



# NATIONAL BIOECONOMY BLUEPRINT

Executive Summary

April 2012







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“The world is shifting to an innovation economy and nobody does innovation better than America.”

—President Obama, December 6, 2011

Economic activity that is fueled by research and innovation in the biological sciences, the “bioeconomy,” is a large and rapidly growing segment of the world economy that provides substantial public benefit.<sup>1</sup> The bioeconomy has emerged as an Obama Administration priority because of its tremendous potential for growth as well as the many other societal benefits it offers. It can allow Americans to live longer, healthier lives, reduce our dependence on oil, address key environmental challenges, transform manufacturing processes, and increase the productivity and scope of the agricultural sector while growing new jobs and industries.

Decades of life-sciences research and the development of increasingly powerful tools for obtaining and using biological data have brought us closer to the threshold of a previously unimaginable future: “ready to burn” liquid fuels produced directly from CO<sub>2</sub>, biodegradable plastics made not from oil but from renewable biomass, tailored food products to meet specialized dietary requirements, personalized medical treatments based on a patient’s own genomic information, and novel biosensors for real-time monitoring of the environment. Increasingly, scientists and engineers are looking to augment biological research with approaches from other scientific disciplines for solutions to our most demanding scientific and societal challenges and seeing exciting options that will profoundly affect our future.

Technological innovation is a significant driver of economic growth, and the U.S. bioeconomy represents a growing sector of this technology-fueled economy. Agriculture, one of the country’s largest industries, is heavily based on advances in biological research and development (R&D). According to the USDA, U.S. revenues in 2010 from genetically modified crops were approximately \$76 billion.<sup>2</sup> Beyond agriculture, based on the best available estimate, 2010 U.S. revenues from industrial biotechnology—fuels, materials, chemicals, and industrial enzymes derived from genetically modified systems—were approximately \$100 billion.<sup>3</sup>

The growth of today’s U.S. bioeconomy is due in large part to the development of three foundational technologies: genetic engineering, DNA sequencing, and automated high-throughput manipulations of biomolecules. While the potential of these technologies is far from exhausted, a number of important new technologies and innovative combinations of new and existing technologies are emerging. Tomorrow’s bioeconomy relies on the expansion of emerging technologies such as synthetic biology (the direct engineering of microbes and plants), proteomics (the large-scale study and manipulation of

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1. [http://www.oecd.org/document/48/0,3746,en\\_2649\\_36831301\\_42864368\\_1\\_1\\_1\\_1,00.html](http://www.oecd.org/document/48/0,3746,en_2649_36831301_42864368_1_1_1_1,00.html)

2. The \$76 billion estimate was derived by prorating the published ERS estimates of revenue (cash receipts) from the relevant crops published here: <http://www.ers.usda.gov/data/FarmlIncome/finfidmu.htm#cashrec> by the estimated share of GM crops for each crop.

3. Biodesic 2011 Bioeconomy Update (Biodesic is a private consulting firm and sole source of data of this type.) [http://www.biodesic.com/library/Biodesic\\_2011\\_Bioeconomy\\_Update.pdf](http://www.biodesic.com/library/Biodesic_2011_Bioeconomy_Update.pdf)

proteins in an organism), and bioinformatics (computational tools for expanding the use of biological and related data), as well as new technologies as yet unimagined. There is also a set of emerging trends in recent research that foreshadow major advances in the areas of health, biological-based energy production, agriculture, biomanufacturing, and environmental clean-up.

In recognition of the potential of the U.S. bioeconomy, in 2010 the Administration included, in its science and technology priorities to inform Federal agency budget submissions,<sup>4</sup> a priority for Federal agencies to “support research to establish the foundations for a 21st century bioeconomy.” Agencies began focusing their efforts accordingly, and have made significant early progress in building a foundation for the future bioeconomy. In addition, strategic objectives that would help to enable a future vibrant U.S. bioeconomy with potential to deliver major economic and social benefits began to emerge.

The modification of biological organisms and construction and use of organisms not found in nature carry potential safety and security risks if misapplied, raising issues of responsible conduct including ethics, responsible use, and environmental awareness, among others. These advances raise important ethical and security issues that are also top priorities for the Administration, but go beyond the scope of this document.<sup>5-8</sup>

On September 16, 2011, President Obama announced that his Administration would release a National Bioeconomy Blueprint as part of his commitment to supporting scientific discovery and technological breakthroughs to ensure sustainable economic growth, improve the health of the population, and move toward a clean energy future. Modeled after the Administration’s 2011 Blueprint for a Secure Energy Future,<sup>9</sup> this **2012 National Bioeconomy Blueprint has two purposes: to lay out strategic objectives that will help realize the full potential of the U.S. bioeconomy and to highlight early achievements toward those objectives.**

The National Bioeconomy Blueprint describes **five strategic objectives** for a bioeconomy with the potential to generate economic growth and address societal needs. Although progress is being made in all of these areas, much work remains if the United States is to remain competitive in a changing world. Summarized below (and described in more detail in the second chapter of this report) are the strategic objectives and the next steps that will help realize the full potential of the U.S. bioeconomy.

