Energy & Manufacturing Competitiveness Partnership

Leverage.

Phase I Sector Study: Advancing U.S. Bioscience

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Letter from the President & CEO

On behalf of the Council on Competitiveness (Council), Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Pacific Northwest National Laboratory and Sandia National Laboratories, we are pleased to present you with a report on the Energy and Manufacturing Competitiveness Partnership sector study on *Advancing U.S. Bioscience: Challenges and Opportunities in Sustainable Energy, Environmental Remediation, 21st Century Agriculture, Human Health & Biomanufacturing*.

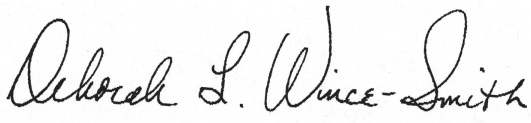
The Council's Energy and Manufacturing Competitiveness Partnership (EMCP) builds on more than a decade of leadership on energy and manufacturing policy. The EMCP is exploring the economic opportunity at the nexus of energy and manufacturing, and bioscience is an exciting and vital part of that exploration.

At the heart of the EMCP's agenda of discovery and action are sector studies that will examine industrial competitiveness through the lens of the energy-manufacturing nexus. Importantly, these sector studies seek to identify the critical cross-cutting and distinct roadblocks in **technology**, **talent**, **investment** and **infrastructure** to leverage America's energy abundance and innovation ecosystem, rebuilding national competitiveness on a strong foundation of manufacturing capacity.

Leverage: Advancing U.S. Bioscience is the fourth report to come out of the EMCP's dialogue series and related activities in year one and it provides a summary and analysis of the tremendous potential bioscience has to transform existing industries and create new ones. Advancing biomanufacturing and biotechnology to address grand scientific challenges for energy, the environment, human health and agriculture requires a strategic, aggressive, focused and coordinated effort to reduce silos among federal agencies, industry and our national laboratories. It is for this reason that bringing together subject matter experts from key sectors—and across sectors—of the U.S. economy is so critical.

We recognize that none of this would be possible without the input and support of our members and experts that provided their valuable insights and unique perspectives and we thank you all for your continued work with us. We look forward to continuing to engage national and regional leaders in industry, academia, national laboratories and government as we capture findings and recommendations across our sector dialogues, and put forward a competitiveness agenda that leverages American manufacturing and drives U.S. prosperity.

Sincerely,



The Honorable Deborah L. Wince-Smith
President & CEO, Council on Competitiveness

Introduction

Participants of the Advancing U.S. Bioscience Sector Study at the Council on Competitiveness Office in Washington, DC.

Bioscience is a top manufacturing technology priority across the federal government and is critical for U.S. competitiveness. While the United States maintains a world leadership position in engineering biology and bioscience technology development, other countries are investing heavily in these areas putting the U.S. at risk of losing its competitive advantage.

The United States, unlike China and the U.K. among others, currently lacks a unifying roadmap to guide investment and innovation in bioscience leaving individual agencies, companies and researchers uncertain as to how best to leverage limited resources in a way that creates the most benefit out of federal investment, in the research lab and in the marketplace.

The EMCP sector study dialogue on advancing U.S. bioscience, hosted on July 27, 2016 by the Council on Competitiveness in partnership with Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Pacific Northwest National Laboratory and Sandia National Laboratories gathered national leaders and experts on the bioeconomy to discuss the importance of bioscience to U.S. competitiveness.

The day-long session focused on the actions needed to be taken in the United States to capitalize on the capabilities and individual successes across the bioscience landscape in each of the Council's four pillars of competitiveness—talent, technology, investment and infrastructure. The resulting recommendations will be incorporated into the Council's competitiveness agenda and, if adopted, will allow the U.S. to retain its leadership position in biomanufacturing—essential to economic growth and national security.

