TURNING THE PAGE:

REIMAGINING THE NATIONAL LABS IN THE 21ST CENTURY INNOVATION ECONOMY

NONPARTISAN POLICY REFORMS FROM

The Information Technology and Innovation Foundation
The Center for American Progress
The Heritage Foundation

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REIMAGINING THE NATIONAL LABS IN THE 21ST CENTURY INNOVATION ECONOMY

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CONTENTS

EXECUTIVE SUMMARY

Since their creation in the 1940s, the Department of Energy's, or DOE's, National Labs have been a cornerstone of high-impact, federally funded research and development. The labs have helped seed society with new ideas and technologies in leading disciplines such as energy, biotechnology, nuclear physics, and material science. While the labs' primary mission must continue to focus on supporting the nation's research needs not met by the private sector, the time has come to move the DOE labs past their Cold War roots and into the 21st century.

As the United States moves deeper into the 21st century, the importance of advancing innovation becomes even more important if our nation is to thrive. Creating wealth depends on the use of traditional inputs such as natural resources, land, and labor, but most importantly, it requires the discovery and development of new ideas and technology. Today's science and technological challenges are increasingly complex and require multidisciplinary and often unique solutions that the labs can help provide.

While the pace of innovation and the complexity of national challenges have accelerated, the labs have not kept stride. Although private-sector innovation will remain the cornerstone of economic growth, lab scientists and engineers do important work that can be of significant future use to private enterprise. Examples include commercial global positioning system, or GPS, applications and genetics analysis. The problem is that the labs' tether to the market is weak, often by design. Though the mission of the labs must not be to subsidize private-sector research, efficient means for transferring scientific discovery into the market should exist. But the labs' bureaucracy remains largely unchanged and does not reflect the nimble characteristics of today's innovation-driven economy. Inefficiencies, duplicative regulations, and top-down research micromanagement are having a stifling effect on innovation. Furthermore, institutional biases against transferring market-relevant technology out of the labs and into the private sector reduce incentives for technology transfer.

The federal government must reform the labs from their 20th century atomic-energy roots to create 21st century engines of innovation. This report aims to lay the groundwork for reform by proposing a more flexible lab-management model that strengthens the labs' ability to address national needs and produce a consistent flow of innovative ideas and technologies. The underlying philosophy of this report is not to just tinker around the edges but to build policy reforms that re-envision the lab system.

The analysis presented by this working group represents a consensus between members of three organizations with diverse ideological perspectives. We may not agree on funding levels, funding priorities, or the specific role of government in technological innovation, and nothing in this report should be construed as support for or opposition to those things. Instead, the purpose of this report is to put forth a set of recommendations that will bring greater efficiency and effectiveness to the DOE lab system, produce more relevant research, and increasingly allow that research to be pulled into the private sector. These recommendations are as relevant to a large, highly funded research agenda as they are to a much more limited one.

Our analysis and policy recommendations fall into three major categories, which are summarized below.

TRANSFORMING LAB MANAGEMENT FROM DOE MICROMANAGEMENT TO CONTRACTOR ACCOUNTABILITY

Creation of a high-level task force to develop DOE-actionable reforms on lab effectiveness and accountability. The Department of Energy, together with the Office of Science and Technology Policy, should lead a top-to-bottom review of the lab-stewardship system with the goal of identifying and reducing redundant bureaucratic processes, reforming the relationships between the labs and the contactors who manage them, and developing better technology-transfer metrics. This report should be submitted to Congress within one year.

Transition to a performance-based contractor-accountability model. DOE should cede decision-making responsibility to lab managers instead of micromanaging the labs from Washington. This builds upon the existing contractor-assurance system, or CAS, and would free lab managers to operate more nimbly with regard to infrastructure spending, operations, human-capital management, and external partnerships. The labs should report to Congress annually during the transition period to the new accountability model to ensure critical congressional oversight of taxpayer resources.

Expand the Performance Evaluation Management Plan process to include a new accountability model. As an alternative to direct transactional oversight for all decisions, Management and Operation, or M&O, contractor performance should be evaluated annually via an expanded and unified review process for all the labs based on the DOE Office of Science's Performance Evaluation Management Plan, or PEMP, process.

UNIFYING LAB STEWARDSHIP, FUNDING, AND MANAGEMENT STOVEPIPES WITH INNOVATION GOALS

Merge the existing under secretaries of science and energy into a new Office of Science and Technology. The new, single under secretary would have both budgeting and stewardship authority for all of the labs except for those currently managed by the National Nuclear Security Administration, or NNSA.

Combine the research functions of the Office of Science and those of the under secretary for energy under the new Office of Science and Technology. Congress should create new, broader program offices under the Office of Science and Technology to better coordinate activities throughout the entire research spectrum.

Remove top-down overhead accounting rules. Congress should remove prescriptive overhead accounting rules and allow labs greater latitude to use overhead funds to support project and mission success. This would include removing the cap on laboratory-directed research and development funds, also known as LDRD, and providing a more inclusive description of technology transfer.

MOVING TECHNOLOGY TO MARKET WITH BETTER INCENTIVES AND MORE FLEXIBILITY

Expand ACT agreements. The Department of Energy should expand the Agreements for Commercializing Technology, or ACT, template to allow for use with any kind of partner, regardless of whether the partnering entity has received other federal funding.

Allow labs to use flexible pricing for user facilities and special capabilities. Congress should remove legal barriers to allow the labs to charge a market rate for proprietary research and to operate technical facilities and capabilities at a level informed by market demand.

Allow labs autonomy in nonfederal funding-partnership agreements. The secretary of energy should grant the labs the authority to implement a pilot program that allows lab managers to agree to collaborations with third parties for research within the United States—through collaborative research and development agreements, Work for Others agreements, or other partnerships—absent DOE preapproval.

Add weight to technology transfer in the expanded PEMP process. DOE should create a new top-level category for the expanded PEMP process called "Technology Impact," which would evaluate labs on the transfer of technology into the U.S. private sector. The exact weight of this category would be negotiated in the M&O contract, based on the unique programs, capabilities, and strategic vision for each lab and DOE administration.

Execute consistent guidelines on conflicts of interest. The secretary of energy should issue new, consistent guidance to the labs encouraging research and management teams to partner with companies and entrepreneurs in the United States to avoid differing interpretations of laws and policies, including guidance on implementing consistent entrepreneurial leave and exchange programs.

PREFACE

We live in an innovation-driven economy.[1] In the 21st century the creation of new wealth and economic prosperity will continue to depend on the discovery and development of new ideas, new methods, and new technologies.

The American free-enterprise system has been an overwhelming contributor to many of these innovations and has been the greatest driver of American prosperity. The federal government has also played an important complementary role. Dating back to the founding of the Smithsonian Institute in 1846 and the land-grant college system in 1862, federal funding for understanding and harnessing science and nature has played a critical role in advancing the scientific knowledge that has driven much of America's economic growth.

Since then public support for science, technology, and engineering has been fundamentally important to developing much of the basic functionality that underpins a wide number of the industries and products we rely on every day, including smart phones, the Internet, microchips, parallel processing, GPS, computing, and genetic analysis, to name just a few. In none of these cases was the government's objective to create something commercially viable; rather, it was to develop a specific capability or to meet a national interest that was not available in the private sector. And in each case, private entrepreneurs were able to spin successful enterprises or products out of government research.

This public-private cooperation between government support for research and private-sector investment in transforming that research into new commercial products and industries continues today. One prominent example is the Department of Energy's National Laboratory system, a collection of 17 labs working on complex, multidisciplinary research to advance national scientific objectives that the private sector is unwilling to address and universities are often incapable of undertaking.

The labs were born out of the single-minded focus on building the atomic bomb. Of course, the labs were successful, which in part led to a quicker conclusion of World War II. And it led to U.S. nuclear capabilities that were a critical deterrent to the Soviet Union. Since the end of the Cold War, however, the nation has struggled to develop a new mission for the labs that effectively harnesses their unique capabilities or even justifies their existence as part of a comprehensive or rational public scientific enterprise.

The sad truth is that the institutional management structures that govern the labs have not advanced far beyond the Cold War, and is outdated, inflexible, and weakly connected to the marketplace, inhibiting U.S. innovation when we need it most.

While the labs have served the public well in the past, the status quo is ill adapted for the needs of the 21st century. It wastes precious taxpayer dollars and denies society the benefit of scientific advances. Making the need for reform even greater, the United States finds itself at a time when technological and scientific innovation is becoming ever more important to economic success. That is not to say all basic research conducted in the labs will or should have commercial application, but it should have the proper opportunity should that be the case.

The underlying philosophy of this working group is not to tinker around the edges. Previous attempts to fix the lab system offered ineffective incremental changes and blue-ribbon commissions that are collecting dust in a Washington basement. Instead, this report aims to re-envision the lab system with an eye toward saving taxpayer money, reducing inefficient bureaucracy, increasing research competition, ensuring contractor accountability, and ultimately, boosting the flow of high-quality research and technology out of labs and into the market.

This working group brings together a diverse set of three organizations from across the ideological spectrum with different perspectives. The participants may not agree on funding levels, funding priorities, or the specific role of government in technological innovation, and nothing in this report should be construed as support for or opposition to those things. Instead, the purpose of this report is to put forth a set of recommendations that will bring greater efficiency to the DOE lab system, produce more relevant research, and increasingly allow the private sector to pull value out of that research. These recommendations are as relevant to a large, highly funded research agenda as they are to a much more limited one.

Furthermore, because the labs would have more flexibility to seek funding streams, the recommendations will allow the size of the lab system to be rationalized based on performance and on demand for its services. Lower federal budgets and low demand from private interests would lead to contraction. The opposite would also be true. This is another way that our recommendations are applicable to reformers of any political persuasion.

That said, after more than a year of research and engagement with the labs, DOE, industry, and academia, as well as countless hours of discussion, this working group does agree that:

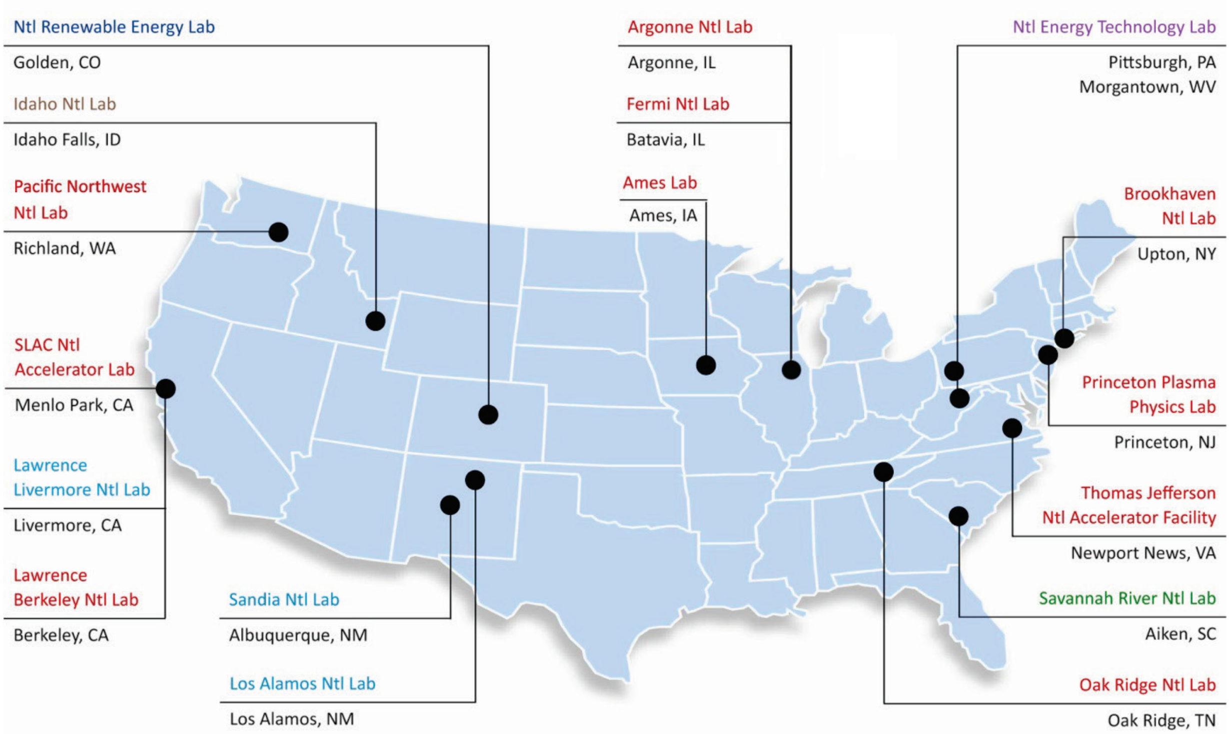
- Federally funded research results in scientific discovery that can play a positive role in America's economic future
- Federally funded research at the labs should not replace or crowd out private-sector and university-based research
- Research should be driven by science and national needs, not special interest politics
- Washington should oversee the labs, not micromanage them
- Barriers preventing the movement of research from the lab to the market should be minimized
- Taxpayer resources should be used as efficiently and effectively as possible
- Market forces can help bring efficiency and rationality to the lab system
- The current system needs substantial reform

We believe that even in a time of policy gridlock in Washington, these nonpartisan reforms simply make sense. The labs have been largely running on autopilot for too long. A jolt to the system is needed now more than ever. It is our goal that this report spurs debate on lab reform but, more importantly, that it instigates tangible and constructive changes from Congress, the administration, the Department of Energy, and the labs themselves.

DEFINING THE NATIONAL LABS

The DOE National Laboratory system, hereafter called the labs, represents 17 facilities and more than $18 billion in public research in fiscal year 2011.[2] Originally created in the late 1940s by the Atomic Energy Commission—the precursor to the modern DOE—to manage the United States' nuclear-weapons research and development, or R&D, the labs are distinctive because of their national research mission, breadth of expertise and knowledge, unique management style, and their ability to take on research projects that may have significant value but that the private sector is unwilling to undertake.

FIGURE 1: Location and stewarding agencies of the 17 DOE labs.



