



# Council on Competitiveness Bioeconomy Initiative

## Working Session 1 Meeting Summary

Build Fast, Scale Big: Investment, Commercialization, and Biomanufacturing Leadership

Virtual Working Session | Thursday, September 17, 2026

## Table of Contents

*Council on Competitiveness Bioeconomy Initiative* ..... 1

    Working Session 1 Prep Brief ..... 1

*Build Fast, Scale Big: Investment, Commercialization, and Biomanufacturing Leadership* ..... 1

    Meeting Summary Report ..... 1

**OPENING REMARKS** ..... 2

    The Hon. Deborah L. Wince-Smith, President and CEO, Council on Competitiveness ..... 2

**THREE PERSPECTIVES ON THE SCALE-UP CHALLENGE** ..... 3

    Dr. John McIntyre, Founding Parnter, Nodl Advisors; Distinguished Fellow, Council on Competitiveness ..... 3

    Dr. Lee Ellen Drechsler, Senior Vice President, Corporate Research and Development, Procter and Gamble .. 3

    Dr. Todd Pray, Chief Strategic Partnerships Officer, Lawrence Berkeley National Laboratory ..... 5

**WHAT THE GROUP IDENTIFIED** ..... 6

    1. Manage commercialization with greater discipline ..... 6

    2. Integrate biology, process engineering, and manufacturing from the outset ..... 6

    3. Build a true U.S. scale-up ecosystem, not a collection of isolated facilities ..... 7

    4. Build a shared national data and learning infrastructure for scale-up ..... 8

    5. Strengthen the science and measurement of biomanufacturing readiness ..... 9

    6. Look across the bioeconomy for platforms and “lily pad” opportunities ..... 10

    7. Build the institutional infrastructure for an engineered bioeconomy ..... 10

    8. Address the U.S. capital and cost disadvantage ..... 11

    9. Build on regional strengths when locating biomanufacturing infrastructure ..... 12

    10. Design for modularity, mobility, and process intensification ..... 12

    11. Create a level playing field and durable market demand ..... 13

**POTENTIAL AREAS FOR FURTHER DEVELOPMENT** ..... 14

**WHAT’S NEXT** ..... 16

The Council on Competitiveness convened the first of six working sessions for its Bioeconomy Initiative on September 17, bringing together leaders from industry, universities, national laboratories, regional innovation ecosystems, government, and organizations focused on biotechnology and biomanufacturing. The session focused on how to move promising biological science and technologies more rapidly from the laboratory into commercial-scale production in the United States.

### OPENING REMARKS

[The Hon. Deborah L. Wince-Smith, President and CEO, Council on Competitiveness](#)

The Hon. Deborah L. Wince-Smith, President and CEO of the Council on Competitiveness, opened the session by underscoring the strategic importance of the Bioeconomy Initiative to U.S. productivity, prosperity, and national security.

The Council launched its Bioeconomy Initiative more than two years ago, with Primient CEO Jim Stutelberg providing leadership and hosting an initial meeting at Primient's headquarters. The work subsequently advanced through the Council's National Commission on Innovation and Competitiveness Frontiers and a March 2026 working meeting in Nebraska hosted by University of Nebraska System President Jeff Gold.

Ms. Wince-Smith noted that while the United States possesses extraordinary talent, technology, and research capabilities, the system for translating those assets into biomanufacturing at scale has not yet been optimized. Other nations, particularly China, are making substantial investments in biotechnology and biomanufacturing, increasing the urgency for the United States to strengthen its own capabilities.

The first session therefore centered on what stands between promising science and the commercial-scale production and industries that can create value in the United States and global markets. Ms. Wince-Smith encouraged the group to look beyond incremental improvements and identify big, actionable, transformational ideas that could accelerate progress.

She also commented that the Council's contribution will build on the substantial work already underway across the biotechnology and bioeconomy landscape. The objective is to bring the Council's competitiveness lens to the challenge and connect the work of industry, government, universities, and national laboratories.

## THREE PERSPECTIVES ON THE SCALE-UP CHALLENGE

Dr. John McIntyre, Founding Partner, Nodl Advisors; Distinguished Fellow, Council on Competitiveness

Dr. John McIntyre, Founding Partner of Nodl Advisors and Distinguished Fellow at the Council on Competitiveness, opened the discussion by challenging the group to look beyond simply calling for more investment.

Drawing on experience across large corporations, startups, investment, boards, and industries ranging from pharmaceuticals to consumer products, Dr. McIntyre pointed to a troubling disconnect between the level of investment and the commercial results being achieved in the bioeconomy. Approximately \$60 billion had been invested in U.S. bioindustrial activity over a ten-year period, while relatively few exits had resulted and significant amounts of that investment had already been written down.