Takeaways & Recommendations

- **Develop an annual strategic roadmap for the advancement of bioscience and biotechnologies to meet energy, environmental, agricultural, national security and economic goals.** The Office of Science, Technology and Policy (OSTP), research agencies, industry, national laboratories and academic experts should partner for the purpose of creating a Bioeconomy Roadmap to be implemented as a top economic priority of the incoming administration.
- **Create tools and processes that capture and analyze basic applied research data, private sector and government-funded activities, and community feedback on the Bioeconomy Roadmap's goals, objectives and milestones.** With the 2012 National Bioeconomy Blueprint[1] as its foundation, a performance indicator document is needed to review the progress of various aspects of bioscience research on a yearly basis. Information pertaining to the success of policy and science programs such as data analysis, workforce development, regulatory barriers and future federal activities will leave researchers better equipped to establish areas of improvement and increase public awareness of the importance of the bioeconomy.
- **Coordinate investments across government agencies, broaden disbursement to cross-disciplinary fields, and focus federal investment in the development of research platforms that more quickly deliver solutions to society.** The diversity of bio-based products cuts across multiple industries like medicine, food, renewable energy, agriculture and many more, creating challenges when coordinating investments. A lack of investment among cross-disciplinary fields or in a diverse collection of industries may inhibit promising advancements, therefore hindering forward movement for bioscience as a whole.
- **Address the issue of public distrust of science and regulation by raising awareness and increasing education and outreach efforts to the public and policymakers.** The public perception of bioscience as a whole is incredibly important to moving forward, and scientists must remain ethically grounded to gain public trust. Combatting uninformed, negative perceptions requires improving U.S. scientific literacy through an education and outreach program that includes STEM education and progress metrics.

1 *National Bioeconomy Blueprint,* The White House, April 2012.

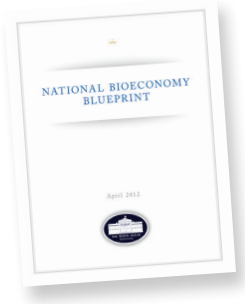
- **Provide opportunities and incentives for stakeholders to determine next generation bio-targets that biotechnologists can use to reinvent products and make them marketable to consumers.** The notion of using biotechnologies to recreate products with next generation applications, like chemicals and fuels that release fewer toxic gases into the atmosphere, simply do not have a strong enough economic value that will appeal to the consumer. Biotechnologists need a target with both next generation properties and next generation values in order to succeed in the market.
- **Develop widespread and easily accessible knowledge bases of principles, methods, processes, successes and failures to more quickly deliver helpful information to stakeholders.** Industry access to central scientific and technical resources will help experts develop and deliver new, innovative products to the market. This will improve the maturation and impact metrics of the bioeconomy and assist in the technology innovation pipeline from development in the laboratory to scaling-up in the manufacturing plants on to consumer outlets.
- **Enable bioscience research platforms to deliver novel and cost prohibitive capabilities to industry.** From start-ups to large companies, academic and agencies' scientists, federal and industry investments in research platforms and bioscience knowledgebases will help overcome the steep barriers to entry for biomanufacturing and product development.
- **Address the talent gap in multidisciplinary areas where bioscience has evolved to require frequent translation of information, updating of codes, and data management skills in high performance computing.** The bioscience talent pipeline has significantly transformed and now demands non-traditional biologists who have trained skills in multidiscipline areas. There must be a frank dialogue among industry and academic leaders about workforce development so we can reestablish training and employment opportunities for graduating students and continue to expand science beyond its current capabilities.

Setting the Stage

Research and development in bioscience plays a current and active role across many industries. From improving U.S. manufacturing competitiveness to advancing technologies for energy, the environment, human health and agriculture, advances in bioscience are vital to remaining on the cutting edge of technological development and to enhancing American prosperity.

In recent years, policymakers have consistently demonstrated support for efforts to better coordinate and strategically plan and invest in bioscience opportunities across agencies, industry, national laboratories and academia. The White House Office of Science and Technology Policy (OSTP) has been a strong advocate for the potential of this field as evidenced by a number of programs and initiatives, including:

- The National Bioeconomy Blueprint, which



signaled to researchers, industry and policymakers the important role of bioscience research for American innovation as a major driver for economic growth, job creation, a healthier environment and stronger communities;

- The Precision Medicine Initiative (PMI), which

seeks to revolutionize modern medicine to improve health and effectively treat disease through innovative medical treatment methods tailored to a patient's genetic makeup, environment, lifestyle and other key characteristics; and

- The Brain Research through Advancing Innovative

Neurotechnologies (BRAIN) initiative, launched in 2013 to pave the way for biological discoveries and future scientific achievements in the way we prevent, treat and cure brain disorders.

Most recently, in 2016, OSTP announced a new National Microbiome Initiative (NMI) to foster the integrated study of microbiomes and support interdisciplinary research, develop platform technologies and expand workforce in this key area.

These initiatives identify some of the opportunities and benefits to the nation that bioscience may deliver with better integration, collaboration, sharing, the building and exploiting of existing competencies among stakeholders and new investments in people and resources. They are not necessarily, however, roadmaps that can guide policymakers, as they make funding and programmatic decisions across the larger breadth of bioscience and biotechnology development.

The nation's siloed approach to research and development among multiple agencies and departments, and among multiple Congressional committees, makes the development of a common and useful roadmap across the government very difficult to develop and implement. Unfortunately, this gap has international competitiveness implications and stymies U.S. economic activity and growth.