SIX DOE SPONSORING AGENCIES

- Office of Science (SC)
- Office of Nuclear (NE)
- Ntl Nuclear Security Administration (NNSA)
- Office of Fossil Energy (government owned & operated) (FE)
- Office of Energy Efficiency and Renewable Energy (EERE)
- Office of Environmental Management (EM)

HUBS OF MISSION-DRIVEN RESEARCH IN THE PUBLIC INTEREST

Public support for science and technology research can play a significant role in helping society seize opportunities to advance national, social, economic, and environmental well-being. The labs are tasked with conducting research in support of the public good that universities or private companies are unwilling or incapable of doing. The broad goals that the labs should be advancing include:

- **Addressing unique national imperatives** such as research for national defense or research to advance measurement science used by regulators and policymakers. This has included satellite communications, explosive- and chemical-detection technologies, and nuclear research. Lab expertise in developing and operating leading-edge computational resources is also often needed to meet the needs of the National Science Foundation, the National Oceanic and Atmospheric Administration, the Food and Drug Administration, and other government agencies.[3]

- **Capturing positive externalities from technology innovation** that are not easily appropriated by any one firm and for which private incentives for investment are not commensurate with the potential for public good. Because the benefits of any one firm's investment in innovation spill over to the benefit of other firms and consumers, limited public support for science and technological capabilities can help establish certain foundational discoveries or technologies upon which others can build. Examples of this phenomenon include the storage and reading of digital information or the basic infrastructure of the Internet, as well as environmental technologies for which market signals are weak.[4]

- **Conducting scientific research with very long time horizons** for which an immediate commercial application is unclear but that has the potential to advance scientific understanding and contribute to our national stock of technical knowledge. The labs' discovery of "good" cholesterol, for instance, has changed the way our society thinks about nutrition.[5]

- **Solving unexpected national and international challenges** such as nuclear disasters, cyber security, and public health issues that require rapid or unique research-based solutions. Lab scientists and engineers, for example, played key roles in responding to the terrorist attacks on September 11, 2001, the 2009 Christmas Day airline bombing attempt, and the nuclear meltdown at Fukushima in 2011 by deploying sensitive explosive- and radiation-sensing equipment and expertise to the scenes within 24 hours to assess the threats and inform abatement plans.[6]

CENTERS OF MULTIDISCIPLINARY RESEARCH

Thirteen of DOE's 17 labs are considered multi-purpose, while four are considered single-purpose. Single-purpose labs, such as the Princeton Plasma Physics Laboratory, or PPPL, and the Thomas Jefferson National Accelerator Facility, or the Jefferson Lab, concentrate on one program that requires extensive scientific expertise. Multipurpose labs, such as the Pacific Northwest National Laboratory, or PNNL, and the Argonne National Laboratory, or ANL, conduct research in many cross-cutting programs and hold expertise in numerous scientific disciplines.

The labs are classified even further by focus: science, energy, and weapons. The science labs were created to work primarily on broad and big-picture science problems. The energy labs work, in theory, on more applied energy problems in nuclear, fossil, and renewable energy. Finally, the so-called weapons labs are tasked with developing and maintaining the thousands of components and technical systems that make up the U.S. nuclear arsenal, as well as conducting other defense-related research.

In the 21st century, however, few of the labs continue to fulfill just their original intended purpose. Energy labs also conduct fundamental research in material science, while science labs shepherd sophisticated applied-research programs in everything from energy efficiency to cyber security to genetics. And weapons labs conduct research in both science and applied research. Sandia National Laboratories, for example, which stewards the blueprints for more than 6,300 of the 6,500 components of U.S. nuclear weapons, also has robust, interdisciplinary research programs and user facilities, such as the National Solar Thermal Test Facility, where the broader academic and industrial research communities are invited to collaborate on issues unrelated to nuclear weapons.[7]

This exists in part because science and technology are becoming more interconnected.[8] While traditional notions of science separate basic and applied as different processes, interviewees for this report and science-policy scholars agree that these distinctions are of decreasing importance.[9] Even the very narrowly focused Fermi National Acceleratory Laboratory, or Fermilab, for example, a single-purpose particle-accelerator laboratory, has contributed to technology transfer in fields as diverse as cancer imaging and power-plant flue-gas cleanup.

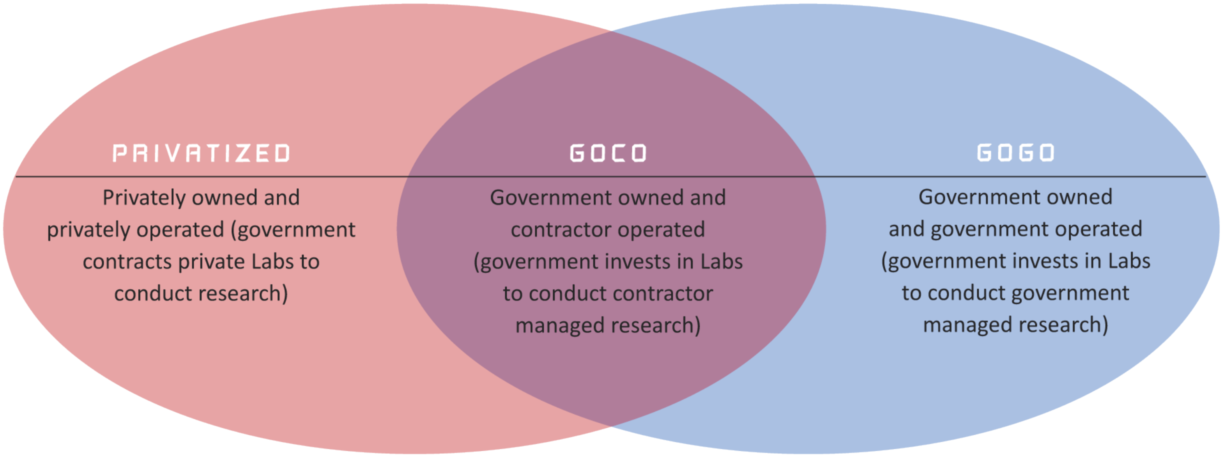
Today, rather than singularly focused research facilities, the labs respond to the needs of modern-day science by serving as platforms where multidisciplinary work can be coordinated on a large scale to tackle national goals. For these reasons, the labs should not be thought of specifically as energy, science, or weapons facilities, despite the fact that the system is housed within DOE. These multidisciplinary national institutions support the scientific and technology missions of government and society writ large. In FY 2011, for instance, the labs received $2.855 billion in research funding from other federal agencies, including the Department of Homeland Security, the National Institute of Standards and Technology, the Food and Drug Administration, the Centers for Disease Control, the Intelligence Community, the Department of Defense, and the National Aeronautics and Space Administration, or NASA.[10]

The labs also support the future scientific and engineering workforce that is crucial to U.S. innovation competitiveness. Systemwide, nearly 300,000 students—from elementary school students to postdoctoral researchers—participate in science training programs at the labs each year, and the labs have partnerships with more than 450 academic institutions in the United States and Canada.[11]

GOVERNMENT OWNED, CONTRACTOR OPERATED

Sixteen of the 17 National Labs operate as government owned, contractor operated, or GOCO, federally funded research and development centers, or FFRDC.[12] The Atomic Energy Commission carefully chose the GOCO model as an alternative to creating either an entirely government-controlled lab system or an entirely private-sector-based system.[13] The GOCO model was meant to provide the best of both worlds: flexible access to highly specialized technical talent and business-tested management practices, as well as the ability to direct complex, risky research unique to national needs. (see Figure 2)

FIGURE 2: Spectrum of lab ownership and management models.



Under this arrangement, the government—in this case, DOE—owns and stewards the lab facilities by setting the big-picture mission and provides funding. Contractor-managed research teams determine how best to carry out the research in pursuit of the public mission. Ideally, the GOCO model should allow DOE to steward the labs by:

- Ensuring that the lab system is properly sized and the research conducted meets America's national goals
- Defining and awarding research dollars to the labs on a competitive basis based on transparent scientific-merit review and in accordance with the law
- Ensuring lab infrastructure, programs, and human capital remain at the cutting edge of science and engineering in accordance with national need
- Providing accountability and performance metrics to gauge whether the research funding awarded to the labs is meeting mission goals

In practice, the contractor operates the facilities and manages the research and staff in partnership with government under an M&O contract, typically on five-year terms. Research teams employed by the lab contractors determine how best to carry out the research based on their scientific and technical expertise, and contractor-provided management teams handle the day-to-day and long-term management of programs, facilities, and human-capital assets.

Because the labs are widely dispersed throughout the country, government oversees and administers the M&O contract through federally staffed site offices at or near the labs. The site offices are tasked with approving lab research agreements, ensuring lab contractors are meeting DOE standards and acting as a proxy for DOE headquarter decisions and directives. Later sections of this report discuss the government-contractor relationship in greater detail, examining several areas where the relationships have diverged over time from their intended purposes, leading to inefficiency and opportunities for reform.

BRIDGES TO THE MARKETPLACE

In 1980 Congress legislated in the Stevenson-Wydler Technology Innovation Act that "technology transfer, consistent with mission responsibilities, is a responsibility of each laboratory science and engineering professional."[14] The goal was to ensure that federally funded research ultimately fulfilled both its stated national mission objective and provided additional economic opportunity, if appropriate. Since then no less than two-dozen laws and executive orders have been promulgated to encourage, incentivize, or assist the labs, among other public research entities, in transferring research and emerging technologies to industry.[15]

The labs facilitate moving research into the market largely through research collaborations with universities and industry, as well as by licensing patented innovations to the private sector. In 2010 the DOE labs earned more than $40 million in licensing revenue from roughly 3,500 active technology licenses and participated in nearly 700 cooperative research and development agreements, or CRADAs, with non-DOE entities.[16] And in 2011, $500 million in research was subcontracted by the labs to universities in instances where academic researchers needed specialized facilities and equipment or larger multidisciplinary teams were needed to solve complex problems.[17]

Another key place for collaboration is through the lab's user facilities, which are facilities with state-of-the-art advanced equipment, skilled staff, and technical capabilities that are made available to the greater government and public research community.[18] The Princeton Plasma Physics Laboratory, for example, is one of only a handful of facilities in the world with a working fusion reactor that scientists can use to advance the understanding of fusion energy.[19] The Los Alamos National Laboratory hosts scientists from around the world to use its ion-beam materials, electron microscopy, proton radiography, and high-energy laser-physics facilities.[20] In 2011, 350 American firms, including 47 Fortune 500 companies, took advantage of lab user facilities to conduct research supporting the creation of new products in industries as diverse as pharmaceuticals, advanced materials for semiconductors and vehicular batteries, telecommunications, and consumer goods.[21]

BETTER MANAGEMENT OF VALUABLE NATIONAL ASSETS

Without a doubt, the labs have created market-changing, nationally important science and technology since their founding. Technology developed in the labs has seeded new American industries and products as diverse as CDs and DVDs, satellite communications, advanced batteries, supercomputing, resilient passenger jets, and cancer therapeutics, all at a cost of about 0.03 percent of gross domestic product, or GDP, annually.[22] The question posed in this paper, therefore, is not whether the United States is getting *any value* from spending public dollars in the labs; rather, it is whether the United States can get *more value* from spending public dollars in the labs than it currently is.

This framing encourages an important discussion on whether today's lab system is properly rationalized to successfully address national challenges and move new research ideas to market as efficiently as possible. Are the labs flexible enough to meet increasingly complex and multidisciplinary issues? Are the labs given the proper institutional and policy tools to successfully conduct federally funded research? Is there a clear institutional model that links lab research with the marketplace? Is there an overriding strategy underpinning lab management, goals, and research?

Our answer to these questions in each case is no. A number of management, funding, and organizational barriers exist that make it increasingly difficult for the labs to efficiently and effectively conduct successful research that leads to positive market outcomes. In important ways, the current system is not properly organized for the 21st century and must be reimagined.

The following sections cover three groups of issues: (1) the dislocation of decision-making authority from the labs; (2) misaligned financing structures and a balkanized approach to research; and (3) the weak link between the labs and the commercial marketplace. For each barrier, a series of policy reforms aimed at strengthening the lab system is advanced.

TROUBLED RELATIONSHIP BETWEEN DOE AND THE LABS

The most pervasive issue with the labs is the slow transformation from their unique stewardship and management model toward a more restrictive system that concentrates decision making in Washington. The GOCO model that provides operational flexibility for managers to creatively pursue national missions has gradually weakened over time. DOE has instead created layers of central control that have shifted lab management to more closely resemble a fully federalized system than ever before. As a result, flexibility is constrained, accountability is no longer the principal method of oversight, and the innovation process is muddled.

MICROMANAGING LAB GOVERNANCE

During the 1980s DOE increased its regulation and oversight of the labs in reaction to intense public and congressional pressure to rein in government waste.[23] Due to lab-specific safety and security issues, DOE increased regulation further during the 1990s, which resulted in additional oversight of all labs, and these blanket measures continue today.[24] As a result, DOE has replaced contractor accountability with direct regulation of lab decisions—including hiring, worker compensation, facility safety, travel, and project management—in an effort to avert future congressional scrutiny such as hearings and budget cuts. While the merits of reducing government waste are laudable, the reality is that DOE has gradually replaced contractor accountability with an increasingly rigid form of micromanagement, which has created inefficiencies with little to show for it.

According to a study by the National Academy of Public Administration, or NAPA, DOE management of lab operations:

> … not only define the deliverables and due dates [of lab work and research] but are very prescriptive about the interim steps to be followed to complete the work assignment. In their view, lab staff are the experts on how the end result should be achieved and they should have the maximum discretion in defining project methodology. The laboratory staff interviewed believed that the issuance of prescriptive work authorizations was not the result of any program office policy but rather was the reflection of individual program managers' management styles or personal preferences.[25]

In practice, this means DOE has added duplicative layers of safety, security, human-relations and environmental regulations in addition to those already mandated by federal and state law. Rules from DOE, the Office of Management and Budget, or OMB, and the Occupational Safety and Health Administration, or OSHA, overlap and often require lab managers to repeatedly jump through similar hoops.

A simple example of the duplicative regulations is a DOE-required ladder-safety protocol, triggered by an incident at one lab but promulgated to all lab campuses.[26] DOE implemented new ladder-safety protocols, including required courses, which went above and beyond OSHA's guidelines for the rest of the country.[27] Another recent example is the regulatory limits placed on the labs for spending public dollars on conferences and travel due to past issues at other agencies. In effect, the extra regulations result in lab employees traversing a long list of DOE approvals simply to attend a conference.[28]

William Banholzer, chief technology officer for Michigan-based The Dow Chemical Company, was quoted recently decrying the unnecessarily duplicative layers of bureaucracy that stifle innovative partnerships. Banholzer stated, "[I]f Dow wants to change the direction of the research that it sponsors at Argonne, it has to seek approval at three levels: Argonne, the University of Chicago (which leads a consortium of contractors that manages the Lab) and the Department of Energy." He said that, "At least one of those is redundant."[29]

Decisions that should be made by research teams and lab managers are instead preapproved and double checked by a long and growing chain of command at DOE. There is no better example of this oversight than the hundreds of DOE site-office employees staffed to regulate lab managers and research by proxy.[30] This adds considerable delay and introduces additional costs to routine business decisions.

