two pathways to accelerating growth in these jobs are (1) faster rates of entrepreneurial business formation and increased business investment in domestic R&D and (2) domestic production of products and services derived from that research.

One way Congress can influence 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: (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 by the original investor for five or more years under Section 1202.

The credit and expensing allowance and tax credit encourage companies to invest more in qualified research than they otherwise would by lowering the after-tax cost of that research. Some analysts and lawmakers argue that the current credit's incentive effect is weaker than it should be. This is due, they argue, to several problems with the credit's design, including a lack of permanence, uneven and arbitrary incentive effects, and the inability of small startup companies to use the credit when they have net operating losses. The credit expired at the end of 2014. The expensing allowance is a permanent tax provision.

The Section 1202 capital gains exclusion is 50% for stock acquired in 2015 and thereafter. The exclusion is intended to boost equity investment in small startup firms in designated industries (including manufacturing) by reducing the tax burden on the returns to that investment relative to the after-tax returns on alternative investments.

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 such firms. Congress may consider the need for new initiatives to increase the rate of growth in domestic high-paying jobs, including new tax incentives.

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 114th Congress*, by (name redacted)

Workforce and Education

Maintaining a rapid pace of scientific and technological advancement requires a sufficient workforce of scientists and engineers. This section discusses workforce-related issues that may come before the 114th 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 differing 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 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 have raised 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—but the data paint a more 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. Some inventories have identified between 105 and 252 STEM education activities at 13 to 15 federal agencies, with annual federal appropriations typically totaling around $3 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. Nevertheless, many observers argue that a *general* increase in STEM abilities among the U.S. workforce could benefit the nation's economy, defense, health, and welfare. On the other hand, some scholars oppose the use of education policy to increase the supply of STEM workers, either because they perceive such policies as overemphasizing the economic outcomes of education at the expense of other values (e.g., personal development or citizenship) or because they perceive the labor market as the more efficient lever in signaling demand for STEM skills.

Analysts differ 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. Concern about the dissemination of federally funded research in STEM education also recurs from time to time.

Governance issues dominated much of the debate about FY2014 and FY2015 funding for the federal STEM education effort. In these years, the Obama Administration sought to make large changes to the federal STEM effort through its annual budget requests. In a series of actions, the number of federal STEM education investments (as defined by the National Science and Technology Council) was reduced from 228 in FY2012 (totaling $2.889 billion) to 136 in FY2014 (totaling $2.818 billion). The FY2015 budget request sought to reduce the number of investments further, to 109 (totaling $2.920 billion). Key questions, now that many of the proposed changes appear to have been made, include the disposition and composition of the federal STEM education effort in FY2015 and FY2016, as well as the alignment of the current effort with the congressionally mandated federal STEM education strategy.

For Further Information

(name redacted), Specialist in Science a nd 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 In Focus IF00013, *The President's FY2015 Budget and STEM Education (In Focus)*, by (name redacted)

CRS Insight IN10011, *The Administration's Proposed STEM Education Reorganization: Where Are We Now?*, 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 114th 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. The agency 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 2014 farm bill (P.L. 113-79) authorized agricultural research (and many other provisions) through September 30, 2018, and amends authority so that only competitive grants can be awarded under certain programs.

The 2014 farm bill increases mandatory spending for agricultural research by $1 billion over 10 years compared with projected baseline spending. Funding was increased for the Specialty Crop Research Initiative and the Organic Agricultural Research and Extension Initiative. Also, mandatory funding was continued for the Beginning Farmer and Rancher Development Program. The farm bill provided $200 million of mandatory funding to establish the Foundation for Food and Agriculture Research, a nonprofit corporation designed to supplement USDA's basic and applied research activities. It will solicit and accept private donations 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 2014 Farm Bill (P.L. 113-79): Summary and Side-by-Side*, coordinated by (name redacted)

Agricultural Biotechnology

The 114th Congress may address issues regarding the commercialization of bioengineered animals for human consumption, the issue of labeling bioengineered foods, or foods containing bioengineered ingredients, and recent technical innovations that raise new regulatory issues for plant biotechnology.

The Food and Drug Administration's (FDA's) review of an application by a Massachusetts biotechnology firm for approval of a bioengineered salmon is nearing completion. If approved, this would be the first bioengineered animal for human consumption. The salmon is engineered to grow to market size in half the time as non-bioengineered salmon. 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. It has been strongly opposed by some 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. Previous Congresses considered but did not pass several bills related to labeling of bioengineered food and preventing the escape of bioengineered salmon. Several similar bills have been reintroduced in the 114th Congress: H.R. 393 would require the labeling of bioengineered fish; H.R. 913 and H.R. 1599 would require labeling of foods containing bioengineered ingredients.