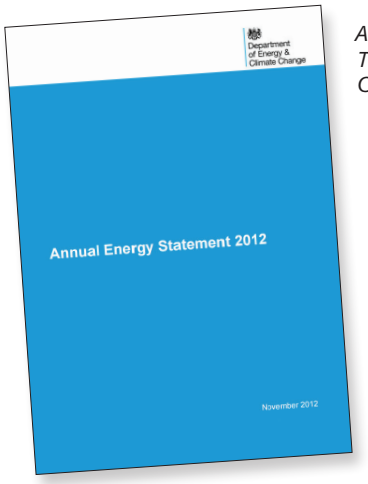
A Global Competition

Bioscience already plays an integral role in the U.S. economy. It has the potential, however, to play an even larger role in enhancing U.S. competitiveness if the nation undertakes a more sophisticated and integrated approach to strategic planning and collaboration that includes increasing targeted investments and developing clear goals and objectives.

A number of countries have recognized the importance of undertaking such an approach and have developed strategic plans and detailed roadmaps with the clear goals, objectives and milestones needed to strategically advance the bioeconomy. One such example is China's 12th Five Year Plan, which calls for hundreds of billions of dollars in funding for research and development in biopharmaceutical, bioengineering, bioagriculture and biomanufacturing R&D. The plan aims to strike the right balance between the seed corn of basic science and the technology development needed for commercial application.[2]

The United Kingdom has also invested resources in building a world-leading bioeconomy. The U.K.'s roadmap, issued by the government in 2012, looks at the opportunities and challenges of biotechnologies from basic science challenges to real world applications, regulatory considerations and health, safety and environmental issues.[3] Although funding allocated to these efforts in the U.K. is significantly lower than in China, the U.K.'s access to top talent, focused approach and clear deliverables are helping to build a strong foundation of scientific leadership and entrepreneurial progress.

Robbie Barbero, Assistant Director, Biological Innovation, Office of Science and Technology Policy (OSTP), delivers opening remarks on the context of bioscience in energy and manufacturing.



Annual Energy Statement 2012, The UK Department of Energy & Climate Change.

In comparison, the United States lacks a unifying roadmap and its efforts are often uncoordinated and disjointed rather than strategic and long-term. The absence of a clear and coordinated approach leaves individual agencies, companies and researchers uncertain about which investments and which lines of inquiry may bear the most fruit.

2 *Full Transmation of China's 12th Five-Year Plan*, The CBI, 2011.

3 *Annual Energy Statement, 2012*, U.K. Department of Energy & Climate Change, November 29, 2012.

Stakeholder Dialogue

Advancing U.S. Bioscience—Infrastructure

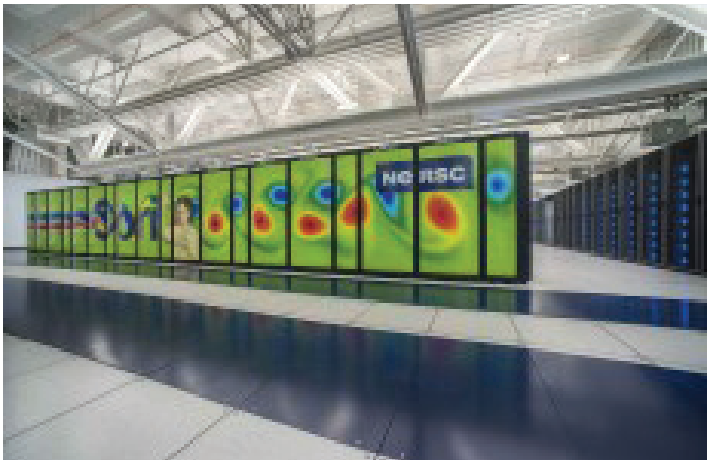
As a global leader in engineering biology and biotechnology development, the United States has developed extensive infrastructure to support development in bioscience. One of the foundations of this infrastructure has been the Department of Energy's national scientific user facilities, which act as creation hubs for the nation's leading scientific research experts, igniting scientific discoveries and technological advancements for the future. By bringing together multi-disciplinary researchers, these facilities enable a level of scientific research that goes beyond the means of most individual corporations or universities.

The United States' advanced capabilities in high performance computing (HPC) are another key component of the bioscience infrastructure. Modern day bioscience research is increasingly dependent on the accumulation and manipulation of huge sets of data, rendering HPC the backbone of bioscience infrastructure in the United States. The Department of Energy's Office of Science Advanced Scientific Computing Research (ASCR) program funds high-end computing centers at the national labs. Also known as "supercomputers," these world-class scientific user facilities support researchers from around the country, from academia and industry, by providing cutting edge computing and computational resources, as well as expertise in data management and analytics, modeling and simulation essential to building the bioeconomy.