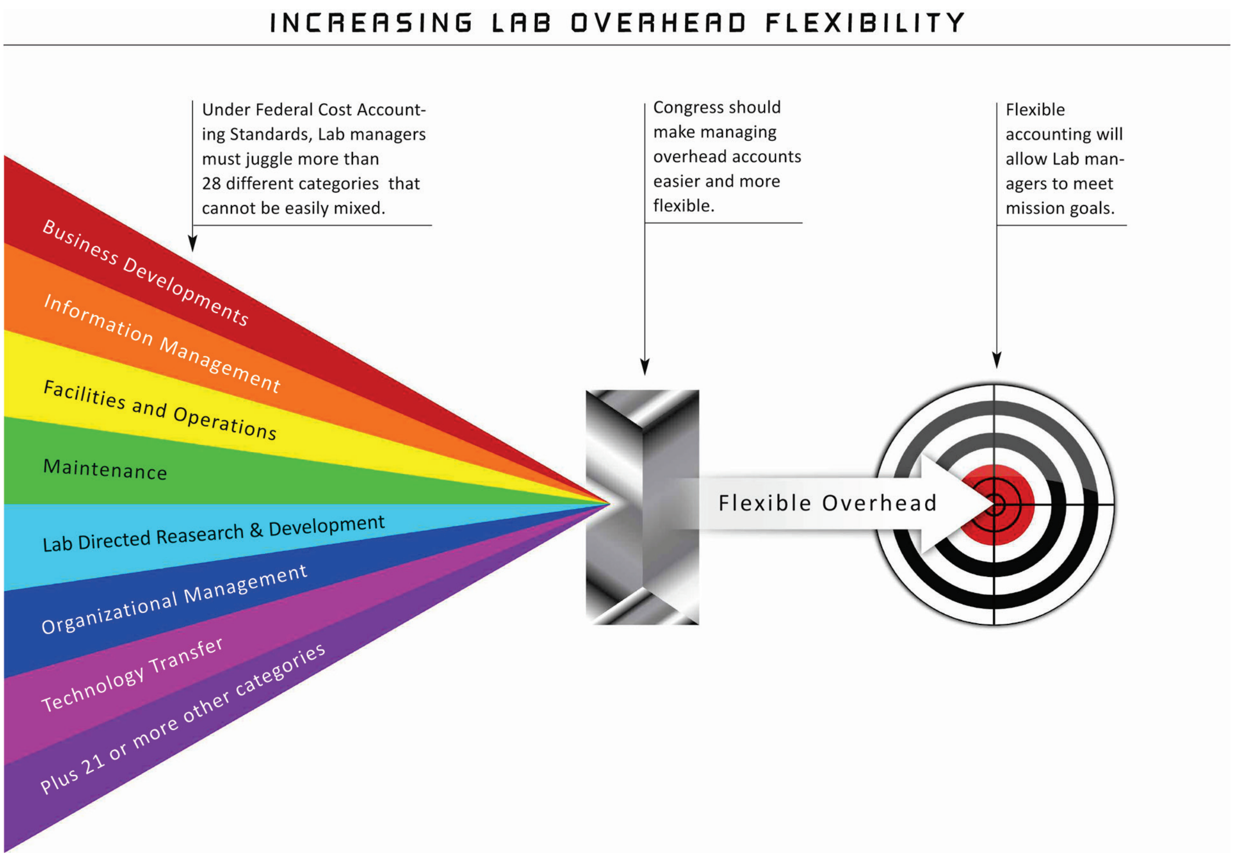
The DOE Inspector General's Office has estimated the cost of complying with these multiple layers of bureaucratic requirements to be well into the millions for an individual lab. A study produced by Perspectives, Inc., found that DOE site offices added 16 days to the processing time of collaborative R&D agreements with industry partners on average.[31] Additionally, the study found that this figure did not include the time spent by the contractor to "prepare" the agreement packages in order to maximize likelihood of site-office approval, and that "much time is spent by the laboratories in addressing Site Office requirements and concerns that is not captured in the cycle time estimates."[32] The reason site-office interference is so burdensome is because DOE, according to respondents in the study, "manage[s] the agreement process with *inflexibility* in mind." [emphasis in original][33]

MICROMANAGING LAB-DIRECTED EXPENDITURES

At the smallest level, DOE, in concert with OMB and Congress, micromanages internal lab-directed investment decisions. Lab budgets are divided into individual accounts with restrictions on how each tranche of funding can be used. These restrictions make it difficult for lab managers to make strategic decisions because they must manage many separate accounts that cannot be mixed.

While the majority of money goes into congressionally mandated research operations, a small percentage of research budgets—defined as “overhead”—goes into other accounts to cover management costs, facility upkeep, and other lab-directed science and technology spending. Tight restrictions on these overhead accounts limit contractor flexibility and make it difficult for managers to strategically invest in advancing promising research or strengthening lab infrastructure or capabilities.

FIGURE 3: Lab overhead accounts are separated into many discrete categories under tight regulation that greatly limits labs’ flexibility in making investments.



In the private sector, businesses have the flexibility to react to changing circumstances and new developments by reallocating funds as necessary among various activities, products, and programs. Congress provides the labs similar opportunity by allowing for laboratory-directed research and development, or LDRD—an overhead account that lab managers can pull from to invest across research projects within very strict regulations.[34] Studies conducted by DOE and the Government Accountability Office have found that projects funded by LDRD, despite its small budget, are often the most productive.[35] LDRD-funded projects, according to one lab, are the "most important single resource for fostering excellent science and technology for today's needs and tomorrow's challenges," and have been "extremely successful in supporting research at the forefront of science, providing new concepts for core missions, and creating an exciting research environment that attracts outstanding young talent."[36] Under today's rules, however, the labs are not allowed to actively manage their own budgets, resources, and priorities to more efficiently meet research objectives, despite the potential merits of this system.

RECOMMENDATIONS TO STRENGTHEN ACCOUNTABILITY AND FLEXIBILITY IN LAB MANAGEMENT

Micromanagement has a stifling effect on lab research and removes the flexibility that the GOCO model was designed to provide. Of course, lab safety, security, and oversight of public investments are important priorities, but adding rules and regulations *in addition to those already implemented by law* may not always provide additional benefits. Instead, it keeps the labs from doing the job they are tasked with doing: conducting successful research that can be applied to national needs.

Clearing away mechanisms by which micromanagement occurs means shifting back to a purer form of the GOCO model. This would allow the government to hold the labs to high standards while freeing up valuable time and resources to allow lab scientists to concentrate on research. Making this change requires peeling back layers of unnecessary regulations and reinstating contractor accountability into the underlying philosophy of DOE stewardship. Three policy reforms are particularly important.

BETTER IMPLEMENT PERFORMANCE-BASED LAB-MANAGEMENT ACCOUNTABILITY

DOE should transition to a contractor-accountability model that places less emphasis on DOE oversight and more emphasis on transparent expectations and rigorous performance evaluation. According to the National Academy of Public Administration, the performance-based model of contractor "trust-and-verify" accountability is designed to "describe the desired results of contractor performance, while leaving the contractor the flexibility to determine how to achieve those results."[37] Senior DOE management supports this model in theory, but DOE has not implemented the model sufficiently in practice.

Under the current system, an annual performance-evaluation process sets accountability and management rules and determines the contractor's fee. The 10 Office of Science labs use a common framework called the Performance Evaluation and Management Plan to act as a kind of annual report card. PEMPs include a number of metrics to rate lab performance, including worker safety, research management, leadership rating, and budgeting, and are also the primary evaluation tool used to determine an M&O contractor's fee for managing the labs.[38] Other DOE offices use similar but differently named procedures to gauge lab performance. For simplicity, this report uses the PEMP terminology when referring to the annual performance scorecard for all of the labs.

Today the PEMP process is a useful tool for enforcing accountability, but it could be leveraged far more effectively. The PEMP influences contractor accountability largely through status—contractors don't want a poor PEMP score compared to the other labs. Yet the PEMP doesn't extend this accountability to financial benefits or penalties. The difference in fee obtained by the contractor for a good PEMP versus an only mediocre PEMP is insignificant relative to the scale of research funding. Furthermore, the PEMP process is conducted separately from many of the other key levers for DOE oversight such as site-office verification of lab performance and lab-facility audits. In other words, the PEMP is a largely superfluous mechanism for determining the M&O contractor's fee and isn't a rigorous evaluation of management performance.

To increase M&O accountability and reduce DOE micromanagement, DOE should adopt an expanded PEMP process that becomes the focal point for lab stewardship and performance evaluation. Instead of requiring DOE review and approval for every transaction, lab management would assume decision-making authority and be held accountable through the PEMP. Contractors would be entrusted with the ability to make decisions for their labs while continuing to share all relevant information with DOE as requested under the M&O contract.

Under these conditions, the labs would still follow federal workplace safety standards and meet environmental regulations, but additional oversight—such as rules governing the use of public research dollars for conference attendance, building construction and management, and human-capital management—would be negotiated as part of the M&O contract and then managed first and foremost by the labs themselves, rather than by site-office staff.

Instead of rationalizing the bureaucratic, difficult, and sometimes arbitrary approval processes for basic lab decisions, the performance of each lab would be determined by its ability to fulfill its contractual obligations with verification ensured during the annual performance review rather than in advance of each decision. Instead of promulgating new regulations on all of the labs because of issues at one lab, DOE would hold the individual contractor accountable for its mistakes. Corrective action—including increased punitive restrictions and financial penalties, up to the eventual firing of the contractor—is outlined in each M&O contract.

To execute this management realignment, a two-step process is appropriate. First, the White House Office of Science and Technology Policy, or OSTP, and DOE should create a task force to begin unraveling duplicative DOE regulation of the labs. This task force would include representatives from key stakeholders, including lab directors, relevant sponsoring agencies and offices, lab contractors, and major outside science and industry users, and it would be tasked with reporting to the secretary of energy on how DOE can maintain necessary oversight of lab operations while removing excessive rules and accelerating bureaucratic processes. The task force should take one year to conclude its findings, at which point it would disband. The secretary of energy and OMB should then enact each recommendation within a reasonable amount of time set by the administration not to exceed six months.

In the absence of OSTP and administration action, Congress should act in a similar fashion by creating a stakeholder commission to address duplicative DOE regulation of the labs and require the secretary of energy and OMB to address each recommendation within a reasonable amount of time. It should do this through legislation or simply by forming a special congressional subcommittee and inviting key stakeholders to participate in a process of hearings with a legislative outcome. Under this approach, Congress should seek to develop findings and implement them within 18 months.

Second, DOE should carefully change the annual performance-evaluation process through M&O contract negotiations. Negotiating the M&O contracts would fall under the proposed Office of Science and Technology (discussed in detail on page 37) in a consistent manner for at least the 14 non-NNSA labs and potentially for all 17 labs, given NNSA buy-in as M&O contracts come up for renewal or competitive rebidding. New language should be negotiated into the contract that clearly states the management practices lab contractors must follow.

It would also be particularly important that each lab, through the DOE, continue to report to Congress the non-DOE funded activities it is undertaking outside of the expanded PEMP process while transitioning from the current system to the new system. The labs could also add, for example, reporting on new cooperative efforts and the potential linkages those partnerships share with national priorities and other taxpayer-funded research. The DOE congressional report could also provide insight on how the new management structure saves money, expands lab capabilities, provides for more efficient technology transfers, and promotes general efficiency.

In this way, lab contracts can be moved away from direct transactional oversight by DOE and toward a trust-but-verify system incrementally and gradually enough to address issues as they arise and adjust course as necessary. Congress would continue to maintain its strong oversight of taxpayer resources through both the public availability of the PEMP as well as an annual reporting process while the labs are transitioning to the new system.

STREAMLINE DOE SITE OFFICES

Shifting to a contractor-accountability system would reduce day-to-day operating oversight by DOE and should obviate the need for such extensively staffed site offices.

As part of the contractor-accountability model negotiated into M&O renewals or new bids, staffing DOE site offices should be negotiated as well. Lab managers interviewed for this report recognized that many labs benefit from interacting with site offices, in particular to account for and manage the significant volume of ongoing public research. But the growth of site offices is indicative of the increasingly heavy hand of DOE regulation.

The size and presence of DOE site offices should conform to the negotiated standards of M&O contracts. Contractors would negotiate with DOE on what they feel would be an appropriate number of field staff given the new set of responsibilities and expectations of the new accountability relationship described above. Giving negotiating rights back to contractors is a better deal for the taxpayers, since fewer resources would be spent navigating the bureaucracy and more resources would be available to fund innovative research and attract the best talent. Under such a system, it is plausible that DOE and the contractors would determine that it is more efficient to engage a mobile team of compliance and audit staff that visits and interacts with lab management on an ad-hoc or as-needed basis, instead of maintaining a stationary site office.[39]

This paper does not take a position on the exact level of site-office interaction; rather, proposes a new system under which DOE preapproval would be required only for the most sensitive lab decisions, leaving the labs themselves to identify potential problems and make strategic decisions about their own management—within the parameters negotiated in M&O contracts. For some labs, a seamless transition could take only months, while others will require a longer transition period with more gradual milestones. DOE must take this heterogeneity into account as it implements new guidelines, in particular for labs with sensitive nuclear and national-security operations.

INCREASE LAB BUDGETING FLEXIBILITY

The labs should be given more leeway to direct their own overhead investments and decision making. To allow the labs greater flexibility in decision making, Congress should replace the existing accounting system with a single, accessible overhead account for lab managers. Congress could provide very broad rules on the types of investments that can be made but should move away from creating rigid accounting "buckets" that reduce budget flexibility. This includes removing the existing 8 percent cap on LDRD spending and allowing the labs greater flexibility to spend their overhead to advance research.[40] DOE would then negotiate additional details on how lab managers can flexibly leverage overhead funds within the M&O contracts.

Congress should also increase budget flexibility by broadening the set of allowed activities that fall under overhead to include more aggressive technology-demonstration projects. In practice, this would enable the labs to spend overhead funds on projects that either removes technology barriers that limit private-sector interest or repurpose original research for new problems. In either case, these funds would leverage previous publicly funded research—that would normally sit on the lab shelf—and advance it closer to achieving potentially successful market outcomes.