The development over the past four years of several new technologies to genetically engineer plants has introduced new regulatory issues. The USDA regulates the older genetic engineering technologies through the Plant Protection Act (PPA; 7 U.S.C. §770). However, USDA has stated that the new technology falls outside the purview of the PPA and thus the department has no regulatory jurisdiction over plants genetically engineered in this way. This has raised important questions about how such genetically engineered plants are to be regulated. As genetically engineered plant varieties created by these techniques become more common, and as the public becomes more aware that these varieties are not regulated under the PPA, Congress may revisit the 1986 framework that governs U.S. biotechnology regulation.

For Further Information

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

CRS Report R43518, *Genetically Engineered Salmon*, by (name redacted) and (name redacted)

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)

CRS Report R43100, *Unapproved Genetically Modified Wheat Discovered in Oregon and Montana: 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 114th Congress may face include the budget and oversight of the National Institutes of Health, oversight of dangerous microbial pathogens in laboratories, and the development of medical countermeasures to chemical, biological, nuclear and radiological threats.

National Institutes of Health: Budget and Oversight Issues

The National Institutes of Health (NIH) is the lead federal agency conducting and supporting biomedical research. Its FY2015 budget of $30.3 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 is 22% lower in FY2015 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. 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, and the Science, Technology, Engineering, and Mathematics (STEM) education program. NIH contends that funds targeted for such programs could be better spent on other research needs; Congress has disagreed.

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.

Other possible oversight topics include human research subject protection and termination in December 2014 of the National Children's Study. As originally envisioned, the 25-year-long $2.7 billion study would enroll 100,000 children, many before birth, and follow them through age 21.

For Further Information

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

CRS Report R41705, *The National Institutes of Health (NIH): Background and Congressional Issues*, by (name redacted)

CRS Report R43341, *NIH Funding: FY1994-FY2016*, by (name redacted)

CRS Report R43944, *Federal Research and Development Funding: FY2016*, coordinated by (name redacted)

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

Microbial Pathogens in the Laboratory: Safety and Security

Scientists have long recognized the need to protect laboratory personnel who work with infectious microorganisms (called "pathogens"). More recent concerns focus on risks to the public from intentional misuse or unintentional breaches in laboratory containment of pathogens.

In addition to its oversight of workplace safety in general, the federal government addresses laboratory worker safety through best-practices guidance such as *Biosafety in Microbiological and Biomedical Laboratories* (BMBL), first published by the Department of Health and Human Services Centers for Disease Control and Prevention (CDC) and National Institutes of Health (NIH) in 1984. BMBL establishes "Biosafety Levels" for work with the highest-risk pathogens. Although BMBL is written as guidance, it is often adopted as a requirement. For example, BMBL compliance is required of federal grant recipients.

Biosecurity requirements, to protect the public from intentional and unintentional releases of pathogens, were first mandated by Congress in 1996, and expanded through subsequent reauthorizations. The federal Select Agent Program, administered jointly by CDC and the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS), oversees the possession of "select agents," certain biological pathogens and toxins with the potential to cause serious harm to public, animal, or plant health. All U.S. laboratory facilities—including those at government agencies, universities, research institutions, and commercial entities—that possess, use, or transfer select agents must register with the program and adhere to specified best practices. All persons given access to select agents must undergo background investigations conducted by the Federal Bureau of Investigation (FBI).

Several incidents involving the mishandling of select agents in federal laboratories occurred in 2014. Samples of decades-old but viable smallpox virus were found in an FDA laboratory on an NIH campus. Laboratories at CDC, one of the select agent regulatory agencies, had incidents involving the anthrax agent, a virulent avian influenza virus, and Ebola virus. Each incident was attributed, at least in part, to lapses in protocol or some other form of human error. CDC

appointed a single head of laboratory safety for the agency among other efforts to address these lapses.

The authorization of appropriations for the Select Agent Program (42 U.S.C. 262a) expired in 2007. Congress has continued to fund ongoing implementation and enforcement. The 114th Congress may revisit program authority or regulations in light of recent incidents to determine whether current safety and security measures are adequate, as well as whether they allow important research on these pathogens to proceed.

For Further Information

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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, including Ebola.

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. 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 agree to buy a countermeasure up to 10 years before the product is likely to finish development. The 113th Congress enacted the Pandemic and All-Hazards Preparedness Reauthorization Act of 2013 (PAHPRA, P.L. 113-5), which reauthorized and modified BARDA and Project BioShield. However, some key issues remain unresolved, including those related to appropriations, interagency coordination, and countermeasure prioritization. In addition to questions regarding the amount of funding, Congress may decide whether to return to funding Project BioShield through a multiyear advance appropriation. Policymakers may consider whether the new planning and transparency requirements in PAHPRA have sufficiently enhanced coordination of the multiagency countermeasure development enterprise. Additionally, Congress may consider the robustness of the countermeasure prioritization process in light of the lack of countermeasures available to respond to the 2014 Ebola outbreak.