Despite the extensive infrastructure available to support innovation in the bioeconomy, partnerships must continue to grow and mature across the board, and ensure quicker and more robust facilitation of the exchange of information not just among industry and government partners but among and within agencies of the federal government. The Obama administration's 2012 National Bioeconomy Blueprint highlights various aspects of bioscience research that must be improved including workforce development, better transitioning breakthroughs from lab to market and addressing regulatory challenges.

Top: *3rd fastest supercomputer in the world, Titan–United States. Source: Oak Ridge National Laboratory, Oak Ridge, TN.*

Bottom: *4th fastest supercomputer in the world, Sequoia–United States. Source: Lawrence Livermore National Laboratory, Livermore, CA.*



Top: *5th fastest supercomputer in the world, Cori–United States. Source: National Energy Research Scientific Computing Center, Berkeley, CA.*

Bottom: *Malin Young, Deputy Director for Science and Technology, Pacific Northwest National Laboratory, leads the discussion on the infrastructure of biosciences.*

Progress on infrastructure development must also include strengthening the entire technology innovation pipeline from research and development in the laboratory to scaling-up in manufacturing plants and on to consumer outlets. The biotechnology industry currently has a disconnected development pipeline in which the many stages within the development-deployment cycle often include multiple destinations or transportation of materials, unnecessarily lengthening the overall process.

Developing and maintaining the relevancy and leadership of the nation's infrastructure for bioscience and other research disciplines requires a multi-stakeholder approach that includes input from the scientific community, industry, academia and government. Sustained, long-term investment in this field, however, is the key to ensuring the nation's bioscience infrastructure is accessible to users and robust, reliable and relevant to today's science and technology development challenges. This requires a strategic roadmap for the bioscience community, federal agencies and other partnering entities detailing the status of current initiatives, providing feedback on performance, drawing incentives for future funding opportunities and influencing the direction of future innovations.

Advancing U.S. Bioscience—Technology

The ideal future of biotechnology is one in which bio-based products are designed with a greatly accelerated research and development process with less trial-and-error, generated from renewable materials and developed into final products complete with advanced properties like self-repairing capabilities or easy recyclability. If the United States can manage to transcend persistent barriers including misinformation, regulatory hurdles, siloed research and development and underinvestment, biotechnology has the potential to advance scientific innovation and human knowledge in ways unimaginable.

In general, biotechnologists face a number of challenges that complicate their ability to remain innovative. One of the most significant challenges to prod-

Jay Keasling, Associate Laboratory Director, Lawrence Berkeley National Laboratory.

uct development in biomanufacturing is designing for utility while also allowing for continuous improvements in performance. For example, new molecules designed with emissions reductions as the primary consumer benefit are unlikely to see long-term market success without also holding the potential to improve or enhance the product's performance. The economic driver or financial incentive is often insufficient without a concurrent enhancement in utility. Unlike consumer electronics such as cell phones or computers in which innovation and performance enhancement are often visible, simply replacing a petrochemical with a bio-based, similarly priced version is not likely to draw the attention required to drive market adoption. Biotechnologists need to design new products not only with these next-generation properties, but also with next-generation value required to succeed in the market.

One way to better align priorities and capabilities of new bioproducts is through the development of a comprehensive, open database for scientists to share solutions in a common space. Design outline templates are needed to build products, modeling and data analytics are needed to turn a design into a realistic product and, more importantly, there is a common need for automation along the molecular biology pipeline. Availability of a computer-designed molecular application could reduce the margin of error and make dissemination of new, innovative products widely scalable and automatic.

Bioscience Area equiptment at Lawrence Berkeley National Laboratory.

The competitiveness of U.S. biotechnology could also benefit significantly from the development of sensor and detection technologies that allow researchers to better understand the properties of microbiomes and their potential benefits. The same sensor and detector technologies could also allow researchers to understand and engineer new, sustainable bioproducts with greater precision and effectiveness by monitoring biological production. These technologies will be critical to developing bioproducts that provide real-world solutions to challenging issues in sustainability and drive American competitiveness.

Advancing U.S. Bioscience—Investment

The bioscience industry has the potential to become an even larger player in the U.S. economy than it is today. With an influence on energy, modern medicine, the food industry and many other sectors of our economy, the diverse bio-based products discovered

Parag Chitnis, Deputy Director, National Institute of Food and Agriculture (NIFA), U.S. Department of Agriculture.

and invented affect various areas of our daily lives. Unfortunately, this wide diversity leads to challenges in coordinating and collaborating investments.