Without adding a single additional dollar of *new* spending, increasing overhead flexibility encourages the labs to independently leverage funds for higher-impact projects through capital spending, LDRD spending, or new talent. To be clear, this working group does not propose that DOE and Congress give up control over federally funded research. Awarding the labs more authority and autonomy to decide how best to allocate overhead resources, however, would focus the interests of science and the nation on how to effectively meet short- and long-term goals. Devolving the decision-making process to those with the specialized knowledge to make the best decisions would also increase both the efficiency and effectiveness of the labs.

In some cases, OMB guidelines and statutory conflict laws may also play a role in preventing lab managers from having an efficient level of autonomy and resource flexibility, such as limits on how M&O contractors can finance infrastructure and building improvements outside of congressional appropriations.[41] In these cases, OMB and Congress should also act to modernize provisions identified by the proposed DOE task force through legislation and reform of OMB guidance.

STOVEPIPED FINANCES, STOVEPIPED VISION

The labs receive the majority of their research funding from the federal government, and while the authors differ in what the size of that funding should be, the labs are consequently beholden to Congress for continued support. But this support is delivered through a complex system of separate but interconnected funding "stovepipes." According to a 2009 NAPA report:

> DOE maintains 51 distinct appropriations from Congress with 111 separate funds or line items for its major programs and activities. Compounding this complex appropriation structure, Congress also establishes more detailed spending controls for DOE through appropriation language or specific limitations in report language accompanying the appropriation bill.[42]

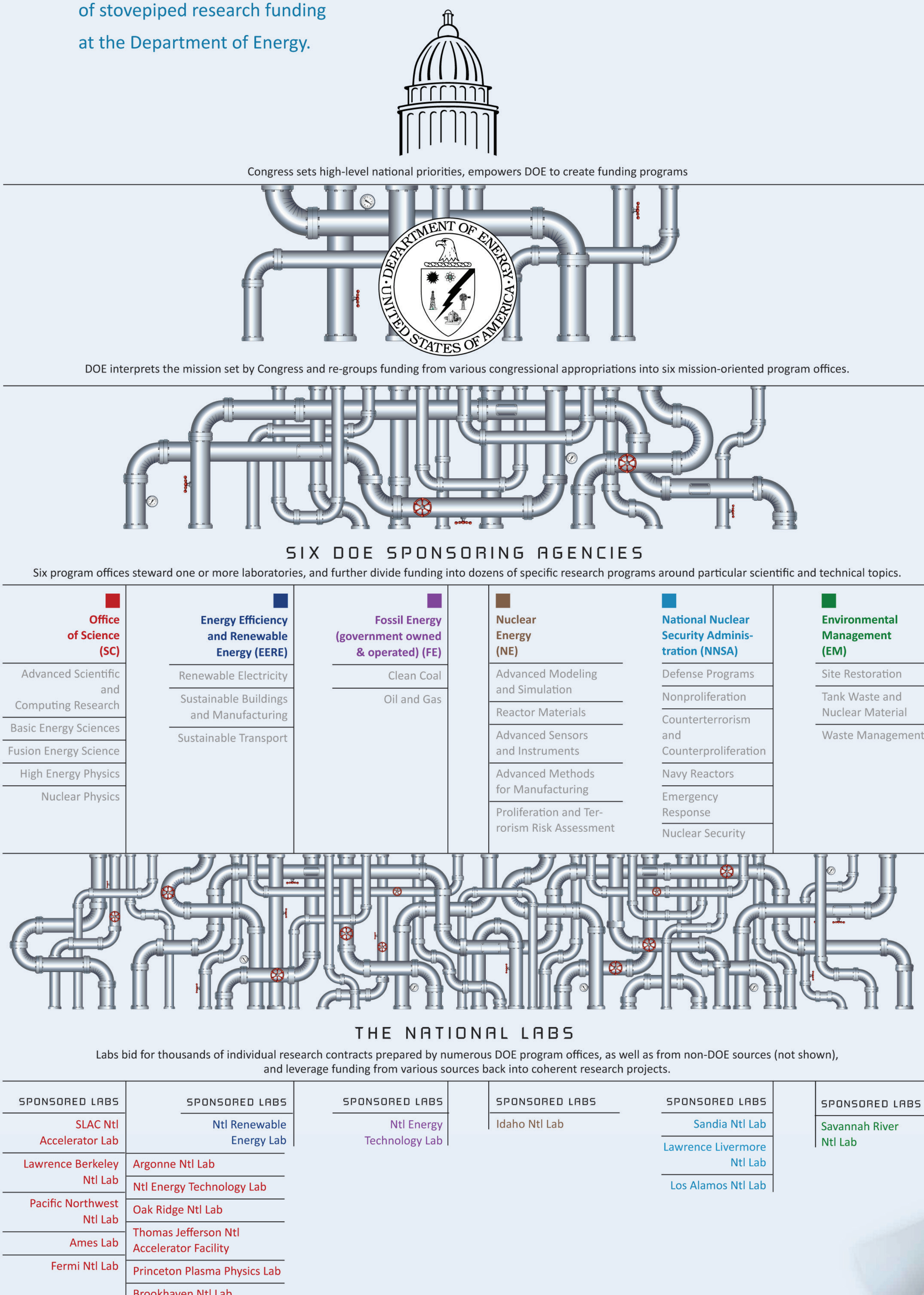
DOE organizes these lines of appropriations into six different program offices run by several under secretaries, directors, and assistant secretaries. The six offices steward the labs and competitively fund research contracts through dozens of lower-level offices and programs. In theory, this process is meant to put research experts in charge of funding and technical decisions, but in practice, it perpetuates a system where innovation is stovepiped across many research programs and bureaucratic offices. The result is a lack of research coordination and strategic planning among labs and research programs.

Money is categorized or recategorized repeatedly as it moves from a congressional appropriation to DOE's budget, through six stewardship offices, and finally through dozens of programs and thousands of specific contracts to end up in the hands of lab managers and researchers. This long and complicated resource-allocation process offers a number of opportunities to leverage efficiency gains. (see Figure 4)

BUDGET ATOMIZATION

Over the past several decades, Congress and DOE have increasingly micromanaged lab finances from a distance. Pursuant to congressional and OMB limitations, DOE has dictated in ever more detail how labs should manage, distribute, and use research funds. Program offices within DOE layer on additional control. The result is thousands of lab accounts that slice research funds into small but heavily regulated bundles, defined here as "budget atomization."[43]

FIGURE 4: Generalized breakdown of stovepiped research funding at the Department of Energy.



Research managers cobble together dozens of separate contracts to fund their work, rather than managing projects with known budgets and goals. Congress appropriates the Office of Energy Efficiency and Renewable Energy's, or EERE's, budget, for example, into 10 technology programs such as solar, wind, and water that are organized into three larger offices—Transportation, Renewable Power, and Energy Efficiency.

Budget atomization is largely due to overly prescriptive DOE and congressional oversight that emphasizes "how" research is being conducted rather than "what" the end goal of the research is. Because each institutional and research category is tasked with funding its own portfolio of technologies, the labs become locked into prearranged research pathways that may not be the cheapest, most direct, or most effective way to solve problems. Program managers focus on short-term research objectives tied to their appropriated grants at the expense of pursuing more promising but longer-term avenues of research.

This results in two immediate impacts: (1) the labs are not well equipped to engage in long-term planning to strategically support promising areas of research unless they lie within existing atomized technology categories, and (2) the labs must spend increasingly more time and overhead bidding on and managing small contracts and grants, which takes resources away from supporting promising research.

GROWING DIVIDE BETWEEN LAB STEWARDSHIP AND FUNDING SOURCES

Not only is research funding inefficiently allocated, it is also disconnected from lab stewardship. Figure 5 shows the six different offices responsible for stewarding the 17 labs. From a bureaucratic point of view, allocating stewardship in this way may make sense—labs are closely associated with the office tasked with conducting research most closely tied to the mission and core competencies of lab researchers and infrastructure. The National Renewable Energy Laboratory, or NREL, for example, conducts translational renewable-energy research; therefore, it is stewarded by EERE. Sandia National Laboratories conducts research relevant to national security, so it is stewarded by the National Nuclear Security Administration.

Lab portfolios, however, have evolved over time due to changing national needs and infrastructure, which has resulted in a growing divide between labs, their associated offices, and their primary funding sources.

FIGURE 5: DOE stewarding agencies for each lab.

LABORATORY	DOE SPONSOR AGENCY
Ames Lab	Office of Science (SC)
Argonne National Lab	Office of Science (SC)
Brookhaven National Lab	Office of Science (SC)
Fermi National Accelerator Lab	Office of Science (SC)
Idaho National Lab	Office of Nuclear
Lawrence Berkeley National Lab	Office of Science (SC)
Lawrence Livermore National Lab	National Nuclear Security Administration (NNSA)
National Energy Technology Lab	Office of Fossil Energy (government owned and operated) (FE)
National Renewable Energy Lab	Office of Energy Efficiency and Renewable Energy (EERE)
Los Alamos National Lab	National Nuclear Security Administration (NNSA)
Oak Ridge National Lab	Office of Science (SC)
Pacific Northwest National Lab6	Office of Science (SC)
Princeton Plasma Physics Lab	Office of Science (SC)
Sandia National Lab	National Nuclear Security Administration (NNSA)
Savannah River National Lab	Office of Environmental Management (EM)
Stanford Linear Acceleration Center	Office of Science (SC)
Thomas Jefferson National Accelerator Facility	Office of Science (SC)

This disconnect produces the perverse effect of splitting up DOE offices charged with overseeing the labs from the government agencies, programs, and offices that provide a significant portion of the funding. In many cases, the offices providing the bulk of research funding are not the offices providing oversight, potentially leading to uncoordinated and inefficient results. This is particularly a problem with DOE's multipurpose labs—those that conduct research across a range of disciplines—which receive research funding from a number of sources often exceeding the funding from the stewarding office. Sandia National Laboratories, or SNL, for example, only receives 55 percent of its funding from its stewarding office, NNSA. The Pacific Northwest National Laboratory receives roughly 80 percent of its funding from agencies outside the DOE Office of Science, its agency sponsor, and Oak Ridge National Laboratory receives less than half. In fact, five of the labs receive 55 percent or less of their funding from the stewarding office. The result is that lab “minority shareholders” are providing the majority of stewardship, potentially decreasing the lab managers’ flexibility to interact with other funding sources and do long-term planning for nonsteward agencies.

FIGURE 6: Funding sources for research conducted in DOE labs.[44]

LAB STEWARD	FUNDING FROM STEWARD (%)	FUNDING FROM OTHER DOE OFFICES (%)	FUNDING FROM NON-DOE OFFICES (%)	TOTAL FY 2011 COST (MILLIONS)
Ames (SC)	70.5%	15.3%	14.2%	$34
Argonne (SC)	55.3%	29.3%	15.4%	$763
Berkeley (SC)	70.1%	14.5%	15.4%	$824
Brookhaven (SC)	83.7%	9.9%	6.4%	$750
Fermi (SC)	99.6%	0.0%	0.4%	$437
Idaho (NE)	55.2%	22.0%	22.8%	$1,063
Lawrence Livermore (NNSA)	74.7%	6.9%	18.3%	$1,584
NETL (FE)	42.3%	53.9%	1.8%	$1,400
Los Alamos (NNSA)	70.7%	18.5%	10.7%	$2,551
NREL (EERE)	89.4%	6.1%	4.5%	$521
Oak Ridge (SC)	48.5%	34.6%	16.9%	$1,542
Pacific Northwest (SC)	20.8%	52.0%	27.3%	$945
Princeton (SC)	98.1%	0.0%	1.9%	$87
Sandia (NNSA)	55.1%	9.5%	35.4%	$2,438
Savannah River (EM)	55.1%	43.7%	1.3%	$2,540
SLAC (SC)	97.1%	0.8%	2.0%	$375
Thomas Jefferson (SC)	93.8%	0.3%	5.9%	$214
Average / Total	**69.4% (average)**	**18.6%**	**11.8%**	**$18,068 (Total)**

The growing divide between stewardship and funding introduces delays and additional costs into the lab system. Today labs conduct significant research for nonsponsor organizations through Work for Others, or WFO, programs. The provisions of these programs vary contract by contract and across agencies, but all include additional policies regulating cost recovery, recordkeeping, subcontracting provisions, and direct competition with the domestic private sector. WFOs also require DOE site-office and headquarter approval, adding additional layers of bureaucracy and costs onto an already bureaucratic process.[45]

As the table above shows, the lab system increasingly serves the entire federal government, as well as academia and industry, rather than only the sponsoring agency. This pattern unfortunately amplifies and perpetuates an increasingly inefficient system.

GAPS IN STRATEGIC PLANNING RESULTING FROM STOVEPIPED MANAGEMENT

The six offices that manage DOE research are each run by a director or an assistant secretary who is allowed significant independence to implement his or her own agendas, manage budgets, and interact with his or her office's stewarded labs.[46] Within the labs, parallel research budgets and authority are effectively walled off from each other, which diminish the potential for cross-lab collaboration and joint strategic planning. According to the National Academy of Public Administration, "[T]here is no comprehensive mechanism to integrate DOE's planning processes to ensure that the Department is optimizing the labs capabilities to meet the most critical needs of the Nation."[47]

To illustrate, the Office of Science publishes a 10-year plan for its user facilities and has an annual research planning process, but it does not strategically plan its broad research for the future. The National Nuclear Security Administration publishes a five-year plan for its three labs, but it is relatively limited in research scope.[48] Meanwhile, the Office of Energy Efficiency and Renewable Energy releases five-year "Multi-Year Program Plans" for each program within its purview, but does not plan annually or tie its work to the ongoing energy research at other offices.[49]

The closest DOE came to long-term strategic planning was the Quadrennial Technology Review, or QTR, completed in 2011, which assessed its energy-technology research portfolio across its offices and labs. It provided a baseline evaluation of DOE research as well as broad and modest short-term strategies across the Department. Unfortunately, it did little to actively coordinate research across labs and offices, and it was a one-time effort—the QTR was not institutionalized or developed for future iterations.

The lack of lab-wide strategic planning is made worse by the growing gaps between lab stewardship and funding. Because each lab receives funding—often more than half of its research budget—from offices and agencies other than its stewarding office, lack of strategic planning potentially leads to redundancy and missed opportunities to leverage the full research base toward solving problems.

PERPETUATION OF 'BASIC' VERSUS 'APPLIED' MYTHOLOGY

The separation of labs into so-called basic and applied program offices further complicates the funding and management issue. The reality is that most of the large basic labs within the Office of Science conduct significant amounts of applied research. The Offices of Fossil Energy, Nuclear Energy, and Energy Efficiency and Renewable Energy largely manage applied research in pursuit of solutions to problems that could potentially have commercial value in the future but that the private sector theoretically will not invest in itself. The authors disagree on the need for continued funding for many of the applied programs but do agree that creating organizational designations within the DOE bureaucracy that balkanizes research is counterproductive.