For Dr. McIntyre, this raises a fundamental question: why is substantial investment not translating into more successful products and companies?

He connected the problem to the broader challenge of declining R&D productivity. Citing the concept of "Eroom's Law" (the reverse of Moore's Law), he described a widening gap between advances in scientific capability and the ability to translate those advances into products. The issue, he suggested, is whether the system surrounding the science can efficiently turn it into something commercially viable.

Dr. McIntyre also challenged the industry to examine its own cost structures and processes and ask where unnecessary complexity and cost have accumulated. At the same time, he warned that the competitive environment is changing rapidly. He pointed to China's growing capabilities in areas including peptides and gene editing and the presence of Chinese-derived products throughout global supply chains.

He closed on a positive note: biology represents a potentially transformative next generation of industrial capability. The combination of biology and AI could unlock capabilities that have previously been inaccessible, creating an opportunity for the United States if it can develop the right recommendations and accelerate the path from innovation to scale.

Dr. Lee Ellen Drechsler, Senior Vice President, Corporate Research and Development, Procter and Gamble

Dr. Lee Ellen Drechsler, Senior Vice President of Corporate R&D at Procter & Gamble, brought a commercial perspective grounded in the experience of a major consumer products company actively developing and scaling biomaterials.

Her starting point: before trying to scale a biological technology, companies need to understand exactly why the material is needed, what it will compete with, and why it makes sense to scale.

She identified two compelling reasons to pursue biomaterials.

First, biology can deliver performance that conventional chemistry cannot easily replicate. Nature can produce molecules and materials that are extremely difficult to make through petrochemical processes. Where biology provides a meaningful performance advantage, it can justify the investment required to develop and scale the technology.

Second, biomaterials can provide more resilient, reliable, or higher-quality supply chains. Dr. Drechsler pointed to high-value fragrances, flavors, ingredients, and feedstocks that currently depend on geographically concentrated or vulnerable sources. In these cases, the value proposition may come not from being "bio" in itself, but from creating a more dependable supply or more consistent material quality.

She made the point that bio-based production should not be pursued simply as a drop-in replacement for products that petrochemical processes already make extremely well. The strongest opportunities are likely to be those where biology provides a differentiated performance, supply-chain, quality, or other economic advantage.

Dr. Drechsler also highlighted several opportunities to rethink how biomanufacturing is designed:

- **Use techno-economic analysis early.** Technology readiness and adoption readiness need to be considered alongside rigorous engineering and economic analysis as early as possible.
- **Rethink where production occurs.** Because biological feedstocks are geographically distributed, there may be advantages to locating biomanufacturing close to the source of the feedstock, potentially placing a bioreactor directly adjacent to agricultural production.
- **Combine disciplines rather than treating them as alternatives.** The most powerful production systems may combine synthetic biology, synthetic chemistry, and gene-edited crops rather than relying exclusively on any one technology.
- **Apply AI and digital technologies to manufacturing.** Downstream processing is often one of the most energy-, water-, and cost-intensive parts of biomanufacturing. Digital tools and AI could help improve process efficiency and reduce the cost of scaling.

Dr. Drechsler offered a concrete illustration of the domestic infrastructure challenge: P&G has technologies in development across areas such as surfactants and polymers that are sufficiently advanced to consider scaling, yet Europe currently offers more downstream processing equipment and available scale. She therefore asked the group to consider why those investments cannot be made in the United States, and how digital and engineering approaches could help encourage the domestic capacity growth.

[Dr. Todd Pray, Chief Strategic Partnerships Officer, Lawrence Berkeley National Laboratory](#)

Dr. Todd Pray, Chief Strategic Partnerships Officer at Lawrence Berkeley National Laboratory, drew on experience working with more than 100 companies on process development, scale-up, and product launches.

Pray commented that the challenge is much broader than the often-cited "valley of death" between research and commercialization and repositioned the scale up experience as "mountain range of despair," with multiple valleys and peaks along the journey from basic R&D to startup formation, demonstration, deployment, and commercial production.

The implication is that no single intervention will solve the problem. The United States needs sustained and coordinated funding across the full development pathway, including research, entrepreneurship, startup support, demonstration, and deployment.

The country already has pieces of this infrastructure: federal agencies, states, land-grant universities, national laboratories, companies, and nonprofit organizations have each developed facilities and capabilities. Can the nation build an optimized ecosystem with the right capabilities, in the right places, for the right products, and at a pace that matches the opportunity?

