

**Statement for the Record
(WRITTEN TESTIMONY)**

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**Before the U.S. Senate Commerce Subcommittee on Science, Oceans, Fisheries and
Weather**

Hearing on: “Securing U.S. Leadership in the Bioeconomy”

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Chairman Gardner, Ranking Member Baldwin, and other distinguished members of the Subcommittee, thank you for holding this important hearing and for inviting me to speak on securing U.S. leadership in the bioeconomy. It is an honor to be here alongside these expert witnesses and to speak about this topic in front of several of the Science Coalition’s Champions of Science. I want to thank members of this subcommittee for their long-standing history of supporting federal investment in basic research and legislation such as the America COMPETES Act that drives the innovation which makes the U.S. the envy of the world in making advances needed to move society forward. To provide my conclusion at the outset, I think the U.S., its citizens, and society will benefit from bold, inter-agency federal investments in securing U.S. leadership in the bioeconomy.

I am a professor of bacteriology at the University of Wisconsin–Madison where my research focuses on bio-based conversion of renewable resources into products. I have served on numerous federal and international research and advisory panels, led large federally-funded

cross-disciplinary biotechnology graduate training programs, and am a Past President and current Secretary of the American Society for Microbiology, one of the largest life sciences professional societies in the world. Since 2007, I have led the U.S. Department of Energy-funded Great Lakes Bioenergy Research Center, a renewable fuels and chemicals center that has trained over 1000 students and staff, and developed technologies leading to 200 patent applications and the formation of five start-up companies. I also serve as interim director of the Wisconsin Energy Institute, an interdisciplinary academic catalyst for biological, physical, and computational research programs that is providing the workforce and knowledge needed to develop tomorrow's renewable energy and bio-based industries.

I would ask you to consider the following issues as you map out a federal strategy to secure U.S. leadership in the bioeconomy.

The bioeconomy space is broad. We can consider this initiative due to previous federally funded basic science advances in genomics, molecular biology, and computational sciences to name a few. The advances made from these investments provide a foundation of approaches and knowledge to support the development of the bioeconomy. Recent reports from the National Academies, the Administration, Federal Agencies, and other organizations, plus the comments of other invited speakers today illustrate the potential for bio-based approaches to:

- Develop sustainable strategies to feed an ever-growing population by increasing plant and agricultural productivity and quality,
- Provide strategies to ensure that future U.S citizens enjoy clean air, water, and a high standard of living,
- Transform human health by providing everything from new pharmaceuticals, reagents for precision medicine, and next generation antibiotics, and
- Produce cost-competitive fuels, chemicals, and materials from abundant renewable resources.

Because the bioeconomy is broad and an interdisciplinary affair, it is my opinion that a bold, inter-agency government investment is required to transform local, non-food, renewable materials into new revenue streams for farmers and industries across the U.S. The success of the

bioeconomy could allow existing industries to access new markets with new bio-based and biodegradable products and materials, growing their economic impact and job base. Given the abundance and diverse suite of renewable materials that are available to feed the bioeconomy, this initiative could:

- Produce bio-based chemicals and materials that industry cannot currently produce,
- Create new jobs and support economic growth nationwide,
- Allow the U.S. to become less dependent on foreign products, intellectual property, and manufacturing processes, and
- Transform medicine and agriculture, and safeguard the environment.

Much of the innovation that will drive development of this bioeconomy is based on past taxpayer investment in basic science. The reports I mentioned earlier illustrate that other countries are making significant investments in the bioeconomy, often capitalizing on discoveries made in the U.S. Moving quickly and boldly will help secure our leadership position in this rapidly emerging field so that U.S. citizens, companies, and the economy reap the benefits of home-grown technologies.

The needs of a bioeconomy workforce. These same reports also predict that by 2030 the bioeconomy has the potential to contribute more than 250 billion dollars in annual revenue and add more than a million jobs to the U.S. economy. The technical foundation of the bioeconomy will require many members of the workforce to have significant training in STEM-intensive fields. The success of the bioeconomy will also depend on a workforce with capacity, interest, and ability to be part of interdisciplinary and collaborative teams that span field, laboratory, and computational settings. Artificial intelligence, along with life cycle and technoeconomic analyses will become increasingly important as the bioeconomy develops. A distinct and important characteristic of the bioeconomy is that it's success will also rely on contributions from farmers, laborers, and educators who inspire others to be part of a diverse, educated workforce.

The U.S. Department of Energy's Bioenergy Research Centers as a bioeconomy exemplar.