The result of fracturing the scientific process into arbitrary labels is that different offices and assistant secretaries manage basic and applied research. By extension, lab research projects are funded along this same divide, creating artificial bureaucratic and cultural barriers between research teams even if they are working on similar problems.

This distinction is at the heart of the debate over the federal government's role in research and development. Advocates for a limited role of government in research believe there is little room, if any, for the federal government in applied research. Those that advocate for an expanded role of government in research believe there is a critical federal role in nurturing a technology until it is ready for hand-off to the private sector. This creates the incentive to label and define research programs as one or the other in order to influence how those programs are perceived and funded, given the political context in which they exist.

While funding the labs (and research in general) through research stovepipes has served this ideological division well, it does not reflect the current state of science. Modern-day scientific challenges merge basic and applied research, making the distinction between the two often meaningless.[50] Applied labs conduct and publish fundamental chemical, biological, and physical experiments, while basic research often leads to unexpected commercial applicability.

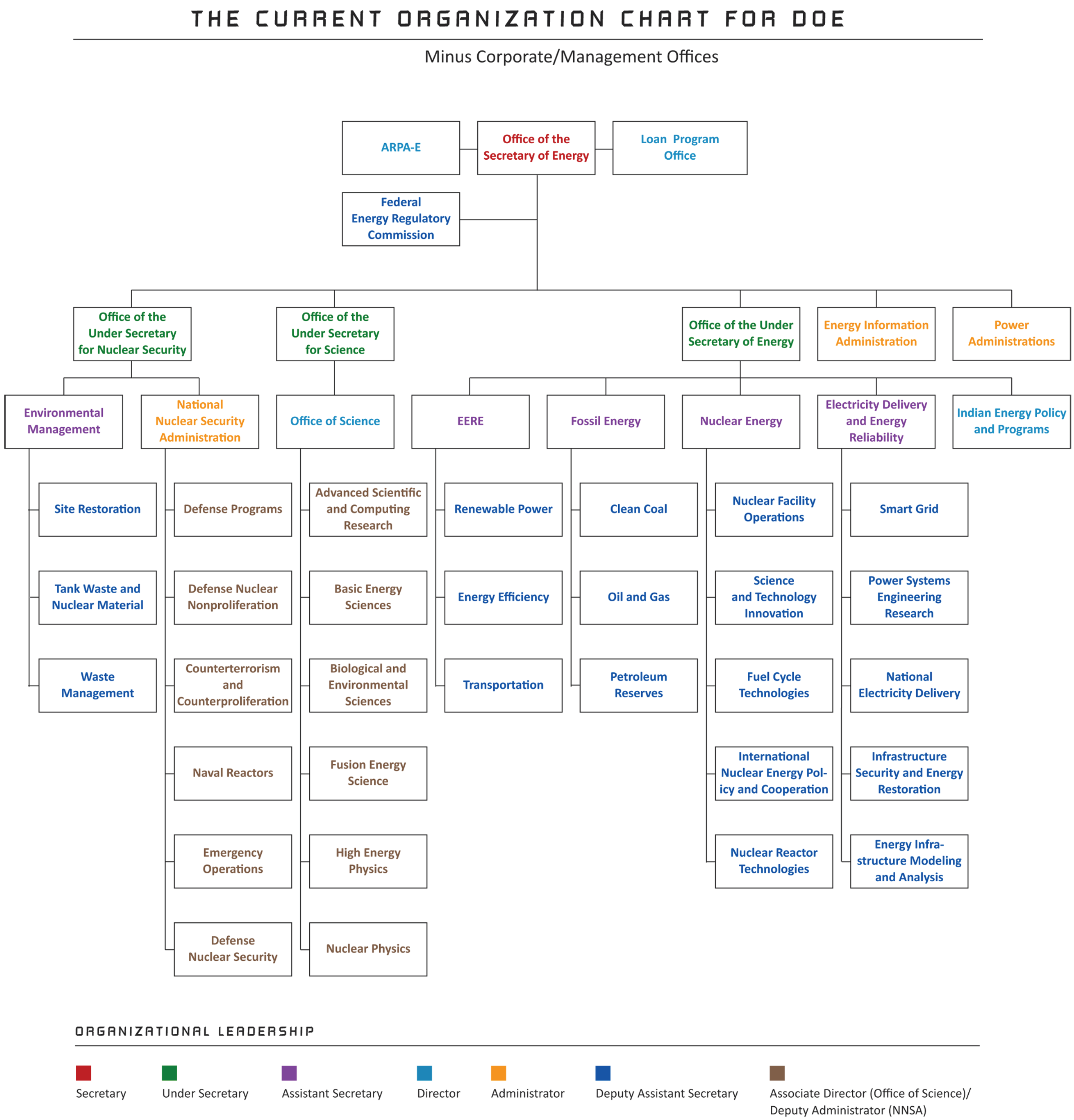
The traditional linear model of research, which views basic discoveries as discrete units moving along a conveyor belt to emerge as applied products and services at some endpoint in the future, is increasingly disregarded by modern science historians and science-policy scholars. Instead, research is better thought of as a cyclical process. Discoveries in the fundamental sciences lead to new applied technologies. At the same time, technical and market challenges faced by more advanced technologies raise new questions that only scientists can answer through feedback loops.[51] In other words, answers to questions in fundamental science inform the path of new technologies, but the reverse is also true—that the challenges faced by new technologies inform the fundamental questions we must ask of basic research. The limitations of institutional stovepiping on DOE and lab strategic planning dismantle the labs' ability to leverage potential synergies among research projects across the innovation lifecycle.[52]

RECOMMENDATIONS FOR BREAKING DOWN STOVEPIPES AND REALIGNING FINANCING AND MANAGEMENT

The stovepipes and growing divide described in this report are not new and have been created over the course of many years due to the bureaucratic layers of congressional committees, DOE headquarters, steward offices, program offices, and individual lab policies. To be fair, Congress and DOE have shown an appetite for addressing the negative impacts of these stovepipes but have come up short on developing and acting on solutions.

In 2005 Congress created a new under secretary of science to advise the secretary of energy on lab management and short- and long-term research activities funded through DOE.[53] Congress aimed to create a single entity that could look past institutional, research, and technology stovepipes and think strategically about DOE research.

FIGURE 7: Existing organizational structure of the Department of Energy, organized by office or program leadership.



Unfortunately, the implementation of the new under secretary position created a number of conflicts. First, the new position was not given direct oversight authority over all of the labs and research functions, perpetuating DOE stovepipes. Only the Office of Science—and its 10 labs— were placed under its authority, leaving three labs below the under secretary of energy and four labs below the under secretary for nuclear security. (see Figure 7) Second, Congress didn't provide the under secretary of science with any budgetary or stewardship authority, which both still rest with the director of the Office of Science. Yet, the director of the Office of Science is technically subordinate to the under secretary of science, even though the position has all necessary budget and management authority. This greatly weakens the under secretary's position and ensures that lab stewardship and funding remain divided.

A second effort was made when the Energy Innovation Hubs and the Energy Frontier Research Centers were created in 2009 to address complex problems with larger appropriations that connected offices and labs.[54] These new programs purposely cross stovepipes by bringing together research from labs, universities, and industry to solve highly complex, multidisciplinary science and technology issues. But these adaptations simply *circumvent* stovepiping and are largely one-off programs, leaving the rest of the labs to fall under an inefficient and outdated system. The bulk of research remains funded by stovepipes.

CREATE A UNIFIED OFFICE OF SCIENCE AND TECHNOLOGY

Breaking down DOE stovepipes requires more than adding layers of new programs on a broken infrastructure or tweaking the existing infrastructure. Congress has tried both and failed. More complex, potentially difficult, and comprehensive institutional reform is needed.

To achieve that reform, Congress should merge the under secretaries of science and energy into one under secretary of science and technology and include relevant budget and stewardship authority. (see Figure 8) In practice, this reform would place 13 of the 17 labs under one leadership office, instead of splitting control of the majority of the labs between many authorities.

Unifying both silos allows for two important changes. First, Congress should task the new under secretary for science and technology to develop and implement a single, expanded PEMP process (discussed in detail on page 23) for its 13 labs. This would allow a single DOE negotiating partner to work with 13 M&O contractors, and it would establish a coherent and unified set of program-management and performance guidelines that could instill the expanded contractor accountability, or trust-but-verify system described above.

Second, Congress should task the new under secretary for science and technology to develop a unified strategic planning process across its 13 labs, so that the strategic plan of each individual lab is incorporated into a system-wide effort that produces annual 5- and 10-year research and facility plans and budgets. These reforms will only be functionally institutionalized under unified leadership for all science and technology labs.

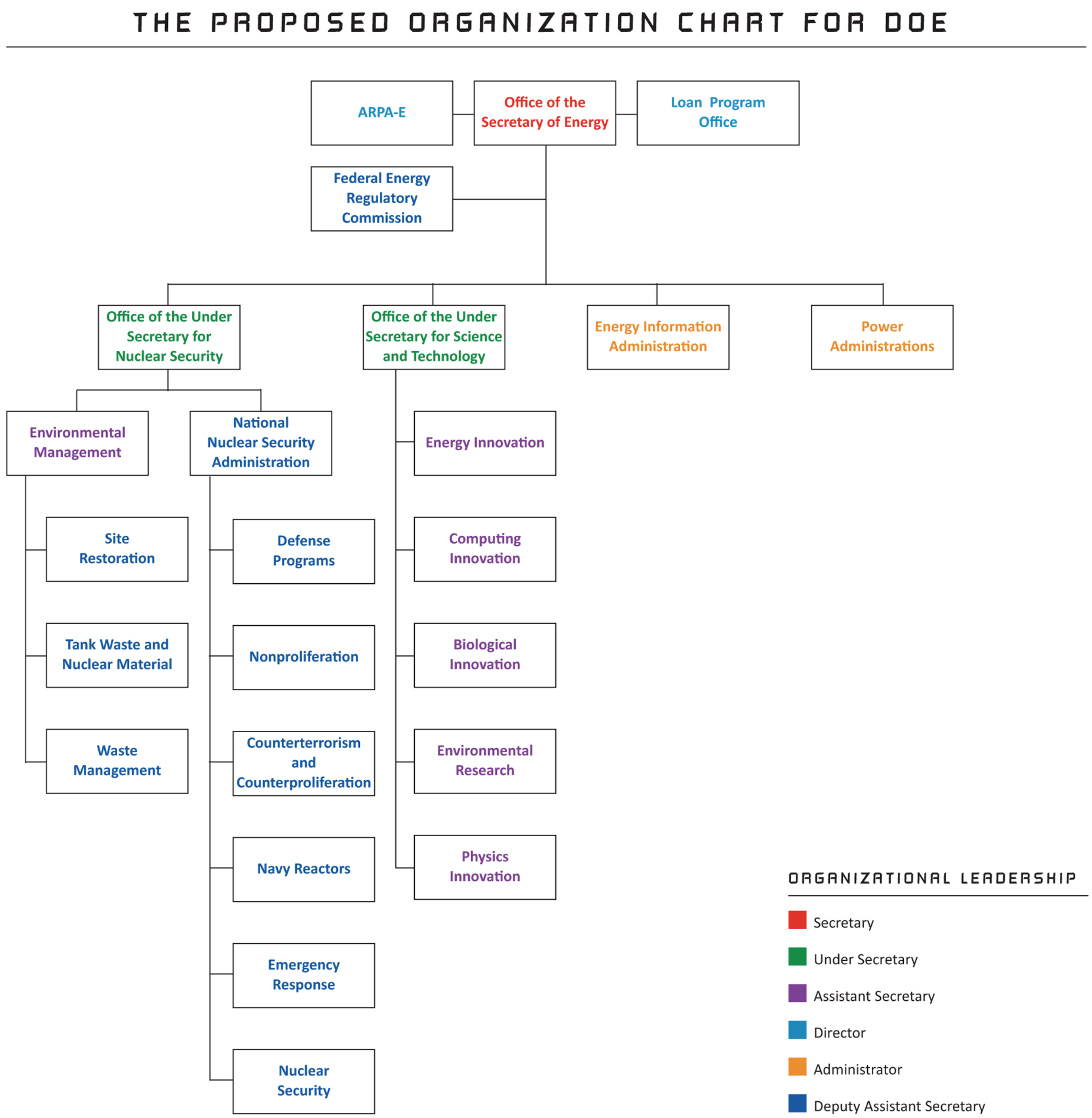
Uniting nearly all lab stewardship and financing functions under a single office enables a unified management philosophy that recognizes the interconnected nature of the many fields of science and engineering research that occur at all of the labs, as well as the diminishing significance of lines between different scientific disciplines.

COMBINE RESEARCH FUNCTIONS UNDER THE NEW OFFICE OF SCIENCE AND TECHNOLOGY

Additional reform is needed to address research stovepiping and budget atomization (the thousands of buckets of funding), even within a unified Office of Science and Technology.

Institutionalizing a unified under secretary for science and technology opens the door to integrating the research functions managed by the existing Office of Science and under secretary of energy structure. There are six basic research programs managed by the director of the Office of Science, for example, and five applied research programs managed by assistant secretaries underneath the Office of the Under Secretary of Energy. Unifying the research conducted among these entities would lead to new synergies across intrinsically related fields. The Office of Basic Energy Sciences within the Office of Science and the Office of Energy Efficiency and Renewable Energy underneath the under secretary of energy, for example, are both investing in new energy storage and battery research and yet are managed by separate bureaucracies.

FIGURE 8: Proposed DOE organizational structure, organized by office and program leadership.



Congress should therefore replace the basic and applied research offices that artificially divide programs with a set of new offices focused on broad innovation areas. These might include the Offices of Energy Innovation, Computing Innovation, Biological Innovation, Physics, and Environmental Research. Within these, grant makers and program managers can award funding to the best projects based on merit regardless of where they sit within the innovation lifecycle. A more integrated approach to science and technology would help improve the mission impact of the office, compared to the stovepipe structure perpetuated today.

To be clear, this working group is not proposing an explicit model for program-level reorganization, and the structure proposed in figure 8 is meant only to be illustrative, not definitive. Instead, it proposes that Congress combine the various research functions within the two offices to better link science and technology development, identify research overlap, and promote general organizational efficiency. It is not as simple as merging existing programs and offices. Deciding what these new programs should look like requires a larger stakeholder discussion among the research community, private sector, and universities to ensure that Congress and DOE are implementing a more synergistic organization.