Despite the obvious benefits to U.S. competitiveness of investing in the bioeconomy, there are a number of challenges that stifle investment. Accelerating the pace of the bioeconomy requires incentivizing potential investors who may be reluctant to finance research and development in this area due to the long time horizons for return on investment compared to other fields. There is also the persistent question of whether to solely fund large, notable institutions or smaller, start-up entities.

In addition to these barriers, funding from different government agencies tends to favor specific components of bioscience rather than the entire industry as a whole. This method may be beneficial for specific industries; however, a lack of disbursement among cross-disciplinary fields or a diverse collection of industries may leave some promising areas underresourced. This approach also tends to leave fundamental platforms that broadly enable bioscience research, such as technological development, disproportionately underfunded and therefore underdeveloped. Investment in technology development can drive the development of technological platforms that can be multi-purposed across the entire bioscience spectrum to create standard processes for biological engineering.

Coordinating investments across agencies to finance cross-disciplinary initiatives could distribute the costs associated with area-specific research and disrupt the current stakeholder fragmentation. A key challenge with coordinating investments include maintaining an agency's mission such that the types of research and development funded do not significantly overlap with another agency's mission space. Agencies also face challenges in collaborative funding because legislation mandates the funding mechanisms agencies can use, such as grants and cooperative agreements, and prevents pooled funding for large-scale challenges. While some of these challenges will need to be overcome through legislation, agencies can be encouraged to coordinate funding to address common goals. Additionally, agencies can be encouraged to fund the development of platform technology solutions that are broadly enabling in addition to the mission-specific research they already fund.

Advancing U.S. Bioscience—Talent

In an age in which biomarkers are now being used to detect disease in humans and animals and disruptions in plants and ecosystems, both of which have major implications for the future of society, attracting and retaining the right talent for the bioscience field is crucial. The talent pipeline for this field is one that has significantly transformed in recent decades. With that comes a high demand for trained biologists with multi-disciplinary backgrounds capable of navigating a broadened knowledge base.

Many of the challenges to expanding expertise in this field circulate around the idea of providing the platform for college students to transition effectively from the classroom to the industry under cross-disciplinary leadership. Students with combined knowledge make for more well-rounded professionals who are skilled in operating at intersections of biology such as bioinformatics. Traditional laboratory biology on its own is no longer an effective model as the demand for computer-savvy biologists trained with the computing skills necessary to develop data management and analysis tools continues to grow exponentially.

There are a number of reasons for the persistent skills gap in areas like biomanufacturing and bioprocess engineering, including previous shifts in federal funding which left bioprocess engineering faculty at universities across the nation without the means to continue researching and developing breakthroughs. Consequently, in recent years there have been few students trained in bioprocessing technology and even fewer experts in the field. Of the few who currently major in this area and move on to the profession, most of their career training takes place inside the companies they go on to work for, leaving significant gaps in this talent pool and a negative impact on development in biotechnology overall.

The current state of industry is not reflective of the changes that need to take place to encourage incoming talent. The translation of information, updating of codes and the communication of data between biologists, engineers and physicists are currently disrupted, making it difficult to attract students to work at this nexus of biology, engineering and manufacturing.

Of all the challenges that exist around finding the talent to fill jobs in bioscience, perhaps the most important is that science is not often hailed as a heroic or public service profession, a serious issue for U.S. competitiveness. Without science, individuals like nutritional scientists who study to fight world hunger may never exist, biologists who research rapid diseases may not be successful in creating cures, and engineers who manufacture renewable energies may not be able to help preserve our environment. Advancing the current talent pool and drawing interest from multi-disciplinary backgrounds would enable the expansion of a diverse collective of professionals needed to discover and innovate in the area of bioscience for generations to come.

Top: *Hugh Welsh, President & General Counsel, DSM North America.*

Bottom: *Sector Study Co-Chairs representing Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Pacific Northwest National Laboratory and Sandia National Laboratories meet to prepare for Capitol Hill Briefing event "Advanced Biosciences for Manufacturing: Driving Solutions in Energy, Health and the Environment" held on July 28, 2016.*

Advancing U.S. Bioscience—Bioethics

When it comes to advancing bioscience—both in the U.S. and globally—it is important that ethicality of science remains at the forefront of intentions. Attempts to alleviate problems and make the significant scientific advances bioscience can facilitate must not consider only the benefits and burdens of scientific practice but also who will benefit and *who* will be burdened.