At the University of Wisconsin–Madison, I am the director and principle investigator of the Great Lakes Bioenergy Research Center. Great Lakes Bioenergy is one of four U.S. Department of Energy Office of Science Bioenergy Research Centers (BRCs) charged with identifying and

solving the basic science challenges associated with producing hydrocarbon fuels and chemicals from lignocellulosic, or non-food, plant biomass. (Information on the BRC program and its active industry interactions is provided to the committee in supplementary material). The transportation fuels and petrochemicals sector has become a global, multi-trillion dollar per year industry to meet society's ever-growing needs for transportation fuels, plastics, and other chemicals that we depend on every day. The BRCs work together as a network to develop the knowledge needed for the sustainable production of a variety of bio-based fuels and chemicals that are currently derived from fossil fuels.

I would propose that Great Lakes Bioenergy and its partner BRCs provide lessons for how the bioeconomy could operate. Our research considers the entire value chain that a bio-based refining industry will need to be environmentally and economically sustainable. This includes:

- The biomass available to support the production of fuels and chemicals across the U.S.,
- The issues associated with growing dedicated energy crops on non-food land,
- The energy, fertilizer, and other inputs into the production of valuable bioenergy crops,
- The features of crops that will increase their value to farmers and industry, and
- The placement of biorefineries that minimize the costs of biomass transport and product distribution.

In addition, the BRCs are addressing challenges that will allow tomorrow's biorefineries to generate valuable products from as much of the biomass as possible. By converting as much of the carbon in biomass as possible into fuels and products, a new biorefinery industry can reduce the selling price of fuels by also making profitable chemicals, including bio-based products that cannot be made by existing technology.

Since its founding in 2007, Great Lakes Bioenergy has made contributions that cut across all of the areas highlighted above. They include:

- Building a nationwide atlas of crop productivity so farmers can identify acreage available to grow dedicated bioenergy crops without competing with food production,
- Combining traditional breeding with systems and synthetic biology to improve the productivity and value of dedicated bioenergy crops,

- Developing low-cost, renewable methods for isolating biomass components needed to produce targeted products,
- Engineering microbial chassis that produce fuels and chemicals from as much of the biomass carbon as possible, and
- Training over 1000 scientists who are now working in industry, government, technology transfer, nonprofit organizations, K-12 education, and academia.

The U.S. bioeconomy is poised to utilize technology derived from federal investment in basic research.

As an example, Great Lakes Bioenergy findings have led to more than 200 global and U.S patent applications, over 100 intellectual property licenses and options, and the formation of five start-up companies. To achieve these goals, we and our technology transfer partner, the Wisconsin Alumni Research Foundation, have developed strong interactions with companies in the agricultural, fuels, chemicals, fermentation, engine, and venture capital sectors. The technology outputs and active industry interactions for all four BRCs is provided in the supplementary materials. I trust this overview illustrates that Great Lakes Bioenergy and the BRC program is an excellent model for the type of academic, industry, and technology transfer ecosystem that will be needed to secure U.S. leadership in the bioeconomy.

In the course of these studies, Great Lakes Bioenergy also made several unanticipated discoveries that one would expect from high-risk, basic science, academic research programs. To give one example, we patented a process to produce acetaminophen, the active ingredient in pain relievers like Tylenol, from renewable biomass instead of coal tar that is the current source of this compound. Other advances in making products from renewable residues have led members of the dairy, food processing, forestry, animal, and municipal waste industries to fund academic research that will enable them to convert their abundant, low-value waste streams into higher-value chemicals, biomaterials, bio-recyclable plastics, and other polymers.

Before closing, I want to stress that the bioeconomy can generate products, jobs, and economic benefits close to home. This distinguishing feature of the bioeconomy will allow all regions of the U.S. to reap the economic and other benefits of producing valuable products that they currently import, from renewable resources. Our citizens have also seen or experienced the disruptions to fuels, chemicals, medicines, and other essential services caused by natural disasters. By hosting elements of the bioeconomy across the U.S., the country will have a

distributed and sustainable supply chain that is more secure, more resilient to periodic interruption, and more able to respond to the ever-growing needs of its citizens.

Finally, as the father of a college-age son and a university employee, I have the pleasure to work with young people every day. I predict that tomorrow's workforce will be ready to help the bioeconomy advance society in a sustainable way. On their behalf and on behalf of my colleagues, I want to again thank the committee and its members for your past support of basic research, and for the invitation to speak today. We want to work together to advance a bold, inter-agency, initiative to secure U.S. competitiveness and global leadership in the bioeconomy. If asked, I stand ready to help as you plan and embark on this journey.