For Further Information

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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 114th 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 and Development

The Department of Defense (DOD) spends over $60 billion per year on research and development. Roughly 80% of this is spent on the design, development, and testing of specific military systems. It includes large integrated combat platforms such aircraft carriers, fighter jets, tanks, etc. It also includes much smaller systems such as small blast gauge sensors worn by individual soldiers. The other 20% (between $11 billion and $12 billion) is spent on what is referred to as DOD's Science and Technology (S&T) Program. The S&T Program includes activities ranging from basic science to demonstrations of new technologies in the field. It provides the knowledge and technological advances necessary to maintain U.S. military superiority. The research, development, testing and evaluation (RDT&E) budget contains close to 1,000 individual line items. Congress provides oversight of the program, making adjustments to the amount of funding requested for any number of line items. These changes are based on considerations such as whether the department has adequately justified the expenditure or the need to accommodate larger budgetary adjustments. RDT&E priorities and focus, including those of the S&T portion, do not change radically from year to year. However, there are a few fundamental policy related concerns that regularly attract congressional attention. These include ensuring that S&T, particularly basic research, receives sufficient funding to support next generation capabilities, seeking ways to speed the transition of technology from the laboratory to the field, and ensuring an adequate supply of S&T personnel. The impact of any further sequestrations on RDT&E may be of interest to the 114th Congress. At the end of 2014, then-Secretary Hagel announced a Defense Innovation Initiative aimed at identifying innovative ways to maintain the dominance of U.S. military capabilities into the future. As part of that initiative he established a new Long-Range Research and Development Planning Program (LRRDPP). The effects of the Initiative and the LRRDPP on RDT&E budgets and results remain to be seen.

For Further Information

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"Department of Defense" in CRS Report R43944, *Federal Research and Development Funding: FY2016*, coordinated by (name redacted)

Energy

The science and technology related-energy issues that may come before the 114th Congress include the funding and role of the Department of Energy's Office of Science and the Advanced Research Projects Agency-Energy, development of biofuels, reprocessing of spent nuclear fuel, and the development of biofuels and of ocean energy technology.

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 a major source of federal funds for 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. Since FY2010, 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 114th Congress, therefore, is whether (and at what level) to reauthorize funding for the Office of Science. (For more information, see the section on the "America COMPETES Act.") FY2015 funding for the Office of Science is $5.068 billion.

A second Office of Science policy question centers on the ITER project. ITER (formerly known as the International Thermonuclear Experimental Reactor) is an international effort 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 management, cost, and schedule. These concerns underpinned an FY2015 Senate Committee on Appropriations proposal to withdraw from ITER. Such provisions were not in the final FY2015 appropriations agreement. The U.S. ITER program's website (https://www.usiter.org) asserts 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."

Other Office of Science topics that the 114th Congress may consider relate to technology transfer, laboratory management, and research on exascale computing.

For More Information

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CRS Report R43880, *The America COMPETES Acts: An Overview*, by (name redacted)

CRS Report R42779, *America COMPETES Acts: FY2008 to FY2013 Funding Tables*, by (name redacted)

CRS Report R43567, *Energy and Water Development: FY2015 Appropriations*, coordinated by (name redacted)

ARPA-E

The Advanced Research Projects Agency-Energy, or ARPA-E, was established to "overcome the long-term and high-risk technological barriers in the development of energy technologies" (P.L. 110-69, §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 360 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 114th Congress include whether (and at what level) to continue providing specific funding and policy authorizations for ARPA-E. In FY2014, there was a $329 million gap between House ($50 million) and Senate ($379 million) appropriations committee recommendations for the agency. ARPA-E received $280 million in FY2014, the same amount it received in FY2015.

It may 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 (GAO-12-112) on this question concluded, "most ARPA-E projects could not have been funded solely by private investors." Given the long-term nature of the type of research ARPA-E funds, it could take decades for the agency's impact to become clear.

For Further Information

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CRS Report R43880, *The America COMPETES Acts: An Overview*, by (name redacted)

CRS Report R42779, *America COMPETES Acts: FY2008 to FY2013 Funding Tables*, by (name re dacted)

CRS Report R43567, *Energy and Water Development: FY2015 Appropriations*, coordinated by (name redacted)

Biofuels

Biofuels—liquid transportation fuels produced from biomass feedstock—are often described 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 landowners 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 (e.g., feedstock costs, timeframe to reach substantial commercial-scale advanced biofuel production). Biofuel resources sometimes overlap with the needs of other industries (e.g., livestock, oil and natural gas). 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" section 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 is gradually to come from advanced biofuels. However, the RFS has been under scrutiny for various reasons, including delayed issuance of final annual usage requirements by the EPA. These delays have created significant uncertainty for stakeholders, with the result that some of the advanced biofuel targets are not being met, and that some view the compliance system as not being transparent. An overarching issue is that the policy may require more biofuel to be produced than can be used given the existing motor fuel distribution infrastructure and the limited fleet of passenger vehicles that are built to run on higher percentage blends of biofuels. A continuing issue is whether a domestic biofuel industry is necessary for national defense, and what, if any, role the military might take regarding biofuel production and purchase. Congress could also consider whether to modify various biofuel promotional efforts, or to maintain the status quo.