One of the most important moral issues of our time is recognizing the dichotomy between the promise and pitfalls of advancement and innovation, particularly when it comes to bioscience. One such example is the argument that global climate change is driven by human activity, specifically the use of carbon-based biofuels. There is a persistent bioethical debate over whether or not humans have taken advantage of, or at the very least neglected to protect, our natural ecosystem in the interest of self-advancement. Such ethical debates have long been part of research, especially when considering genetic engineering for human enhancement, socially-based bioengineering and altering the natural world.

A public distrust of science is both a symptom and a consequence of such ethical debates. Education is the first step to raising public awareness and driving a large scale shift toward raising public awareness, understanding and trust of proven, scientific models and facts. Re-establishing trust and combatting ignorance go hand-in-hand with public perception and can enhance safety in the midst of an unknowable world. Ultimately, it is essential that those with the power to change the world be honest, careful and rational champions for all humanity, all while remaining ethically sound and socially conscious of the risks and benefits to scientific modification of world.

Moving Forward

This third and final sector study dialogue held during Phase 1 of the EMCP reinforced a series of common themes and recommendations that held true throughout the year one activities. As the Council's EMCP concluded 2016 with the completion of the first phase of sector studies on water and manufacturing, advanced materials and bioscience, we transitioned into the second phase of studies. This will continue with deep-dive discussions on American competitiveness and, among other key policy efforts, the Council's engagement with the new Congress and administration.

Phase 2 sector studies will continue with a strategic focus on:

Agricultural & Consumer Water Use

The Council kicked off its Phase 2 sector studies with a workshop on Agricultural & Consumer Water Use on January 11, 2017 with co-chairs Jim Hagedorn, Chairman and Chief Executive Officer of The Scotts Miracle-Gro Company and Hugh Grant, Chairman & CEO of Monsanto. This sector study focused on the challenges to innovation posed by competition between agriculture, consumers and industry for access to water. The study will also look to identify opportunities around talent, technology, investment and infrastructure that can help maximize water use and efficiency.

Energy

Our second sector study under Phase 2 addressed energy—an economy-wide competitiveness linchpin and a formidable, diverse and transforming industry in its own right. Co-chaired by Chris Crane, Chairman & CEO of Exelon Corporation and Eric Barron, President of Penn State University, the sector study looked at continuing challenges posed by evolving consumer behavior and expectations and a changing regulatory landscape while seeking to drive a more dynamic and resilient energy system in which emerging technologies lead to new business models, energy products and services that increase U.S. energy security.

Aerospace and Defense

In the second half of 2017, the Council will look at the aerospace and defense sectors, which are critical to advanced manufacturing and national security. Building on some of the findings of the EMCP's Phase 1 sector study on advanced materials, the aerospace and defense sector study will look at how advanced materials, technologies and processes will define the competitiveness of these sectors as they look to out-innovate their global competition.

Pharmaceuticals and Healthcare

As we look to build on the important findings and recommendations in this report on advancing U.S. bioscience the Council will look more in depth at the pharmaceutical sector as an energy-intensive but vibrant competitiveness driver. This Phase 2 sector study will focus on energy and manufacturing as key drivers of opportunities and efforts to reduce U.S. healthcare costs and hone a cost-edge over our global competitors.

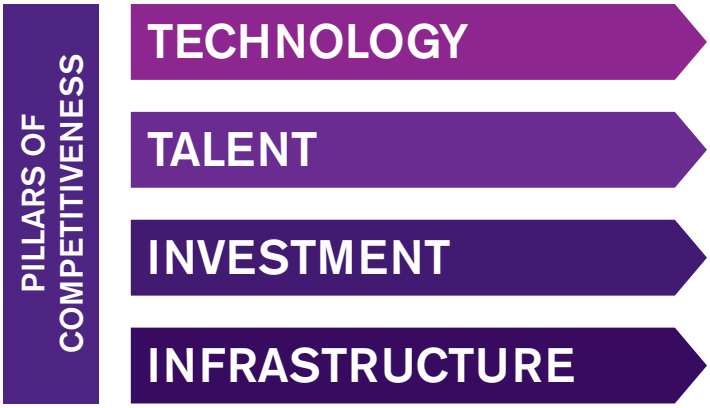
About the Energy & Manufacturing Competitiveness Partnership (EMCP)

The bioscience sector study is part of a larger initiative of the Council on Competitiveness known as the Energy and Manufacturing Competitiveness Partnership (EMCP). The EMCP unites Council members to focus on the shifting global energy and manufacturing landscape and how energy transformation and demand is sharpening industries critical to America's prosperity and security.