Nonetheless, Congress should follow three high-level guiding principles for program-level reorganization:

1) Research programs should aim to address broader science and technology problems rather than specific technologies.

2) As a result, instead of funding very small grants with incremental goals based on preprescribed methodologies, DOE should work to fund larger projects focused on achieving certain goals, allowing lab research and management teams to devise the solutions.

3) Avoid bureaucratic structures that promote special-interest research, which could include research that subsidizes private interests otherwise lacking in technical merit or market rationale.

A NOTE ON THE NATIONAL NUCLEAR SECURITY ADMINISTRATION AND OFFICE OF ENVIRONMENTAL MANAGEMENT

While other DOE functions, such as the Energy Information Administration, Federal Energy Regulatory Commission, Loan Programs Office, Advanced Research Projects Agency for Energy and the four power administrations could also be reorganized as part of the creation of an Office of Science and Technology, the focus of this report is on unifying the lab-based research functions of DOE. To that effect, creating a new Office for Science and Technology within DOE would effectively unify the planning, stewardship, and funding of 13 of the 17 labs. The working group proposes that the four remaining labs—the three labs stewarded by the National Nuclear Security Administration and one lab stewarded by the Office of Environmental Management, or EM—continue to be managed and funded outside of the proposed reorganization in recognition of their unique research focus and institutional footprint.

Congress created NNSA as a semi-autonomous agency within DOE in 2000 to address a number of security and espionage failures at the nuclear-weapons labs, which stoked concerns that there was a lack of DOE oversight of its national-security programs.[55] By creating NNSA, Congress aimed to insulate the weapons and security programs from DOE's policies, hiring, management, and budgeting process. The Savannah River National Laboratory, stewarded by the Office of Environmental Management, also falls under the leadership of the under secretary for nuclear security. (see Figure 7)

By all accounts though, implementing the NNSA semi-autonomous model has encountered additional criticism from Congress and is currently under review and pending potential reform legislation. Because of these special circumstances and the unique national-security and cleanup roles that the four labs—Los Alamos, Sandia, Savannah River, and Lawrence Livermore labs—fulfill, it is likely that Congress will continue to view these labs independently from their science and energy counterparts.

But these labs also conduct a broad portfolio of research in technical areas with implications and applications beyond nuclear security and cleanup. The remaining policy reforms proposed in this report, even in the absence of including them in the proposed Office of Science and Technology, are relevant to the NNSA and EM labs, particularly to their non-national security research programs. As Figure 6 showed previously, these labs leverage their significant infrastructure to conduct research outside of their national-security roots. Regardless of what Congress decides to do with the NNSA and EM structure, the stewardship, management flexibility, and technology-transfer policy reforms outlined in this report can be adopted independently at the NNSA and EM labs to boost innovation and create a more efficient and rationalized lab system. In practice, this means that the under secretary for nuclear security should be tasked with implementing the same policy reforms proposed for the newly created under secretary of science and technology and is coordinating lab stewardship processes closely with the other DOE labs.

THE MISSING LINK BETWEEN LAB AND MARKET

Applying federal lab research to solving real problems is ultimately one of the most realistic metrics available to determine the success of publicly funded research at the labs. The goal of research, publicly or privately funded, is, *ipso facto*, to advance the capabilities of the government and private sector to respond to specific mission requirements and support technology-based economic activity.

Although any given project in pursuit of fundamental scientific discovery performed at DOE may not have immediate commercial applicability, the goal should be to create a system that enables a strong link between lab-conducted research and the marketplace so that when there are opportunities, they can be realized. Unfortunately, that strong link has remained elusive. Beliefs ingrained in the research community, particularly within DOE, hold that technology transfer fundamentally detracts from the research mission. This thinking persists due to a number of policy, budgeting, cultural, and institutional barriers to interacting with industry, to actively tying potential commercial goals with research, and to leveraging the labs' vast knowledge and talent base as resources for universities, industry, and other agencies.

LAB MANAGERS HAVE WEAK INCENTIVES TO WORK WITH INDUSTRY

Industry collaboration with the labs should not be thought of as a dirty phrase when industry is picking up the tab. No one wants to see corporate welfare, but the labs directly collaborating with industry in the United States is the most expeditious way research developed in the lab is transferred to the market. Today, if industry wants to purchase time on high-value machinery or partner with specialized laboratory experts to conduct proprietary research, lab management can only charge the total research, facility, and overhead cost of doing so, rather than charge more for high-demand infrastructure and services. Nonproprietary research such as that typically conducted by universities and published in peer-reviewed journals is not charged. In most cases, partnering with an outside entity goes through a merit-review process, which places nonproprietary research at a higher level of priority than paid proprietary research.

While this system works reasonably well to ensure that lab assets are available to all on a fair basis, it does not provide a strong mechanism to either capture the true value of an asset for the taxpayer or to incentivize lab managers to maximize the productivity of the labs' assets. When a lab manager is only allowed to charge a predetermined fee for a service that has value to a third party, for example, one of two things is likely the case. If the fee is too low, the taxpayer is subsidizing the third party and losing the value of that asset. If the fee is too high, the facility will be underutilized, and only resource-rich parties will be able to access the facility.

A market-based approach would fix both problems and create additional benefit to the taxpayer. Though ensuring that government requirements always take precedence, a market-based approach would provide greater value to the taxpayer, promote a more efficient use of excess lab capacity, and facilitate cooperation between the labs and the private sector for mutual benefit. The key to such an approach is for lab managers to be permitted to set the facility access and other fees for all nonfederal government parties based on market demand.

Currently, when a lab generates nonappropriated funds through third-party cooperation—such as intellectual property licensing fees or a user facility fee—those dollars are used either to directly offset the cost of the exact capability being used, to reinvest in lab maintenance and overhead, or is distributed to the Treasury Department General Fund.[56] Additionally, funds should be able to provide an additional incentive, such as a fee bonus, to the management contractor. Instituting a more flexible, market-based approach would allow for some perhaps substantial increase in these types of funds. Although their distribution should be consistent with current law, specifics should be negotiable based on each cooperative agreement.

The benefit to the taxpayer is potentially significant. First, taxpayer spending for lab overhead or other costs will be reduced as labs raise more funding from increased utilization of capabilities. Not only can this result in reduced spending, but it will also lead to better maintenance of the public facility, as lab managers can direct spending to where it is most needed. A market-based approach would also generate competition between the labs, which will seek to attract users for their facilities and cooperative arrangements to develop research for any excess capacity. This competition could result in more vibrant and state-of-the-art facilities on one hand, while clearly distinguishing those that have little value on the other.

A market-based approach to managing laboratory assets would allow for a significant expansion of lab capabilities—or contraction if there was not market for it—by determining a market value of the labs' excess capacity. This system would allow those technologies developed within the labs as part of their core missions that may lead to commercial applications to being pulled into the private sector.

Of course, as good stewards of government-owned facilities, the contractor would be accountable for making specialized capabilities available first and foremost to its government sponsors. To protect national security, all third-party cooperative efforts would continue to be subject to the same laws and protections that govern lab-industry agreements today. It is also worth noting that this report does not recommend that DOE's National Nuclear Security Administration necessarily adopt these reforms, though the working group would consider many of these recommendations appropriate for the NNSA labs.

Care must also be taken to ensure that university and other public-sector, nonproprietary research continue to retain a strong carve-out at user facilities and other lab capabilities in order to meet demand and fulfill the core mission of promoting scientific inquiry and research. But increased flexibility for the management and pricing of specialized capabilities would allow labs to extract more value from their capabilities while ensuring that the capabilities are better rationalized by market needs.

INCONSISTENT LAB-INDUSTRY AGREEMENTS

DOE has created, at Congress's urging in some cases, a number of tools the labs can use to collaborate with industry, including Work for Others Agreements;[57] Cooperative Research and Development Agreements, or CRADAs; User Facility Agreements, or UFAs; Other Transaction Agreements, or OTAs; and direct technology licensing through offices of technology transfer. In 2012 DOE created a pilot program called Agreements for Commercializing Technology, or ACT, which gives the labs more flexibility to negotiate with research partners. These agreements and the limitations of each are described in Figure 9 below.

Issues with the labs collaborating with industry persist, however, owing less to problems in the legislation and more to how each of the labs and DOE carry out these agreements. A report by the Government Accountability Office in 2009 found that, "policies defining technology transfer are unclear and headquarters and laboratory officials do not always agree on which activities should be included."[58] Each federal agency independently interprets how to carry out the agreements outlined by law. By extension, each DOE stovepipe and lab also interprets how to carry out industry agreements as long as it fits within the statutory guidelines.

From industry's perspective, interacting with the labs is not as simple as negotiating within the framework of the five or six different DOE-lab-industry agreements. Over the years DOE has implemented increasing layers of requirements needed to process agreements. And nearly all technology-industry partnership or technology-transfer agreements require preapproval from the Department of Energy. By one account, the Idaho National Laboratory catalogued 110 requirements that the lab and researchers must meet to facilitate technology transfer.[59]

FIGURE 9: Summary of existing lab cooperative research agreements compared to characteristics of proposed changes to cooperative agreements (last column, red text).

AGREEMENT → ATTRIBUTES ↓	COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT (CRADA)	WORK FOR OTHERS (WFO)	USER FACILITY AGREEMENT (UFA)	OTHER TRANSACTION AGREEMENT (OTA)	AGREEMENT FOR COMMERCIALIZING TECHNOLOGY (ACT)	PROPOSED PRINCIPLES FOR CONTRACT MODELS
DESCRIPTION	Collaborative research project with an outside partner where both parties provide some resources and conduct some work to solve a shared problem.	Non-standard contracted work for an outside party. For example: running a chemical analysis of a material for a 3rd party and sending results back.	Agreement to use pre-approved "user facilities" that DOE and the lab maintains explicitly for outside collaboration. These are the easiest to use agreement types.	An unusual agreement form for non-standard partnerships that must be negotiated by DOE HQ and approved by the secretary.	A new agreement created in 2012 and being piloted in some labs that allows the contractor more flexibility in assuming risk in exchange for more flexibility.	Agreements should treat lab capabilities more like user facilities: plug and play. Contractor should be free to manage lab resources in best interest of contractor and DOE, subject to annual review process.
INTELLECTUAL PROPERTY	Participant and contractor each retain their own copyrights, patents, and generated technical data. Undivided rights to jointly developed IP in the agreement.	Sponsor has the ability to own all copyrights and patents generated from work UNLESS DOE denies patent waiver. Sponsor can generate new proprietary information and protect any information brought in from outside the agreement.	User and contractor each own their own copyrights, patents, and data. Undivided rights to joint IP. Under a proprietary UFA, user can keep proprietary information, otherwise: no.	DOE has the ability to negotiate copyright rights, patents, and proprietary information on commercially reasonable terms.	Lab contractor has the ability to negotiate copyright rights, patents, and proprietary information on commercially reasonable terms	Contractors should be free to negotiate IP terms on DOE's behalf. DOE involvement only required for government IP from outside the lab. In general, funder should own IP.
COMPETITION WITH INDUSTRY (FOR FEDERAL WORK)	Not allowed	Not allowed	Not allowed	Probably not	Possible – only if a non-Federal partner is involved	Not allowed.
RISK SHARING BETWEEN CONTRACTOR AND INDUSTRY	Yes: Participant indemnifies Government and Contractor	Yes: Sponsor indemnifies Government and Contractor	Yes: User indemnifies Government and Contractor	Yes: but DOE must negotiate risk.	No: Contractor bears all risk and may indemnify participant.	Contractors should be allowed to negotiate risk in all agreements.
FEE STRUCTURE	Parties pay for their own costs unless 100% of funds coming from participant. No fee/incentive to contractor	Full cost recovery to lab only; no fee/incentive to contractor	Non-proprietary: No cost recovery; Proprietary work: Full cost recovery to lab, no fee/incentive to contractor.	No fee to contractor, other terms negotiable with DOE.	Contractor can negotiate terms and fee with user, and assumes risk.	Contractors should be allowed to charge a market rate on own behalf or behalf of the Lab as appropriate. All other pricing terms negotiable by contractor on behalf of DOE.
DOE REVIEW AND APPROVAL	Yes	Yes	No	Yes: Secretary level review.	Depends	Not required.
MULTI-LAB AGREEMENTS POSSIBLE	Yes (only with significant DOE involvement)	Yes (only with significant DOE involvement)	No	Yes (determined and negotiated by DOE)	Yes	Should be encouraged and allowed without DOE involvement.

DOE site offices add yet another layer of interpretation that industry must navigate. As a result, partnering with industry can be as complex as negotiating within the four agreements interpreted 17 different ways (or 68 different agreements in addition to site-office interpretations). This leads to significantly different forms and industry payments for lab research, indemnification provisions, liability, and intellectual property, among other areas of negotiation.

DOE has partially responded to these issues by creating the ACT pilot program, which ameliorates many negotiating issues by allowing the labs to agree to more flexible partnership terms, which dramatically shortens negotiating turnaround time. Most importantly, it allows the labs to offer performance standards at the contractor's own risk in exchange for a fee.

Under ACT, DOE receives advanced payment for research costs, and lab contractors are allowed to collect an additional fee for taking on specific performance risks above what DOE is typically willing or able to take. In essence, it incentivizes the labs to interact with industry and provides a simpler system in which to do so.

Unfortunately, the ACT agreement—unlike CRADAs and WFOs—is limited to lab research partners that do not receive federal funding. In other words, if a company receives federal funding—such as a defense contractor, small business innovation research grantee, or biotechnology company working with National Institutes of Health funding—it is not eligible for the more flexible, performance-based ACT agreement. This limits the potential impact of ACT, since the kinds of technology companies would typically want to partner with the labs also tend to be the kinds of companies that are working within the federally funded R&D system.

As a result, the existing tools available to the labs for partnering with industry are too costly, rigidly applied, and time intensive.[60] According to the Science and Technology Policy Institute, or STPI, the convoluted steps industry must take to partner with researchers results in a situation where "industry is largely unaware of opportunities to collaborate with the federal laboratories."[61] Larger corporations may be able to work around these roadblocks (but often do not), but smaller companies with limited budgets and staff aren't able to do so. According to STPI, "New companies, especially small businesses, may not have the resources required to perform intensive searches to know what technologies and capabilities the laboratories have."[62]

In addition to lack of awareness and poor marketing, the complication of the process is also a barrier. Because of restrictive regulations and increasingly onerous DOE oversight, for example, through headquarters as well as the site offices, it often takes three to six months to complete a collaborative industry agreement—more time than many companies are willing to wait because of short business and product-development cycles, particularly for small technology startup companies.