For Further Information

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

CRS Report R43325, *The Renewable Fuel Standard (RFS): In Brief*, by (name redacted)

Ocean Energy Technologies

The 114th Congress may consider technology issues related to oil and gas exploration on the U.S. Outer Continental Shelf (OCS) and potential deployment of renewable ocean energy resources. One area of interest is technology for deepwater oil and gas drilling, particularly in the U.S. Gulf of Mexico. Interest in expanding deepwater operations has prompted advances such as ultra-deepwater-capable drilling ships and support vessels. Research has also focused on safety concerns; for example, after the Deepwater Horizon oil spill of 2010, a consortium of energy companies that operate in the Gulf developed a subsea containment system to help prevent blowouts at ocean depths of up to 10,000 feet. Congress may monitor such safety technologies as deepwater operations expand in federal waters.

Congress may also consider technology issues related to offshore drilling in the Arctic. The region's extreme weather, sea ice, and lack of developed infrastructure pose challenges for the economic viability and safety of oil and gas exploration. A focus of industry R&D is on technology to extend the Arctic drilling season beyond the brief periods where sea ice is absent—for example, by developing ice-capable mobile offshore drilling units (MODUs). Another concern is response to potential oil spills, given the region's remoteness and harsh conditions. The Department of the Interior (DOI) proposed safety regulations for Arctic exploratory drilling in February 2015 (80 *Federal Register* 9915). Some have argued that they require unnecessary and costly steps to prepare for oil spills, and give inadequate weight to available technologies (such as those for well capping) that could reduce these costs. By contrast, others question whether any rules or technologies can adequately ensure drilling safety in the Arctic given the environmental challenges. Congress may consider such competing concerns in its oversight of the DOI regulations.

Among renewable ocean energy technologies, only wind energy is poised for commercial application in U.S. waters. DOI has issued seven commercial wind energy leases on the OCS, but none is yet producing. Hurdles have included project financing and concerns about impacts on navigation, coastal aesthetics, and marine life. Developers are exploring technologies to increase offshore turbine efficiency and reduce costs including larger turbines with sub-structures such as jackets and tripods, and floating turbines for deep waters, which could reduce conflicts with activities in near-shore areas. Other research explores changes to electrical infrastructure, such as integrating transmission networks for multiple projects and shifting from alternating-current transmission lines to more efficient direct-current lines. Other renewable ocean energy technologies, such as those to capture kinetic forces of ocean currents or waves, are at earlier stages of research, development, and demonstration. In considering whether and how to facilitate the development of offshore wind and other renewables, Congress could potentially consider grants for R&D, project loan guarantees, extension of federal tax credits for renewable energy production, and regulatory issues for these emerging industries, among other matters.

For Further Information

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

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

CRS Report R40175, *Wind Energy: Offshore Permitting*, 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" or "recycled" 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 away from UREX+ and toward development of technology options for a wide range of nuclear fuel cycle approaches, including direct disposal of spent fuel (the "once through" cycle), deep borehole disposal, and partial and full recycling. The total FY2016 funding request for this program was $217.8 million, a 10.5% increase from the enacted FY2015 level of $197.0 million.

For Further Information

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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)

Environment

Science and technology play an increasingly large role in environmental issues. Science- and technology-related environmental issues that may come before the 114th Congress include climate change science, carbon sequestration, and ocean acidification.

Climate Change Science

Climate change, including the policy questions of whether and how the federal government might address it, is on the agenda of the 114th 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 proposed greenhouse gas (GHG) regulations on power plants to be promulgated by the Environmental Protection Agency (EPA) and dubbed the Clean Power Plan. The cost and legal justification for the standard may depend on the commercial availability of Carbon Capture and Sequestration (CCS) technology (see the "Carbon Capture and Sequestration" section for additional information).

For FY2016, the President requested $7.4 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. Many of the clean energy programs are identified as supporting EPA's Clean Power Plan, as would approximately $280 million for EPA. Additionally, the President has proposed billions of dollars of changes to tax and other incentives to deploy technologies in the United States that variously lead to greater 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.

Many bills were introduced in the 113th Congress to address climate change, some of which have been reintroduced in the 114th. Past and current proposals variously would prohibit the Administration from promulgating rules on GHG emissions without congressional approval; establish new federal programs to reduce GHG emissions; tax carbon in fossil fuels; reduce or increase 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 incentives for biofuel production and carbon sequestration, energy efficiency, and other emissions abatement from electricity generation and petroleum refineries. Support for technologies (including information technologies to address potential impacts of climate variability and change) as investments to lessen damages from future extreme weather events may also be proposed.

Technologies to support resilience 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 decisionmaking to anticipate and be resilient to changes. It may also consider efforts already begun to incorporate climate change projections into agency management of federal resources, infrastructure and operations, 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.