### **1. Support R&D investments that will provide the foundation for the future U.S. bioeconomy.**

Although many studies show that research provides a healthy return on investment, a major justification for government investments in science and technology is to overcome market failures; these occur when private investors invest less in technology than the socially optimal level because they cannot reap the full benefits of their investment. In this context, scientific discovery is a public good that benefits all.

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4. Executive Memorandum (M-10-30) <http://www.whitehouse.gov/sites/default/files/microsites/ostp/fy12-budget-guidance-memo.pdf>

5. [http://oba.od.nih.gov/biosecurity/about\\_nsabb.html](http://oba.od.nih.gov/biosecurity/about_nsabb.html)

6. <http://bioethics.gov/cms/synthetic-biology-report>

7. [http://www.whitehouse.gov/sites/default/files/National\\_Strategy\\_for\\_Counteracting\\_BioThreats.pdf](http://www.whitehouse.gov/sites/default/files/National_Strategy_for_Counteracting_BioThreats.pdf)

8. <http://www.whitehouse.gov/the-press-office/2011/12/05/fact-sheet-seventh-review-conference-biological-and-toxin-weapons-conven>

9. [http://www.whitehouse.gov/sites/default/files/blueprint\\_secure\\_energy\\_future.pdf](http://www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf)

The pursuit of a greater understanding of natural systems yields knowledge, ideas, and technologies that the private sector can build on, sparking economic growth by giving rise to new products, services, and jobs. Coordination of Federal bioeconomy-related research activities can improve the efficiency and effectiveness of those investments and is especially important when budget growth is constrained. Coordinated strategic programs and targeted investments will accelerate progress in biological research and technology areas, and this in turn will drive discovery for an American bioeconomy.

**Moving Forward: Coordinated, integrated R&D efforts will help strategically shape the national bioeconomy R&D agenda.**

**Expand and Develop Essential Bioeconomy Technologies** – Foundational technologies have made possible unprecedented discoveries in biological research. Multiagency collaborations for emerging foundational technologies such as synthetic biology, biology-related information technologies, proteomics, and others are being fostered in order to grow the bioeconomy.

**Integrate Approaches across Fields** – The complexity of modern research questions requires that traditional boundaries between fields of study become permeable and programs concentrate expertise from diverse disciplines around societal challenges where it is needed most. The Administration will prioritize additional multidisciplinary efforts to enable biological research at the boundaries of fields, such as physics, chemistry, engineering, computer sciences, and mathematics, that support the bioeconomy.

**Implement Improved Funding Mechanisms** – Creating or modifying funding mechanisms to support creative, high-risk/high-reward research can enable researchers to pursue daring—and potentially groundbreaking—research that may be constrained by typical funding mechanisms or approaches. Agencies should further explore the use of new or modified funding mechanisms in and across agencies to stimulate the discovery of new bioinventions with potential to grow the bioeconomy.

**2. Facilitate the transition of bioinventions from research lab to market, including an increased focus on translational and regulatory sciences.**

If it is to be successful and thrive, the bioeconomy will be based on a steady flow of new products and services that address American needs. To ensure this flow, policies must be developed and taxpayer dollars must be used responsibly to foster an ecosystem that supports discovery, innovation, and commercialization.

**Moving Forward: A dedicated commitment to translational efforts will accelerate movement of bioinventions out of laboratories and into markets.**

**Accelerate Progress to Market** – An increased focus on entrepreneurship, translational sciences, regulatory science, and technology transfer can help ensure that ideas with potential for application move beyond the laboratory. Strategic, coordinated investments in translational and regulatory sciences will accelerate progress in many sectors of the bioeconomy. To capitalize on the promise of the newly reauthorized Small Business Innovation Research (SBIR) program, agencies should evaluate and update SBIR programs. Some relevant objectives include reducing application response times, hiring/training program staff to enhance relevant in-house experience, and increasing the use of industry experts as peer reviewers to evaluate industry proposals.