The EMCP taps into a diverse membership of leaders from business, academia, national laboratories and the labor community to understand the discrete and distinct challenges critical sectors of the U.S. economy face in the energy-manufacturing convergence and how decision-makers can bolster the critical pillars of competitiveness—technology, talent, investment and infrastructure.

Over the course of the three-year EMCP, the Council will develop an ambitious roadmap to focus national attention on the intersection of energy and manufacturing. Through a range of activities and dialogues such as the EMCP bioscience sector study workshop, the EMCP will deliver action-oriented recommendations to decision-makers at the highest levels of government and industry.

The EMCP is especially designed to culminate with the delivery of a concrete, 100-day action plan ahead of the 2016 national elections, detailing and prioritizing the policies, tools and partnerships the President and Congress should leverage to unleash a sustainable manufacturing renaissance in the United States.



The Energy & Manufacturing Competitiveness Partnership Concept Paper, August 2015.

About the Council on Competitiveness

Who We Are

The Council on Competitiveness is a nonpartisan leadership group of CEOs, university presidents, labor leaders and national lab directors working to ensure U.S. prosperity. Together, we advance a pro-growth policy agenda and promote public-private partnerships in the emerging "innovation ecosystem" where new technologies are born.

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How We Operate

The Council Operates by:

- Identifying emerging competitive challenges.
- Generating new policy areas to shape the competitiveness debate.
- Forging public-private partnerships to drive consensus.
- Galvanizing stakeholders to translate policy into action and change.

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Deputy Director—Science and Technology
Pacific Northwest National Laboratory

Laurie Zoloth
Professor of Medical Humanities and BioEthics
Northwestern University

APPENDIX C

Agenda

MORNING

8:30 Registration and Light Breakfast

9:00 Welcome

Deborah L. Wince-Smith
President & CEO
Council on Competitiveness

9:10 Setting the Stage: Defining Critical Goals and Objectives

Building upon more than a decade of work on energy and manufacturing policy, the Council launched the Energy and Manufacturing Competitiveness Partnership (EMCP). The EMCP work is divided into sector studies designed to gather subject matter expertise on key sectors of the U.S. economy to explore the Council's four cross-cutting pillars- infrastructure, technology, investment and talent- to produce tangible policy recommendations for future growth and development in energy and manufacturing.

William Bates
Executive Vice President & Chief of Staff
Council on Competitiveness

9:20 Putting Bioscience in Context with the Energy & Manufacturing Agenda

This dialogue will build upon the advanced bioscience research and development expertise at the national laboratories and the Council's long history of policy development and advocacy for energy solutions and manufacturing competitiveness. Central to this initiative is a reduction in the silos among federal agencies, industry and the labs that discourage collaboration and the efficient sharing of capabilities, resources and knowledge.

Robbie Barbero
Assistant Director, Biological Innovation
Office of Science and Technology Policy (OSTP)

9:30 Advancing U.S. Bioscience—Infrastructure

Infrastructure forms the foundation on which the research and implementation of bioscience occurs. This session will focus on the availability (or lack thereof) of hard assets needed to fully capitalize on the opportunities, as well as the regulatory infrastructure necessary to enable progress in this field.

Presenter:

Malin Young
Deputy Director for Science and Technology
Pacific Northwest National Laboratory

Kickoff Discussants:

Rina Singh
Senior Director, Policy
Biotechnology Industry Organization

Sharlene Weatherwax
Associate Director of Science
Department of Energy BER

Doug Friedman
Executive Director
Engineering Biology Research Consortium

10:30 Networking and Coffee Break

11:00 Advancing U.S. Bioscience—Technology

From improving the nation's biomanufacturing competitiveness to addressing grand scientific challenges for energy, the environment, human health and agriculture, this discussion will focus on the development of cross-cutting technologies and platform scientific tools that will broaden and deepen the United States' bioscience and bioengineering capabilities.

Presenter:

Jay Keasling
Associate Laboratory Director
Lawrence Berkeley National Laboratory

Kickoff Discussants:

Thomas Reed
Founder & Chief Science Officer
Intrexon Corporation

Brent Shanks
Director, Center for Biorenewable Chemicals
Iowa State University

Anup Singh
Director, Biological & Engineering Sciences
Sandia National Laboratories

AFTERNOON

12:00 Networking lunch

12:30 Bioethics Discussion

1:00 Advancing U.S. Bioscience—Investment

Over the past few years, federal agencies, the National Academy of Sciences, and the President's Council of Advisors on Science and Technology, among other groups, have published thoughtful recommendations on how the federal government can better focus and fund bioscience R&D. This session will look at new approaches to funding, organizing and leveraging bioscience research and development among federal agencies, universities, national laboratories, industry and philanthropic entities in an integrated fashion.