For Further Information

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CRS Report R43229, *Climate Change Science: Key Points*, by (name redacted)

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

CRS Report R43915, *Climate Change Adaptation by Federal Agencies: An Analysis of Plans and Issues for Congress*, coordinated by (name redacted)

CRS Report R43572, *EPA's Proposed Greenhouse Gas Regulations for Existing Power Plants: Frequently Asked Questions*, by (name redacted) et al.

CRS Report R43199, *Energy-Water Nexus: The Energy Sector's Water Use*, by (name redacted)

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

Carbon Capture and Sequestration

Carbon capture and sequestration (or storage)—known as CCS—is a physical process that involves capturing manmade carbon dioxide (CO_2) at its source and storing it indefinitely before its release to the atmosphere. CCS could reduce the amount of CO_2 emitted to the atmosphere while allowing the continued use of fossil fuels at power plants and other large industrial facilities. An integrated CCS system would include three main steps: (1) capturing CO_2 at its source and separating it from other gases; (2) purifying, compressing, and transporting the captured CO_2 to the sequestration site; and (3) injecting the CO_2 into subsurface geological reservoirs. Following its injection into a subsurface reservoir, the CO_2 would need to be monitored for leakage and to verify that it remains in the target geological reservoir. Once injection operations cease, a responsible party would need to take title to the injected CO_2 and ensure that it stays underground in perpetuity.

The U.S. Department of Energy (DOE) has pursued research and development of aspects of the three main steps leading to an integrated CCS system since 1997. Congress has appropriated approximately $6 billion in total since FY2008 for CCS research, development, and demonstration (RD&D) at DOE's Office of Fossil Energy: approximately $3 billion in total annual appropriations (including FY2014), and $3.4 billion from the American Recovery and Reinvestment Act (P.L. 111-5).

To date, there are no commercial ventures in the United States that capture, transport, and inject large quantities of CO_2 (e.g., 1 million tons per year or more) solely for the purposes of carbon sequestration. However, the CCS RD&D program has embarked on commercial-scale demonstration projects for CO_2 capture, injection, and storage. The success of these demonstration projects will likely bear heavily on the future outlook for widespread deployment of CCS technologies as a strategy for preventing large quantities of CO_2 from reaching the atmosphere while power plants continue to burn fossil fuels, mainly coal. The September 20, 2013, re-proposal of an EPA standard to limit CO_2 emissions from new coal-fired power plants has invited renewed scrutiny of CCS technology and its prospects for commercial deployment. Congress may wish to carefully review the results from these demonstration projects as they

progress in order to gauge whether DOE is on track to meet its goal of allowing for an advanced CCS technology portfolio to be ready by 2020 for large-scale demonstration and deployment in the United States.

For Further Information

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CRS Report R42496, *Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S. Department of Energy*, by (name redacted)

CRS Report R41325, *Carbon Capture: A Technology Assessment*, 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. Federal water science and R&D are spread across more than twenty agencies. No single water research strategy or formal coordination or prioritization mechanism exists.

The National Research Council in its 2004 report, *Confronting the Nation's Water Problems: The Role of Research*, found that the distribution of water research funding was inconsistent with the nation's priority water research needs and favored short-term research. 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. A 2014 GAO report, *Freshwater: Supply Concerns Continue and Uncertainties Complicate Planning*, found that state water management activities could benefit from federal efforts to enhance data collection and maintenance, data accuracy and timeliness, and data-related collaboration and coordination.

In recent Congresses, water research, its coordination, and federal funding have received attention in hearings and in legislation. At issue for the 114th Congress are several topics; these include whether to provide additional direction for the federal water research portfolio, support specific research topics (e.g., energy-water research, groundwater monitoring and science), and reauthorize appropriations for existing efforts (e.g., federal desalination research and federal support of state water resources research institutes).

For Further Information

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

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

Ocean Acidification Research and Monitoring

Ocean acidification is the increase in the acidity (decrease in pH) of seawater. Ocean chemistry is changing as increasing amounts of CO_2 from the atmosphere are absorbed by the earth's oceans forming carbonic acid. Scientists are concerned that ocean acidification and related changes to ocean chemistry could reduce growth or cause the mortality of shell-forming animals (e.g., corals, mollusks, and certain planktonic organisms), disrupt marine food webs, and affect the reproductive physiology of specific marine species. While not yet fully understood, the ecological and economic consequences of ocean acidification could be substantial.

The 111th Congress passed the Federal Ocean Acidification Research and Monitoring Act of 2009 (FOARAM; Title XII, Subtitle D, of P.L. 111-11). FOARAM established an interagency working group on ocean acidification (IWGOA) to coordinate federal activities and to develop a strategic research and monitoring plan to guide federal research on ocean acidification. In 2014, the Strategic Plan for Federal Research and Monitoring of Ocean Acidification was finalized. The plan is organized into the following seven themes:

- monitoring of ocean chemistry and biological impacts;
- research to understand responses to ocean acidification;
- modeling to predict changes in the ocean carbon cycle;
- technology development and standardization of measurements;
- assessment of socioeconomic impacts and development;
- education, outreach, and engagement strategy; and
- data management and integration.

