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Responses to numbered items in RFI.

(14) What specific steps can Federal agencies take to improve the predictability and transparency of the regulatory system? (Please specify the relevant agency.)

Biology is unique in its capacity for massive scale. No other programmable substrate can operate inexpensively in varied environments at the scale of continents. Many of the most important future applications in the bioeconomy will leverage this scalability and require the release of genetically modified organisms to affect the environment *in situ*. Examples include manipulating the soil microbial community to improve the yield of food and energy crops, using microbes for environmental cleanup, deploying biological countermeasures against the spread of disease viruses or microbes, manipulating the human gut microbiome to treat disease, and more.

The regulatory framework to support the deployment of genetically modified organisms (outside of plants) lacks clarity and thus companies are currently unable to shoulder the risk of developing new organisms for these applications. Specifically, the EPA should outline the guidelines for approving the deliberate release of engineering organisms other than plants into the environment.

(16) What are the highest impact opportunities for public-private partnerships related to the bioeconomy? What shared goals would these partnerships pursue, which stakeholders might participate, and what mutually reinforcing commitments might they make to support the partnership?

The US government has served as the risk-tolerant, first customer for many advanced technologies including microchips, airplanes, satellites, computers, networks, and many more. By playing this role, the government has bootstrapped industries that are the foundation of our modern economy. Two of the largest applications of the bioeconomy will be in energy and advanced materials and it is essential that the Department of Energy and Department of Defense take leadership roles by serving as first customers for new technologies in these areas.

The US Navy's "Green Fleet" is a laudable first step in this direction. If this effort were amplified across all branches of the military it would create significant market pull for fuel production in the bioeconomy. The Department of Energy could also establish a complement to the 772M barrel U.S. Strategic Petroleum Reserve made up entirely of domestically manufactured renewable fuels. Both the Renewable Reserve itself and the domestic energy production technologies created in its wake would be strategic assets.

Engineered organisms are capable of atomic-level precision in manufacturing and will surely yield a revolution in “smart materials”. One need only compare the self-repairing properties of biological systems to the frailty of current high-performance military materials to envision the potential. The Department of Defense through agencies such as DARPA should support the development of such advanced materials and the armed forces should serve as first customers.

Additional note: The National Bioeconomy Blueprint need not include medicine.

The bioeconomy is fundamentally about manufacturing. Biology represents the ultimate manufacturing technology – it operates with atomic-level precision, is capable of stereo- and regiospecificity in chemical reactions, works efficiently in mild process conditions, and typically produces environmentally benign waste products. A commitment to the bioeconomy represents an opportunity for the U.S. to rebuild our leadership in manufacturing and reestablish a skilled manufacturing workforce.

Government support of biology research for medical applications is already mature and well served by the National Institutes of Health. While medicine will continue to be a healthy segment of the bioeconomy, it has little room for further growth. On the other hand, energy, chemicals, and materials have been impacted little to date by advances in engineering biology and there has been comparatively little government support in these areas. As we replace petroleum as our principal raw material input in the next century there is little doubt that the impact of biology as a manufacturing technology will be transformative and the economic opportunity unparalleled. Thus the largest leverage for government investment in the bioeconomy will be in non-medical applications of biology research.