CONFLICT-OF-INTEREST LAWS QUASH CULTURE OF ENTREPRENEURSHIP

Conflicts of interest are a serious problem, and proper enforcement of laws to ensure that taxpayers support research for the common good above private profit is a must. An example of a conflict of interest is if a lab researcher simultaneously owns a stake in a company that stands to profit from the research he or she is doing for the lab. But overly conservative interpretations of conflict-of-interest laws effectively prohibit many forms of potentially useful collaboration between researchers and industry partners, prevent researchers from doing their best work in their field of expertise, and create a barrier between research and practice.

Part of the problem stems from lab legal counsels' different interpretations of conflict-of-interest laws. Similar to industry-partnership agreements, this disconnection results in different labs adopting divergent policies based on a reading of the same legal text. The Stevenson-Wydler Technology Innovation Act is clear about encouraging the labs to be proactive in resolving conflict-of-interest issues.[63] Yet many restrictive conflict laws remain on the books, and interpretations of how to enforce these laws vary from lab to lab. This makes it difficult for researchers to form innovative partnerships and creates the misconception that such partnerships are morally or ethically dubious.

The Stevenson-Wydler Act also asks the labs to:

> [E]ncourage … the development of technology through the recognition of individuals and companies which have made outstanding contributions in technology; and encourage the exchange of scientific and technical personnel among academia, industry, and Federal laboratories.[64]

The bill even explicitly spells out how funding could be used to develop curriculum around entrepreneurship. The spirit of the act is unambiguous about encouraging agencies to work to eliminate unnecessarily restrictive conflict-of-interest policies. Nonetheless, these congressionally mandated directives have never been implemented to the fullest extent possible, and the culture at the labs remains skeptical and conservative when it comes to the commercial application of public knowledge.

The working group recognizes that many of the labs have "entrepreneurial leave of absence" programs and monetary rewards for technology transfer.[65] These incentives are a small step toward helping create a culture that is as open to technology transfer and entrepreneurship as it is to scientific inquiry. But there remain numerous examples of lab researchers forbidden from doing research in a field in which they have prior professional history. Lab researchers who own a patent on technology related to their field of expertise, for example, face many disincentives to working in that field for the labs—even if that is their field of greatest expertise.[66] This has the unintended consequence of preventing preeminent scientists from operating at their full potential, robbing programs of the best talent.

LAB-EVALUATION METRICS DISCOURAGE TECHNOLOGY TRANSFER

In addition to weak incentives for individual researchers, the lab managers themselves do not have strong incentives to think creatively about the commercial applicability of their research and capabilities. Two issues with lab metrics complicate technology transfer: the lack of weight placed on technology transfer in lab-wide evaluation procedures and the lack of good metrics used within these evaluation procedures to measure technology transfer. Despite the congressional mandate to promote technology transfer and economic outcomes, DOE holds technology transfer as a relatively low priority on the annual PEMP report cards.[67]

While technology-transfer metrics are included in the report card, they only account for a very small share of the overall grade. (see Figure 10) In fact, technology transfer is not even one of the main eight criteria used for evaluation and is instead listed as the fifth bullet point underneath the sixth criteria titled Business Systems. It also carries scant weight. As a result, the labs are not encouraged to invest time, energy, or resources in facilitating technology transfer, despite potential financial upsides.

FIGURE 10: Office of Science PEMP accountability metrics.

1.0	Mission Accomplishment
2.0	Design, Fabrication, Construction and Operations of Research Facilities
3.0	Science and Technology Program Management
4.0	Sound and Competent Leadership and Stewardship of the Lab oratory
5.0	Integrated Safety, Health, and Environmental Protection
6.0	Business Systems
7.0	Operating, Maintaining, and Renewing Facility and Infrastructure Portfolio
8.0	Integrated Safeguards and Security Management and Emergency Management Systems

In addition to being given little weight in the evaluation, the metrics by which technology transfer is measured at all are poorly developed. According to the Government Accountability Office, "DOE cannot determine its laboratories' effectiveness in transferring technologies outside DOE because it has not yet established department-wide goals for technology transfer and lacks reliable performance data."[68] What little measurement of technology transfer does take place is measured in terms of intermediate research *outputs*—number of licenses, CRADAs, etc.—rather than mission *outcomes*—meeting research goals, problems solved, or market impact.

The Science and Technology Policy Institute summarized this output versus outcome disconnect by saying, "Labs push technologies instead of responding to market pull."[69] Better metrics can also encourage lab Technology Transfer Offices, or TTOs, to commit to meaningful technology-transfer relationships that move technology to market and solve problems.

One metric of technology transfer that is frequently measured, for example, is the number of patent applications filed. While it seems reasonable, evaluating based on this metric creates an incentive for contractors to file many low-quality patent applications, no matter how spurious or redundant or removed from actual commercial applicability they may be. The Science and Technology Policy Institute suggests that better metrics for measuring technology transfer *inputs, activities*, *outputs*, and *outcomes* should be developed to better manage the flow of technology to market. Specifically, the lack of strong measurement and evaluation of technology transfer holds labs back from implementing the process into their research operations from the beginning.[70] TTOs are only brought into the research process if a successful project merits patent disclosures or licensing agreements—outputs—rather than actively engaging from the beginning to facilitate potential industry or government connections to accelerate technology development.

RECOMMENDATIONS TO MAKE LABS BETTER INDUSTRY PARTNERS

Relationships with industry—managed properly and with transparency—are beneficial to both the scientific and economic outcomes of research. Congress and DOE should provide the labs a consistent and flexible set of technology-transfer tools, metrics, and policy support so a higher share of public research dollars have a better opportunity to provide tangible economic and social benefits. To ingrain a culture of technology transfer and industry collaboration at the labs, new incentives are necessary to spur change. The working group proposes the following actions.

EXPAND ACT AGREEMENTS TO FEDERALLY FUNDED ENTITIES

ACT provides many of the flexible terms and conditions absolutely necessary for the labs to increase their interactions with industry. In fact, ACT has the potential to bridge many of the gaps left by existing partnership agreements. For that to happen, DOE needs to first move ACT from pilot stage to availability for all labs. Second, the Department of Energy should expand the application of ACT agreements to collaborations between a lab and a company that receives other federal funding. This would allow the labs to partner with private entities that receive other federal funding, as well as provide more negotiating flexibility for the labs in terms of risk, fee, and intellectual property with DOE preapproval. This would immediately provide the labs with a more customizable tool for working with industry and boost the number of lab-industry research collaborations.

ALLOW LABS TO PILOT NEW PARTNERSHIP MODELS WITHOUT DOE PREAPPROVAL

Under current rules, the Department of Energy must approve any agreement between a lab and a third party for cooperation, except for preapproved user-facility agreements, which are limited in scope to just a handful of specific facilities. In accordance with the shift toward a trust-but-verify accountability model (discussed on page 23), the secretary should grant labs the authority to pilot all of the partnership agreements listed in Figure 9 without transactional DOE preapproval. To protect the national interest, only those existing agreement types listed in Figure 9 would be included, but DOE should work collaboratively with labs to develop entirely new contracting templates if and where necessary and make the process of doing this simpler. The lab managers would hold ultimate responsibility, liability, and accountability for any cooperative efforts negotiated under this program.

In accordance with other recommendations made in this report, these activities may not take precedence over government-needed research. And to ensure that national security is protected, foreign partners should be subjected to the same scrutiny that they come under when cooperating with the Department of Energy on any other project.

At first, such a program should operate within a limited size and scope of allowable arrangements, financial risk, and liability terms. Beyond those basic restrictions, the M&O contractor and its negotiating partner(s) should be free to determine other conditions of the agreement such as scope of activity, fees, personnel, and ownership of any intellectual property or physical products as a result of the research, as discussed in Figure 9. The approach would maximize the lab's ability to meet market demand for its capabilities while minimizing the bureaucratic drag caused by DOE. But over time and in accordance with successful implementation, the pilot program could be expanded and eventually made permanent, giving the lab contractors much greater flexibility to actually manage the technology assets they are hired to manage.

In practice, this would allow labs to manage all of their capabilities, whether officially designated user facilities or other capabilities, in such a way that entering into agreements with industry could be done more quickly and efficiently within established frameworks that have governed such cooperative efforts in the past—but without the need for direct involvement from DOE's bureaucracy.

If a technology company wanted to rent time on a machine or make use of a key lab capability, for example, under this arrangement the lab would be encouraged to use the simplest possible agreement that satisfies both parties' needs, whether it be a user-facility agreement, CRADA, WFO, or other kind of partnership, and that agreement could be approved at the discretion of the laboratory managers directly, without the need for additional reporting to and from DOE. That is not to say that all records would not be *available* to DOE for ongoing monitoring and review, just that DOE's permission would not be required before finalizing agreements. Paperwork should not slow down the speed of innovation. Importantly, allowing the contractor to assume risk and responsibility in exchange for a fee or other compensation creates a much stronger incentive for the labs to invest in productive technology-transfer partnerships.

ALLOW THE LABS TO USE FLEXIBLE PRICING FOR USER FACILITIES AND OTHER ASSETS

The labs have the tools to interact with industry—albeit they are complex, uneven, and often onerous to implement. But the labs have little motivation to *proactively do so*. In addition to providing the labs with greater flexibility in how they partner with outside parties, a new lab-stewardship philosophy should also provide greater incentives for the labs to do so. Congress should allow the labs to charge flexible rates for services regardless of full cost recovery. This would motivate the labs to pursue technology transfer and other cooperative efforts where the private-sector willingness to pay exceeds the accounting cost of lab capabilities. It goes without saying that any additional flexibility in pricing should not preclude any existing national-security protections.

In principle, allowing for market-based pricing to guide access rationalizes the lab system. Those facilities that attract substantial outside interest at a minimum can pay for themselves, thus reducing the taxpayer burden, and could set a precedent for future self-reliance. Ultimately, if a facility or capability can attract enough investment to sustain itself through private-sector revenue, the government could consider divesting of that capability, should doing so not jeopardize a national interest. On the other hand, those facilities that attract neither public nor private funds can be closed. In most cases, however, neither of those will likely happen. Instead, the additional funds generated through market-based pricing will simply be used to offset the cost to the taxpayer for upkeep of the public facility, and the additional access to those facilities by third parties will ensure that the nation is maximizing the impact of its publicly funded research infrastructure.

Lab user facilities and research capabilities in high demand could charge more for proprietary, non-published research. As is currently the case, these additional funds could be directed toward lab maintenance and overhead through the flexible overhead accounts described on page 26 and a fee bonus for the contractor and/or given to the Treasury Department to offset taxpayer costs as described on page 43. These incentives would encourage contractors to leverage their unique capabilities in the marketplace and in their interactions with industry. Here again, high-enough demand could in theory lead to a divestiture of public resources.

Of course, care must always be taken to ensure that public-sector and academic research continues to have open access to lab capabilities at reasonable rates. This system must include safeguards to ensure industrial use of the labs does not crowd out public-sector use of research facilities. Academic and government use of the labs would continue to take precedence under this new system. In theory, fees from high-demand services and capabilities could be used to expand that capability to meet demand or to help subsidize the expansion of no-cost operations for nonproprietary research. Also, some lab infrastructure may serve the sole purpose of meeting DOE mission objectives or be central to national security and would not have industry applications. Under this model, these capabilities would continue to be funded and stewarded by the appropriate funding agency.

REFORM AND CONSISTENTLY APPLY CONFLICT-OF-INTEREST LAWS ACROSS ALL LABS

Cultivating a culture of technology transfer at the labs also requires actively praising researchers for participating in entrepreneurial activities and working to reverse the prevalent social stigma in many academic circles against collaboration with industry. As a first step to address this, DOE should provide secretary-level guidance on its interpretation of conflict-of-interest laws so that they are enforced more openly and uniformly across all of the labs, including entrepreneurial leave and exchange programs. DOE can look to its agency brethren for examples on how to do so.

The National Institute of Standards and Technology, or NIST, for example, a major laboratory system stewarded by the Department of Commerce, took steps in 2010 to reverse a draconian conflict-of-interest policy preventing researchers from participating in research in any field in which they happened to also control a patent.[71] These reforms serve as a model for broader reform to encourage lab research teams to contribute to the economy while serving their publicly guided science missions, as well as to ensure that highly skilled researchers aren't barred from contributing to lab and agency missions.

Increasing the flexibility of individual lab staff to engage with industry means extending trust to those individuals while holding them accountable for infractions. The same trusting philosophy but with verified accountability should govern the relationship between labs and DOE and should extend to individual researchers.

INCREASE WEIGHT AND IMPLEMENT BETTER METRICS FOR TECHNOLOGY TRANSFER IN EXPANDED PEMP PROCESS

Instead of waiting to see what technologies emerge from the black box of research, the labs should involve market rationale in the research planning process. The annual PEMP process currently treats successful transfers of technology to market as mere afterthoughts. Elevating this important function to its own category would have significant impacts on the management philosophy of the labs and help reverse the buildup of decades of skepticism and intransigence toward commercialization.

Certainly, some labs are better positioned for commercialization than others. The so-called applied energy labs already work more closely with industry across diverse technical areas than do the single-purpose particle physics labs, for example. As such, there may not be one exact weight that works for all labs. Instead, the weight could be negotiated through a collaborative process with the lab managers in the M&O contract during each contract renewal cycle.

Importantly, the new Office of Science and Technology could do this within the existing DOE authority. The expanded PEMP contractor-accountability system proposed earlier (see page 23 and 45) could be made to include a new, ninth category of explicit evaluation, titled “Technology Impact.” This category would evaluate the economic impact of lab-developed technology, creating a stronger incentive for lab managers to focus on market implementation of valuable government intellectual-property assets and technical capabilities. Traditional metrics pertaining to CRADAs, WFOs, UFAs, and licensing would be used as a basis for this evaluation.

In addition, the previously proposed Office of Science and Technology Policy task force (see page 24) should be tasked with developing better metrics to measure technology transfer. Things such as economic impact, job-creation impact, revenue generating from spinoff technologies, and other market impacts of lab-developed research could be included among the traditional metrics of CRADAs and patents. Implementing these changes could likely be done through executive authority alone, in the context of better implementation of the Stevenson-Wydler Act, which already calls for labs to maximize commercial outcomes of publicly funded research to the greatest degree possible without compromising the government mission of the labs.