FOARAM required the Secretary of Commerce to establish an ocean acidification program within the National Oceanic and Atmospheric Administration; the Director of the National Science Foundation to support proposals for research and monitoring of ocean acidification; and the NASA Administrator to ensure that spaced-based assets are used to monitor ocean acidification.

In the 113th Congress several bills related to ocean acidification were introduced including the Coastal Communities Ocean Acidification Act of 2014 (H.R. 4692), the Ocean Acidification Innovation Act of 2014 (H.R. 4732), and a bill to reauthorize FOARAM (H.R. 5545). Potential issues for the 114th Congress are related to the need to continue and enhance interagency coordination at the federal, state, and local levels, and whether adequate resources are available for research and monitoring activities.

For Further Information

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Homeland Security

The federal government spends billions of dollars supporting research and development to protect the homeland. Some of the issues that the 114th 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.

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 can contribute to all these goals.

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 Coast Guard conducts R&D, testing, and evaluation relating to its mission. These three organizations are the only DHS components that report R&D expenditures to the Office of Management and Budget. However, according to the Government Accountability Office, at least 10 DHS components fund R&D and R&D-related activities.

Coordination of DHS R&D is a long-standing congressional concern. In 2012, GAO concluded that because so many components of the department are involved, it is difficult for DHS to oversee R&D department-wide. In January 2014, the joint explanatory statement for the Consolidated Appropriations Act, 2014 (P.L. 113-76) directed DHS to implement and report on new policies for R&D prioritization. It also directed DHS to review and implement policies and guidance for defining and overseeing R&D department-wide. In July 2014, GAO reported that DHS had updated its guidance to include a definition of R&D and was conducting R&D portfolio reviews across the department, but that it had not yet developed policy guidance for DHS-wide R&D oversight, coordination, and tracking.

The S&T Directorate oversees a system of federal laboratories, federally funded R&D centers, and university centers of excellence. In recent years, building and maintaining this infrastructure has consumed a growing share of the directorate's budget. This trend may have constrained the funding available for R&D projects.

The S&T Directorate has expanded its role in technology acquisition and operational support of other DHS components. It oversees operational test and evaluation for major acquisitions and provides other scientific and technical assistance throughout DHS. Its R&D activities are primarily short-term and incremental, with less 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

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CRS Report R43064, *The DHS S&T Directorate: Selected Issues for Congress*, by (name redacted)

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, has led to the development and 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.

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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 so 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.

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, claiming 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.

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. Beginning in 2007, OHA pursued procurement of this type of sensor, which it termed Generation 3, or Gen-3. However, after a critical 2012 Government Accountability Office report (GAO-12-810), several procurement delays, and growing skepticism among some Members of Congress, DHS announced the termination of further Gen-3 procurement activities in April 2014.

Congressional appropriators have at times sought to limit funding for BioWatch program expansion and/or have 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 continued in the 113th Congress. The Administration requested FY2015 funding solely to maintain current BioWatch operations without upgrade. Appropriators provided funding accordingly. However, both House and Senate Appropriations Committees urged OHA to continue its efforts to improve the program's detection capability. The President's FY2016 budget request also seeks funding only to maintain current BioWatch operations without upgrade.

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"Office of Health Affairs," in CRS Report R43796, *Department of Homeland Security: FY2015 Appropriations*, coordinated by (name redacted)

Information Technology

The rapid pace of advancements in information technology presents several issues for congressional policymakers, including those related to cybersecurity, potential changes to how the Internet is governed, federal networking R&D, broadband access, and 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 should take into account the diversity and continuing evolution of the technology and threats, as well as 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, and
- the cybersecurity workforce.

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.

Legislation enacted in the 113th Congress addressed FISMA reform, and some issues related to the federal cybersecurity workforce, protection of critical infrastructure, and R&D. The 114th Congress is considering some cybersecurity legislation and additional proposals are expected.

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CRS Report R42114, *Federal Laws Relating to Cybersecurity: Overview of Major Issues, Current Laws, and Proposed Legislation*, 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 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. A contract between the U.S. National Telecommunications and Information Administration (NTIA) and ICANN—specifically referred to as the "IANA [Internet Assigned Numbers Authority] functions contract"—authorizes ICANN to manage the technical underpinnings of the domain name system and gives NTIA the authority to maintain a stewardship and oversight role with respect to ICANN and the domain name system.

On March 14, 2014, NTIA announced its intention to transition its stewardship role and procedural authority over key domain name functions to the global Internet multistakeholder community. If a satisfactory transition can be developed by that community, NTIA could let its contract with ICANN expire as early as September 30, 2015. NTIA has stated that it will not accept any transition proposal that would replace the NTIA role with a government-led or an intergovernmental organization solution. Supporters of the transition argue that it will enable the United States to more effectively advocate against proposals for intergovernmental (e.g., United Nations) control over the Internet. Critics cite the risk of hostile foreign governments gaining influence over an Internet domain name system no longer subject to U.S. government oversight.