Dr. Pray also highlighted the policy environment. Renewable fuel policies, tax incentives, and other policies can favor incumbent energy, materials, and chemicals industries, creating an uneven competitive environment for emerging biological alternatives, particularly in commodity markets.

For Dr. Pray, therefore, the challenge is simultaneously technical, financial, commercial, and policy-related. Long-term stability, a level playing field, and a credible pathway to commercialization are all necessary. Federal programs and initiatives must also be better aligned across these different stages if the overall system is to work.

## WHAT THE GROUP IDENTIFIED

The discussion that followed the kickoff remarks expanded these themes and began to reveal a more integrated picture of the challenge. One suggestion that surfaced from Dr. Roger Wyse was to use two practical measures when considering the ideas that emerge from the initiative: which actions could have the greatest impact on reducing the time required to reach market, and which could improve the economics of doing so? This framing provides a useful lens for considering the discussion points, opportunities, and potential recommendations that surfaced during the conversation, shared below:

### 1. Manage commercialization with greater discipline

Mr. Tim Fowler, General Manager, Biosolutions at Primient, elevated the need to manage commercialization efficiently, moving strong science and compelling value propositions into sustainable businesses. He cautioned that “Build Fast, Scale Big” should apply to smart, proven ideas. Mismanaged commercialization can destroy substantial value, while repeated failures can make investors less willing to provide capital.

Dr. Yongqin Jiao, Deputy Division Leader of Science and Technology at Lawrence Livermore National Laboratory, made a related point from an industrial processing perspective: sustainability alone is not enough. Biology has to earn its place.

This suggests a useful discipline for commercialization decisions: identify the specific advantage that biology provides, quantify it, and determine whether that advantage is sufficient to overcome the cost and complexity of developing a new production pathway.

### 2. Integrate biology, process engineering, and manufacturing from the outset

Several participants argued that the United States has historically focused on getting the biology right at laboratory scale without devoting comparable attention to the science of manufacturing and scale-up.

Mr. Fowler put the point directly: the science of manufacturing and efficiently managing the commercialization process of an innovation is as important as the breakthrough scientific discovery itself. Dr. Drechsler similarly noted that there is as much fundamental science and engineering in designing and commercializing a bioprocess as in the breakthrough discovery, but that U.S. academic funding does not always recognize this distinction.

Dr. Deepti Tanjore, Director of the Advanced BioProcess Development Unit (ABPDU) at Lawrence Berkeley National Laboratory, noted that biomanufacturing has often focused more heavily on the “bio” than on the manufacturing side.

Dr. Jiao offered a detailed example from a decade of work scaling a protein-based technology for rare-earth separation. Her experience reinforced the point that a better biological system does not necessarily produce a better commercial technology. The biological design has to be developed in conjunction with process design.

In the rare-earth application, for example, the protein offered highly selective separation, but the economic opportunity depended on reducing the hundreds of stages traditionally required for extraction. Process intensification therefore became the “North Star”: fewer stages, lower energy consumption, and improved economics. Biological performance ultimately had to translate into process and economic performance.

The lesson extends beyond this application: biological engineering and process engineering need to be treated as an integrated design challenge from the beginning.

### 3. Build a true U.S. scale-up ecosystem, not a collection of isolated facilities

One of the strongest themes from the discussion was the lack of infrastructure connecting laboratory-scale innovation to first commercial production.

Biomanufacturing differs fundamentally from many forms of digital technology. Commercialization often requires continued investment in physical infrastructure and fixed assets. A business cannot necessarily scale simply by creating intellectual property and adding customers. Reactors, processing equipment, pilot and demonstration facilities, and ultimately commercial plants are all needed. The availability, location, and economics of this infrastructure are therefore critical to scaling domestically.

Mr. Fowler identified a particular gap between pilot-scale development and the first commercial plant. BioMADE and Primient’s iPROOF initiative are helping address this gap, but the United States needs multiple regional ecosystems capable of supporting companies through the full pathway from scientific discovery and proof of concept to first commercial production.

Dr. Jill Zullo, Executive Vice President and Chief Operating Officer of BioMADE, noted pilot infrastructure such as BioMADE and iPROOF can help de-risk technologies and processes, but the country must also plan for what comes next in the process. If technologies are successfully de-risked in the United States but the economics of constructing commercial facilities are substantially better overseas, the country risks developing the technology here only to see production move elsewhere.

The objective should be an end-to-end U.S. pathway in which companies can move through testing, validation, pilot production, demonstration, and first commercial production without having to leave the country.

Dr. Drechsler took this idea a step further, posing the question if a single facility could take a feedstock all the way through to a final product.