SUMMARY OF POLICY REFORMS TO STRENGTHEN THE NATIONAL LABS

For the past 50 years, the DOE labs have served the public well and have been valuable drivers of new technology and industries. But as the nature of technology and the needs of the nation have evolved, the lab management and stewardship model has failed to keep pace. This report proposes a series of pragmatic nonpartisan policy reforms needed to ensure the labs remain effective and continue to deliver national benefits to the taxpayers. The working group's policy reforms described herein have three main goals:

- Increasing the effectiveness of each dollar spent on research to get the greatest benefit to taxpayers
- Ensuring that labs are well positioned to leverage private-sector investment in serving the national interest
- Making lab research more nimble, relevant, and accessible to public and private interests

Using these basic principles, the following is a summary of the proposed reforms to boost innovation, increase economic benefits, and rationalize the lab system.

REFORMS REQUIRING CONGRESSIONAL ACTION

THE FOLLOWING REFORMS REQUIRE CONGRESSIONAL LEGISLATION

Allow labs to use flexible pricing for user facilities and special capabilities. Congress should allow the labs to charge a market rate for all proprietary research, rather than only being allowed to charge just full-cost recovery. Additional fees raised in this way could then be directed toward incentives for the management contractor, additional lab overhead expenses, and/or the taxpayer as necessary per the management contracts. (see page 51)

Merge the existing Offices of Science, Energy Efficiency and Renewable Energy, Fossil Energy, and Nuclear into a new Office of Science and Technology. The new Office of Science and Technology would be managed by a single under secretary of science and technology with both budgeting and lab-stewardship authority. The new under secretary would fund and steward all of the DOE labs except for the four that are currently managed by the under secretary for nuclear security. (see page 37)

Coordinate the research functions of the Office of Science and those of the under secretary of energy under the new Office of Science and Technology. Congress should direct the secretary of energy to create new, broader program offices under the Office of Science and Technology for better coordination of the entire spectrum of publicly funded research. Congress should solicit comments from the research, industry, and academic communities to ensure that the new programs reflect the multidisciplinary nature of science and technology today and facilitate the integration between research and the marketplace. (see page 38)

A note on NNSA and EM labs. This working group recognizes the unique national-security circumstances involving the NNSA and EM labs and Congress's special interest in their management. Nearly all of the reforms outlined in this report can and should be applied to the NNSA labs. Given the nuances of nuclear security and the unique history of the semi-autonomous National Nuclear Security Administration, however, determining how the NNSA labs are co-managed with the rest of the labs under a new under secretary of science and technology was determined to be beyond the scope of this report. (see page 40)

Remove top-down overhead accounting rules. Congress should instruct DOE to remove prescriptive overhead accounting rules and instead provide broad categories of funding that the labs can spend as necessary. Instead of prescribing how each dollar is spent, congressional oversight should focus on the labs' ability to meet the research outcomes as described in their governing contracts. Congress should remove the cap on LDRD funds and provide a description of technology transfer that allows labs to spend overhead funds on early-stage demonstrations that either remove technology barriers limiting private-sector interest or repurpose original research for new problems. Specific details on these funding categories should be left to DOE-lab negotiations as part of the M&O contract. (see page 26)

REFORMS REQUIRING DOE, OMB, OR ADMINISTRATION ACTION

THE FOLLOWING REFORMS CAN BE IMPLEMENTED THROUGH DEPARTMENT OF ENERGY ACTION. IN ABSENCE OF DOE ACTION, THE FOLLOWING CAN ALSO BE IMPLEMENTED BY EITHER THE ADMINISTRATION OR CONGRESSIONAL ACTION AS WELL

Expand ACT agreements. Move ACT from a pilot program to one that is usable by all labs and expand the capabilities of ACT agreements to allow for greater flexibility and use with any kind of partner, regardless of whether the partnering entity receives federal funding. (see page 50)

Create a high-level task force for lab effectiveness and accountability. The Office of Science and Technology Policy should create a high-level task force with representatives from all key stakeholders in the lab system, stewarding agencies, and industry leaders who partner with the labs. The task force should assess two issues:

1. **Lab oversight to reduce red tape and speed up bureaucratic processes.** In particular, the task force would assess how to devolve greater authority to the labs themselves for self-management, reducing the need for direct DOE involvement in many day-to-day decisions, including execution of CRADAs and other partnership agreements. (see page 24)

2. **Developing better technology-transfer metrics to be implemented in an expanded PEMP process** that explicitly includes technology-to-market evaluation as a key metric for M&O contractor success, subject to each M&O contract. Both sets of recommendations could be implemented by DOE in a reasonable amount of time either by executive action or congressional mandate. Congress should implement this recommendation should OSTP fail to do so. (see page 53)

Transition to a performance-based contractor accountability model. Day-to-day management of lab operations should be managed by contractors per the M&O contract and evaluated annually via an expanded and unified review process for all the labs based on the Office of Science's PEMP process. (see page 23)

Include site-office oversight responsibilities in the M&O contract. As part of the new contractor-accountability model, site offices should be negotiated as part of the agreement between the contractor and DOE. If it is agreed that decreased or no site-office presence is needed, then DOE must act accordingly. (see page 25)

Allow labs autonomy in nonfederal funding partnership agreements. The secretary should grant labs the authority to implement a pilot program to allow lab managers to agree to cooperative efforts with third parties using preapproved contractual frameworks for research absent DOE preapproval under some circumstances. Over time, DOE approval can be scaled back under a wider variety of circumstances as contractors show themselves able to effectively manage risk for their own labs. (see page 50)

Add weight to technology transfer in the expanded PEMP process. Create a new category for the expanded, system-wide PEMP process called "Technology Impact," which would evaluate labs on the market impact of technology. The exact weight of this category would vary from lab to lab, to be negotiated upfront in the M&O contract depending on the degree of market applicability of each lab's research portfolio. Explicit details for this new category would be informed by task force recommendations. (see page 53)

Execute consistent guidelines on conflicts of interest. The secretary of energy should issue new, consistent guidance to the labs encouraging research and management teams to partner with companies and entrepreneurs so that each lab doesn't interpret conflict-of-interest laws differently and each lab provides consistent entrepreneurial leave and exchange opportunities for researchers. (see page 53)

CONCLUSION

As stated previously, the working group may not agree on research funding levels, funding priorities, or the specific role of government in technological innovation, but debating those important issues is not the purpose of this report. Instead, this report puts forth a set of recommendations that will bring greater efficiency to the DOE lab system, produce more relevant research, and increasingly allow that research to be pulled into the private sector—issues on which all members agree.

The facilities that make up the Department of Energy's National Lab system arose from diverse origins and have been tasked with a range of mission objectives over time. From their covert beginnings as places for top-secret military research, the labs have evolved to become centers of multidisciplinary research, partners with industry, and assets to society. No longer singularly focused organizations geared toward developing weapons tech-nology, the labs play an important role in innovation, competitiveness, and the technological ecosystem of our nation's government, industries, and economy.

In the 21st century, as the speed and breadth of innovation increases and as the public sector and the private sector increasingly rely upon each other to solve problems and create solutions to shared challenges, the labs must evolve. Today's scientific and technological challenges and approaches rarely fit within narrowly defined boxes, and effective research and development management requires a big-picture view of the entire technology-development lifecycle. Now more than ever, basic research methods are informing critical industrial and commercial interests, while a fast-moving marketplace is informing the questions that scientists must ask of their research.

The three sets of reforms proposed in this report are designed to better position the labs to address the realities of innovation in an increasingly competitive, globalized, and knowledge-driven 21st century economy. They will provide the labs with the increased flexibility that they need to better engage with the private sector while still ensuring strong congressional oversight.

First, increasing operational flexibility for the labs by pulling DOE back from its oversight role in every transaction is a first step toward shifting decision-making authority closer to where the research itself occurs. For half a century the GOCO model has served the United States well as a way to allow the government to set the mission and operating parameters for the labs and the most-skilled managers of the private sector to most effectively fulfill the mission within those parameters. But today the DOE's micromanagement of nearly every significant decision and transaction undermines the GOCO system. This comes at a cost to the taxpayers, dampens innovation and creativity, and ultimately brings less economic bang for our taxpayer dollars spent on science and research.

Second, the increasing complexity of lab funding and stewardship negatively impacts the United States' ability to effectively plan for solving national challenges. Three under secretaries and seven assistant secretaries decide policy for 17 labs funded through more than 100 separate congressional line items, which makes holistic and system-wide strategic planning difficult. The labs need more operational flexibility, more vision, and more dynamic leadership to tackle the nation's most significant challenges.

Third, the labs must also be able to more flexibly engage with industry and academia. Current partnership agreements are limiting, costly, and inflexible. A combination of bureaucratic micromanagement and misaligned incentives leave moving new ideas from lab to market too much to serendipity and not enough to market-informed rationale.

Implementing these reforms would be an important step toward better positioning the labs to tackle 21st century challenges. Increased management flexibility will allow the labs to do more with less. Better alignment between stewardship and funding will improve the ability for DOE to better articulate and implement strategic plans and system-wide missions. And more operating flexibility will allow the labs to make smarter decisions more informed by market realities, enter into productive partnerships, and contribute more fully to the U.S. innovation economy. The end result will be more impactful research, more economic impact, more jobs, and wiser use of taxpayer dollars.

Thomas Jefferson—himself an influential scientist whose discoveries in archaeology are still in use today—had prolific words about the need to continually renew public institutions to keep up with the progress of society:

> Laws and institutions must go hand in hand with the progress of the human mind. As that becomes more developed, more enlightened, as new discoveries are made, new truths discovered and manners and opinions change, with the change of circumstances, institutions must advance also to keep pace with the times. We might as well require a man to wear still the coat which fitted him when a boy as civilized society to remain ever under the regimen of their barbarous ancestors.[72]

It's time for the lab system to shed its 20th century coat and don new policies fit for the challenges of the coming decades.

ENDNOTES

1. Nobel-Prize-winning economist Robert Solow attributed at least half of the growth in the U.S. economy since World War II to advances in science, technology, and engineering. For a good discussion on the fundamental role of innovation to growth, see Michael Boskin and Lawrence Lau, "Generalized Solow-Neutral Technical Progress and Postwar Economic Growth." Working Paper W8023 (National Bureau of Economic Research, 2000); Robert Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics* 39 (3) (1957): 312–320; Gregory Tassey, *The Technology Imperative* (London: Edward Elgar Publishing, 2009); Robert D. Atkinson and Stephen J. Ezell, *Innovation Economics: The Race for Global Advantage* (New Haven, Connecticut: Yale University Press, 2012). The World Economic Forum, an international nongovernmental organization that assesses global business and socioeconomic policy, has also classified the United States as an "innovation-driven economy." See Organisation for Economic Co-operation and Development, "Economics: Innovation Central to Boosting Growth and Jobs" (2010), available at www.oecd.org/sti/innovationinsciencetechnologyandindustry/economicsinnovationcentraltoboostinggrowthandjobs.htm.

2. Estimates on National Lab budgets vary depending on whether totaling only Department of Energy research expenditures or also counting non-DOE and industry investment in lab research. The National Science Foundation Statistical Tables, for example, estimated that labs represented $12.632 billion in FY 2011, including stimulus spending but not NETL and SRNL. See National Science Foundation, "Federal Funds for Research and Development: Fiscal Years 2009–11" (2012), p. 46, available at http://www.nsf.gov/statistics/nsf12318/pdf/nsf12318.pdf. The National Academy of Public Administration estimated a total FY 2011 lab budget of $14.128 billion, not including NETL and SRNL. See National Academy of Public Administration, "Positioning DOE's Labs for the Future: A Review of DOE's Management and Oversight of the National Laboratories" (2013), p. 23, available at http://www.napawash.org/wp-content/uploads/2013/01/DOE-FINAL-REPORT-1-2-13.pdf. The Department of Energy disclosed SRNL's budget as $2.54 billion in FY 2011. See Doug Hintze, "Presentation to the SRS Citizens Advisory Board: Budget Update and Integrated Priority List" (U.S. Department of Energy, 2013), available at http://cab.srs.gov/library/meetings/2010/fb/hintze_cab_budget_ipl_update.pdf. NETL disclosed a FY 2012 budget of $815 million in addition to $600 million for managing EERE's Project Management Center. See National Energy Technology Laboratory factsheet at http://www.netl.doe.gov/publications/factsheets/corporate/NETL_flyer.pdf. The working group estimates a FY 2011 labs budget of $18.068 billion, which represents their budget appropriations as well as stimulus funding. Please note that because of stimulus spending, the labs budget in FY 2011 was larger than in previous funding years.

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5. Ibid.

6. Rose Hansen, "Lending a Hand to an Oily Problem," *Science & Technology Review* (2011): 10–17, available at https://str.llnl.gov/Mar11/pdfs/3.11.2.pdf.

7. For information on the National Solar Thermal Test Facility, see Sandia National Laboratories, "National Solar Thermal Test Facility," available at http://energy.sandia.gov/?page_id=1267 (last accessed June 2013).

8. Robert Frodeman, Julie Thompson Klein, and Carl Mitcham, "The Oxford Handbook of Interdisciplinary" (Denton, Texas: Center for the Study of Interdisciplinarity, University of North Texas, 2012), available at http://www.csid.unt.edu/research/Oxford-Handbook-of-Interdisciplinarity/index.html.

9. Ibid.

10. Figure calculated from aggregate budget data described in endnote 2 using Department of Energy and National Academy of Public Administration budget disclosures for FY 2011. The total lab-system budget was estimated at $18.068 billion, and 15.8 percent of the budget was gained from non-DOE sources.

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18. National User Facility Organization, "Participation by Industrial Users in Research at National User Facilities: Status, Issues, and Recommendations: Preliminary Report" (2009), available at http://www.nufo.org/handlers/report.ashx?id=3.

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38. Office of Science, Office of Science Laboratory Performance Appraisal Process and PEMP Preparation Guidance (U.S. Department of Energy, 2011), available at http://scms.sc.doe.gov/OrbitSearch/LD/LAP/LAP_Exh1.pdf.

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THE INFORMATION TECHNOLOGY AND INNOVATION FOUNDATION

The Information Technology and Innovation Foundation, or ITIF, is a think tank based in Washington, D.C., and is at the cutting edge of designing innovation strategies and technology policies to create economic opportunities and improve quality of life in the United States and around the world. Founded in 2006, ITIF is a 501(c)(3) nonprofit, nonpartisan organization that documents the beneficial role technology plays in our lives and provides pragmatic ideas for improving technology-driven productivity, boosting competitiveness, and meeting today’s global challenges through innovation.

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