The 114th Congress is likely to closely examine NTIA's proposed transition of its authority over ICANN. As a transition plan is developed, Congress may monitor and evaluate that plan, and seek assurances that an Internet and domain name system free of U.S. government stewardship will remain stable, secure, resilient, and open. Meanwhile, the Consolidated and Further Continuing Appropriations Act, 2015 (P.L. 113-235) provided that no funding may be used to relinquish the responsibility of NTIA during FY2015 with respect to Internet domain name system functions.

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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. According to 2013 Census data, roughly one in four American households do not subscribe to broadband. 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 114th Congress may address a range of broadband-related issues. These include the transition of the telephone-era Universal Service Fund to the broadband-focused Connect America Fund, funding and oversight of the broadband loan program reauthorized by the 2014 farm bill, the development of new wireless spectrum policies, and to what extent, if any, regulation is necessary to ensure an open Internet. Additionally, the 114th Congress may choose to examine the 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.

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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 reda cted)

Access to Broadband Networks and the Net Neutrality Debate

As policymakers continue to debate telecommunications reform, a major point of contention is whether action is needed to ensure unfettered access to the Internet. The move to place restrictions on the owners of the networks that compose and provide access to the Internet, to ensure equal access and non-discriminatory treatment, is referred to as "net neutrality." While there is no single accepted definition of "net neutrality," most agree that any such definition should include the general principles that owners of the networks that compose and provide access to the Internet (i.e., broadband access providers) should not control how consumers lawfully use that network, and should not be able to discriminate against content provider access to that network.

A focal point in the debate centers on whether it is necessary for policymakers to take steps to ensure "unfettered" access to the Internet for content, services, and applications providers, as well as consumers, and if so, what these steps should be. Some policymakers contend that more specific regulatory guidelines are necessary to protect the marketplace from potential abuses which could threaten the net neutrality concept. Others contend that existing laws and policies are sufficient to deal with potential anti-competitive behavior and that additional regulations would have negative effects on the expansion and future development of the Internet.

What, if any, action should be taken to ensure "net neutrality" is part of the overall discussion regarding broadband regulation. As the marketplace for broadband continues to evolve, some contend that no new regulations are needed, and if enacted will slow deployment of and access to the Internet, as well as limit innovation. Others, however, contend that the consolidation of broadband providers, coupled with their diversification into content, has the potential to lead to discriminatory behaviors which conflict with net neutrality principles. The two potential behaviors most often cited are the network providers' ability to control access to and the pricing of broadband facilities, and the incentive to favor network-owned or affiliated content, thereby placing unaffiliated content providers at a competitive disadvantage.

A consensus on the net neutrality issue remains elusive. Some Members of Congress support the FCC's adoption of the 2015 *Open Internet Order* establishing regulations for broadband Internet access. Others, while acknowledging that some regulation may be needed, feel that the FCC has overstepped its authority and advocate that the FCC look to Congress for guidance to amend the current law to update FCC authority before action is taken. Still others feel that regulation of the Internet is not only unnecessary, but harmful. The need for broadband regulation and the FCC's authority to implement such regulations is an issue of growing importance in the wide ranging policy debate over broadband access.

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

CRS Report R40234, *Net Neutrality: The FCC's Authority to Regulate Broadband Internet Traffic Management*, 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 and to 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 Networking and Information Technology Research and Development (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.

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

Wireless Communications and the Internet of Things

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. 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 policymakers—is how to bring wireless network technology to the next level of accomplishment, assuring American leadership in a wireless, mobile economy for decades to come.

Recent growth in the wireless communications industry has by most accounts placed the United States as the global leader in the deployment of fourth-generation wireless technologies. This strength combines with another area where the United States is judged to be a world leader: cyber-physical systems, in which physical processes are tightly intertwined with networked computing. The "Internet of Things," a term often used to describe consumer devices linked to the Internet, and the "Industrial Internet," used to refer to uses by manufacturing and other non-consumer industry sectors, are cyber-physical systems. An increasing number of these systems require access to radio frequency spectrum in order to connect to the Internet or other networks. The development of fifth-generation (5G) wireless technologies is likely to develop in tandem with the Internet of Things and the broader field of cyber-physical systems.

The Internet of Things may be the focal point of far-reaching debates during the 114th Congress about the impact of technology on almost every facet of life and the likely role of government in responding to these changes. As the Internet of Things changes the world around it, policies may need to be modified to meet the demands of the new technologies. For example, access to the Internet has changed, and will continue to change, the ways that education is delivered. What policymakers expect of education may also change, to assure that needed skills are obtainable from the labor market. The Internet of Things represents more than devices connected through networks, more than Internet or radio frequency spectrum policy; its arrival will likely require significant changes in—and coordination among—every department of government, from agriculture (precision farming) to transportation (self-driving automobiles and unmanned aerial vehicles).