**Enhance Entrepreneurship at Universities** – Academic research is traditionally disconnected from its economic implications, making it difficult for innovative ideas to progress beyond the lab. Integrating entrepreneurship and industry involvement into the university research experience will facilitate the path from research to commercialization and help innovative ideas reach the marketplace. As an additional benefit, students can be exposed to the broader benefits of academic pursuits, as well as introduced to potential future careers in areas outside of academia. Innovative programs that enhance entrepreneurial activities at universities are needed to help academic discoveries become commercial realities.

**Utilize Federal Procurement Authority** – The purchasing authority of the Federal government offers opportunities to help drive some aspects of the bioeconomy. By procuring biobased and sustainable versions of products used in agency missions, the Federal government supports markets and promotes innovation, while creating jobs in rural America where many of these businesses are located and bio-products are manufactured. To drive the creation and growth of new bioeconomy markets, Federal agencies should prioritize procurement of biobased and sustainable products where appropriate and cost-effective.

### **3. Develop and reform regulations to reduce barriers, increase the speed and predictability of regulatory processes, and reduce costs while protecting human and environmental health.**

Regulations are essential for protecting human health and the environment and reducing safety and security risks associated with potential misapplications of technology. When they are not carefully crafted or become outdated, however, they can become barriers to innovation and market expansion and discourage investment.

**Moving forward: Improved regulatory processes will help rapidly and safely achieve the promise of the future bioeconomy.**

**Improve Regulatory Processes and Regulations** – Agencies should improve predictability and reduce uncertainty in their regulatory processes and requirements. To reduce costs and impediments to investments but without compromising safety and efficiency, attention should be given to application review times, sequential reviews by multiple agencies should be coordinated to allow parallel reviews, and specific guidance should be issued in response to stakeholder needs. When an emerging technology enters the regulatory process, Federal agencies must have a robust framework that identifies lead agency responsibilities, clarifies supporting agency roles, and delivers timely, specific guidance for applicants.

**Collaborate with Stakeholders** – Improved agency regulatory processes rely on productive stakeholder collaborations to identify needs and impediments to progress and investment. Federal agencies should focus on building new, and augmenting existing, stakeholder collaborations to inform efforts, streamline processes, and reduce costs and response times, while preserving safety and ensuring substantive benefit to public health.

#### 4. Update training programs and align academic institution incentives with student training for national workforce needs.

Many jobs in science and technology-related businesses remain unfilled despite high rates of local unemployment.<sup>10</sup> Opportunities exist to enhance training efforts at all levels to keep pace with changing career pathways. At the K-12 and undergraduate levels, the Administration has made significant progress in developing approaches to improve science, technology, engineering, and mathematics (STEM) education, and to increase the number and diversity of STEM students. For example, in 2009, the President launched the Educate to Innovate campaign to move American students from the middle to the top of international rankings in STEM achievements over the next decade. Building upon and expanding these efforts, particularly with regard to graduate-level training enhancements, would help to align academic institution incentives with training for future workforce needs. Also needed is the development of metrics to measure progress over time.

**Moving forward: Federal agencies should take steps to ensure that the future bioeconomy has a sustainable and appropriately-trained workforce.**

**Employer-Educator Partnerships** – Foster increased industry participation in the development of programs and in training students at all levels for the future bioeconomy workforce.

**Reengineer Training Programs** – Incentives for academic institutions to enhance entrepreneurship and restructure training programs would better prepare the future bioeconomy workforce, whether individuals are bound for careers in industry or academia. Federal agencies should develop incentives for institutions to adapt training to meet the needs of the 21<sup>st</sup>-century bioeconomy workforce. Following reengineering of training programs, agencies should consider convening industry stakeholders from various sectors to assess the success of training programs to meet the needs of employers.

#### 5. Identify and support opportunities for the development of public-private partnerships and precompetitive collaborations—where competitors pool resources, knowledge, and expertise to learn from successes and failures.

Partnerships enable private industry, government agencies, and academic institutions to pool resources and expertise around an idea, dramatically improving chances for success. Many companies do not invest in early ideas because they are unlikely to pay off immediately. This is one place where the government can play a crucial role. The President has emphasized that the Federal government, universities and companies should work together to invent, deploy, and scale the cutting-edge technologies that will create new jobs, spark new breakthroughs, and reinvigorate America today and in the future.

**Moving forward: Federal agencies should provide incentives for public-private partnerships and precompetitive collaborations to benefit the bioeconomy broadly.**

**Catalyze Public-Private Partnerships** – Great potential exists for partnerships and collaborations where sharing information about successes and failures is anticipated to generate transformative outcomes. Federal agencies are encouraged to broadly pursue opportunities for effective public-private partnerships in health, energy, agriculture, and manufacturing to leverage Federal investments and industry investments and expertise.

10. <http://www.conference-board.org/data/helpwantedonline.cfm>