#### 4. Build a shared national data and learning infrastructure for scale-up

The discussion identified scale-up experience and failure data as underdeveloped national assets. Participants suggested that the United States needs a more systematic way to capture what works, what does not, and why, so that lessons from individual projects can be applied across the broader bioeconomy.

Dr. Tanjore argued for greater investment in collecting and making available both positive and negative scale-up data. Publicly funded institutions, in particular, could play an important role in capturing lessons that individual companies may be unable or unwilling to share.

Prof. Timothy Donohue, Director of Wisconsin Energy Institute and Director of Great Lakes Bioenergy, University of Wisconsin-Madison, reinforced the point from the research side, suggesting that the field needs to better understand not only which technologies succeed, but what actually causes promising technologies to fail when they encounter commercialization. He also suggested the Council examine successful federal investments and institutional models that have generated tangible results. The DOE Bioenergy Research Centers, for example, have produced substantial scientific and commercial outputs, including more than a thousand patents, hundreds of licenses, and numerous startups.

Rather than focusing exclusively on what is broken, Prof. Donohue suggested identifying what has worked, why it worked, and which elements of those models could be replicated or expanded. Developing case studies of both successful commercialization and failed or stalled projects could help identify recurring “pinch points,” illuminate the conditions that contribute to success, and give companies, researchers, investors, and policymakers a stronger basis for determining where and how to intervene.

Maj. Gen. (Ret.) Paul Friedrichs, M.D., Former Deputy Assistant to the President and Former Director of the White House Office of Pandemic Preparedness, drawing on a recent visit to China, described Chinese efforts to aggregate, standardize, and share data across government, research, and industry. He also noted China’s efforts to recognize data as an asset within corporate accounting frameworks, arguing that this can create incentives for companies to develop and retain data within the country.

For the United States, this raises a broader question about whether data generated through publicly supported R&D and industrial scale-up can become a shared national resource that accelerates future innovation, while appropriately protecting intellectual property and commercial interests.

Mr. Carlos Cabrera, Distinguished Associate at FGE NexantECA, argued that pooling knowledge across government, industry, and universities could generate breakthrough capabilities, particularly if mechanisms can address intellectual-property concerns and enable knowledge sharing where there is a broader national interest.

The opportunity, therefore, is to establish the case studies, data structures, sharing mechanisms, and incentives that allow the bioeconomy to learn collectively. Over time, this could turn the experience generated by individual scale-up efforts into a shared national capability, reducing the cost, time, and risk of moving the next generation of biological technologies to commercial scale.

Gen. (Ret.) Friedrichs also noted that the United States does not have a monopoly on the knowledge needed to build the bioeconomy. The country will need the humility and pragmatism to recognize where other countries and institutions are creating knowledge and to learn from and partner with them.

## 5. Strengthen the science and measurement of biomanufacturing readiness

The discussion also highlighted a related but distinct challenge: the United States needs better ways to understand, measure, and predict what happens as biological technologies move from the laboratory to commercial production.

Dr. Tanjore pointed to limitations in the data generated during scale-up itself. Current bioreactor measurements often emphasize traditional process variables such as temperature and pH, treating biological systems much like conventional chemical reactors. But biological systems are dynamic, and these measurements may not adequately capture what is happening within the biology.

This creates an opportunity to develop a stronger science of scale-up, with better measurements, models, and understanding of how biological systems behave as they move from laboratory to industrial conditions. Without that capability, companies are more dependent on expensive trial-and-error approaches, increasing the cost and risk of domestic scale-up.

Participants also discussed the limitations of traditional technology readiness levels, which do not necessarily capture the manufacturing, commercial, and economic dimensions of readiness. Ms. Melissa Roberts Chapman, President and Regional Innovation Officer of the KC BioHub, pointed to the Biomanufacturing Readiness Level framework developed by NIIMBL as one existing approach that could inform this work.

A stronger readiness framework could give companies, investors, researchers, and policymakers a clearer picture of whether a technology can be manufactured economically, whether a viable market exists, what risks remain, and what stands between the current state of development and a commercially viable operation. It could also provide a common language

and set of stage gates for determining what capabilities, investments, and interventions are needed to advance a technology.

Together, better measurements, stronger models, and more comprehensive readiness frameworks could reduce reliance on trial and error and improving the ability to move promising technologies into competitive domestic production.

### 6. Look across the bioeconomy for platforms and “lily pad” opportunities

The conversation also raised a question that cuts across traditional bioeconomy sectors: how can technologies and capabilities developed for one market create advantages in another?

Dr. Kirk Dombrowski, Vice President of Research and Economic Development at the University of Vermont, observed that the same underlying technology can face very different market conditions depending on whether it is applied to food, fuel, medicine, or another sector. That can make it difficult to develop a cohesive ecosystem if each application is treated as a separate silo.