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CRS Insight IN10191, *What Is 5G? Implications for Spectrum and Technology Policy*, by (name redacted)

CRS Insight IN10168, *Spectrum Needs of Self-Driving Vehicles*, by (name redacted)

CRS Report R43595, *Mobile Technology and Spectrum Policy: Innovation and Competition*, 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 114th 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. Enacted funding for NSF in FY2015 is $7.344 billion.

Arguably, the foremost NSF policy concern for the 114th Congress centers on the foundation's funding levels and the future of the "doubling path policy." (This issue is also discussed in the section on the "America COMPETES Act.") Since 2002, NSF authorization acts have pursued a policy of authorizing large increases in the NSF budget over a short period of time (e.g., a 100% increase over five years). Actual appropriations have rarely reached authorized levels. However, doubling path policy advocates assert that steep and fast increases in NSF funding are necessary to ensure U.S. competitiveness. 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. Some observers prefer to direct federal funding to more purpose- or mission-oriented research than that which is typically funded at NSF. Other analysts favor increasing research tax credits for private industry over funding for government grants (see the section "Tax Incentives for Technological Innovation"). Still other policymakers seek a reduction in NSF funding in light of the federal deficit and debt.

Other enduring federal policy issues for the NSF focus on the balance between scientific independence and accountability to taxpayers; funding for behavioral and social sciences; the geographic distribution of grants; the selection, funding, and management of scientific 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.

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CRS Report R43585, *The National Science Foundation: Background and Selected Policy Issues*, by (name redacted)

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 FY2014, Congress has appropriated approximately $19.4 billion for nanotechnology R&D; the President requested $1.5 billion in FY2015 funding. 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.

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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)

Space

Congress has historically had a strong interest in space policy issues. Two space topics that may come before the 114th 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 114th Congress will likely address NASA reauthorization legislation, which was considered in both chambers in the 113th Congress but not enacted. Issues include the goals and strategy of NASA's human spaceflight program and the impact of constrained budgets on NASA's other missions.

With the end of the space shuttle program in July 2011, the United States lost the capability to launch astronauts into space. Since that time, NASA has relied on Russian spacecraft for crew transport to the International Space Station (ISS). For ISS cargo transport, NASA-contracted U.S. commercial flights have been delivering payloads of supplies and equipment since October 2012.

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 become operational in 2017.

Second, for human exploration beyond Earth orbit, NASA is developing a new crew capsule called Orion and a new heavy-lift rocket to launch it. NASA expects the first crewed test flight of Orion in FY2021 or FY2022. 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 did not materialize. In considering reauthorization, the 114th 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 unmanned science satellites, aeronautics research, and space technology development. Some of those other missions have their own issues as well, such as the cost and schedule of the James Webb Space Telescope, future plans for unmanned Mars exploration, and NASA's role in Earth science.

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CRS Report R43144, *NASA: Issues for Authorization, Appropriations, and Oversight in the 114th Congress*, by (name redacted)

CRS Report R43419, *NASA Appropriations and Authorizations: A Fact Sheet*, by (name redacted)

CRS In Focus IF10016, *Space Exploration*, 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 Niño and La Niña 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 the Joint Polar Satellite System (JPSS), designed to provide daily measurements from polar orbit that inform weather forecasts and storm predictions. JPSS has experienced delays and higher costs than originally projected. JPSS is currently scheduled to launch in 2017. A potential problem 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 satellite—now filling the operational gap until the JPSS spacecraft is operational. The Suomi-NPP mission only life extends to 2016; there is a risk that its instruments will fail before JPSS is launched, which will result in a gap in polar-orbiting weather satellite coverage.

On February 11, 2013, NASA launched Landsat 8, a remote sensing satellite jointly operated by the U.S. Geological Survey and NASA. Landsat 8 is the latest in a series of Earth-observing satellites that began on July 23, 1972, with the launch of Landsat 1. Landsat has been used in a wide variety of applications, including land use planning, agriculture, forestry, natural resources management, public safety, homeland security, climate research, and natural disaster management, among others. A question for Congress is, should there be a Landsat 9? More generally, should Congress support the development of another moderate resolution land-imaging satellite, and what are the alternatives?

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CRS Report R40594, *Landsat: Overview and Issues for Congress*, by (name redacted)

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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 S&T funding & policymaking	John F. Sargent, Jr.	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
Ocean acidification	(name redacted)	7-....	-redacted-@crs.loc.gov
Ocean energy	(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
Tax policy (S&T-related)	(name redacted)	7-....	-redacted-@crs.loc.gov
Water	(name redacted)	7-....	-redacted-@crs.loc.gov

Area of Expertise	Name	Phone	Email
Wireless Spectrum	(name redacted)	7-....	-redacted-@crs.loc.gov
Workforce	John F. Sargent, Jr.	7-....	-redacted-@crs.loc.gov