Presenter:

Parag Chitnis
Deputy Director, National Institute of Food and Agriculture (NIFA)
U.S. Department of Agriculture

Kickoff Discussants:

Theresa Good
Deputy Division Director, Molecular & Cellular Biosciences
National Science Foundation

Mary Maxon
Biosciences Area Principal Deputy
Lawrence Berkeley National Laboratory

2:00 Advancing U.S. Bioscience—Talent

This final session will discuss of key challenges related to the education and skills needed to capitalize on opportunities in bioscience at the nexus of manufacturing and energy, as well as attracting top students and workers from around the world to manufacturing and energy fields of study and employment.

Presenter

Daniel Peterson
Director, Institute for Genomics, Biocomputing, and Biotechnology
Mississippi State University

Kickoff Discussants:

Ken Turteltaub
Division Leader, Bioscience & Biotechnology Division
Lawrence Livermore National Laboratory

Hugh Welsh
President & General Counsel
DSM North America

3:00 Coffee Break

3:15 Connecting Key Themes & End of Day Summary

Staff will capture main themes of the day and gather closing thoughts, key ideas, and insights to facilitate a final wrap-up discussion.

William Bates
Executive Vice President and Chief of Staff
Council on Competitiveness

3:45 Conclusion & Next Steps

APPENDIX D

Advancing U.S. Biosciences

Addressing Challenges and Capturing Opportunities in
Sustainable Energy, Environmental Remediation, 21st Century Agriculture,
Human Health, and Biomanufacturing

OVERVIEW

Over the past few years, federal agencies, the National Academy of Sciences, and the President's Council of Advisors on Science and Technology, among other groups, have published thoughtful recommendations on how the federal government can better focus and fund biosciences R&D. Although the Administration and Congress have taken some initial steps to realize the potential of biosciences coordination and biomanufacturing, neither has developed a comprehensive, well-coordinated and broad program of activities, funding and goals—from basic science through applied development—that would help to maintain U.S. leadership in biotechnology and advance economic growth more aggressively in the non-health and health related biosciences. Additionally, little progress has been made in collectively examining the biosciences as a national ecosystem taking advantage of the breadth of the physical, engineering and life sciences research that goes on in the US to advance biotechnology and bioengineering leadership and solutions across all national needs – from human health to energy and agriculture.

New approaches to funding, organizing and leveraging biosciences research and development among federal agencies, universities, national laboratories, industry and philanthropic entities in an integrated fashion are needed. Through a coordinated public-private partnership approach to investments and policy initiatives, the federal government can facilitate more efficient use of R&D resources and more strategically drive investments that will drive new paradigms of biomanufacturing, advanced agriculture, human health and moving energy solutions more quickly to the marketplace.

A COLLABORATIVE EFFORT

The Council on Competitiveness in partnership with its national laboratory partners will convene on July 27, 2016, around 40 key representatives from across government, academia and industry for a daylong, invitation-only, and in-depth discussion to present specific recommendations that will speed the harnessing of advance biosciences to address national needs.

From improving the nation's biomanufacturing competitiveness to addressing grand scientific challenges for energy, the environment, human health and agriculture, this group and the discussion will focus on the development of cross-cutting technologies and platform scientific tools that will broaden and deepen the US's biosciences and bioengineering capabilities. Particularly the group will consider what shared resources and technologies will drive progress across all agencies that depend on research, development and deployment to meet their mission objectives.

The immediate goal of the discussion will be to,

Focus the attention of key policymakers, federal funders, academia, companies and national labs on the potential for advances in the biosciences through the development of platform technologies and the reduction of silos among agencies to speed and advance solutions to grand challenges and agencies' specific mission needs;

A longer-term goal will be to,

Successfully establish an ongoing initiative to explore paths forward for better coordination and more strategic leveraging of existing resources among federal agencies and the development of more widely available technology platforms to drive biosciences based solutions for energy, the environment, human health and agriculture.

Issues to be addressed include:

- Identifying roadblocks, gaps, bottlenecks, and expectations of industry, policy makers, and consumers in harnessing advanced biosciences;
- The development of platform technologies and resources and their potential application across areas of greatest potential impact;
- How to better take advantage of and leverage existing federal resources and areas of expertise to advance bioscience solutions by agencies, companies and universities;
- Examination of social, regulatory and economic issues surrounding manufacturing and the adoption of bio synthetic products;
- United States' international competitive standing in the biosciences and its impact on economic development.

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