Participants offered several ways to think about this. Mr. Fowler suggested beginning with the market where a technology is most advantaged, then using the scale and experience gained there to help de-risk subsequent applications. Dr. Drechsler noted that consumer products companies have already benefited from biotechnology and processing technologies developed for therapeutics, describing this as a “lily pad” model in which capabilities developed in one sector create a platform for progress in another.

Dr. Dombrowski similarly pointed to the possibility that once metabolic pathways can be reliably engineered, microbes can become a general-purpose manufacturing substrate, much as silicon provides a general-purpose platform for computing. He cited semi-synthetic artemisinin as an example of engineered biology producing a chemical precursor that can then be converted into a valuable product.

The opportunity, then, may be to identify platform technologies and manufacturing capabilities that can cross sectors, while recognizing that market structures, regulatory requirements, and demand conditions differ substantially across applications.

### 7. Build the institutional infrastructure for an engineered bioeconomy

Biology is increasingly becoming an engineering discipline, but the institutional infrastructure surrounding it has not necessarily evolved at the same pace.

Participants pointed to gaps not only in standards, testing, measurement, specifications, and certification, but also in the economic classification systems used to describe the emerging

industry. Dr. Nazish Jeffery, Founder & Principal, Helix Advisory, and Senior Advisor, KC BioHub, noted that biology does not have nearly as many NAICS and NAPCS codes as more established engineering and industrial fields.

That may sound like an administrative issue, but the implications are broad. Classification systems help determine how economic activity is measured and understood, how emerging industries are mapped, how markets and supply chains are analyzed, and how policymakers and investors see new areas of economic activity.

The same issue applies to standards. As biological systems become increasingly designed, engineered, measured, and manufactured, the field needs common standards and testing protocols that allow technologies and products to be compared, validated, specified, certified, and adopted.

An opportunity, therefore, is for the United States to build out the economic and technical infrastructure of an engineered bioeconomy, just as previous generations built the standards, classifications, measurement systems, and institutions that enabled other advanced industries to scale.

#### 8. Address the U.S. capital and cost disadvantage

The group also focused on the economics of building and operating biomanufacturing capacity in the United States.

Dr. Zullo noted that building physical facilities in the United States can be substantially more expensive than in competing countries. She estimated that putting steel in the ground can be 30–40 percent more expensive in the United States than in other countries, including China, India, and Brazil.

At the same time, the United States has important advantages in variable operating costs. Zullo pointed to the competitiveness of U.S. feedstock costs, particularly in the Corn Belt, as well as favorable utility economics in some regions.

This creates a fundamental tension: the United States may have attractive feedstocks and operating economics, but the upfront capital cost of building facilities can undermine the overall business case.

Participants suggested that public support may therefore be particularly important for capital-intensive infrastructure, where commercial companies must make decisions based on their own P&Ls and global alternatives.

Mr. Fowler reinforced this point, noting that support may be needed not only for construction, or CapEx, but also for operating costs, or OpEx, during the early stages of scale-up. The

economics may become competitive at full scale, but companies must survive the period required to get there.

Mr. Cabrera argued that the United States also faces disadvantages in the cost and speed of research, development, and commercialization, with competitors in Asia able to build and move faster and at lower cost.

The broader issue is whether capital can be deployed into U.S. projects quickly enough, cheaply enough, and with sufficient confidence in the pathway to commercialization.

### 9. Build on regional strengths when locating biomanufacturing infrastructure

The geography of the bioeconomy emerged as another important opportunity.

Dr. Drechsler raised the possibility of locating bioreactors and processing facilities close to agricultural feedstocks. Unlike petroleum, which is concentrated in large point sources, biological feedstocks are geographically distributed.

Dr. Peter Dorhout, Vice President of Research at Iowa State University, expanded on this idea. In the agricultural heartland, farmers already deliver biomass to centralized facilities, while existing transportation infrastructure and industrial ecosystems provide a foundation for additional development.

This suggests an opportunity to build on existing regional strengths rather than starting from scratch: agricultural production, transportation infrastructure, energy, universities, national laboratories, workforce, and existing processing facilities can potentially be combined into regional biomanufacturing ecosystems. Dr. Dorhout surfaced the NSF RuralSTAMINA Biomanufacturing Engine in Iowa and Nebraska as one example of emerging scale-up infrastructure in this model.

### 10. Design for modularity, mobility, and process intensification

Ms. Melissa Roberts Chapman, President and Regional Innovation Officer of the KC BioHub, suggested that the United States should not attempt to compete with China's scale advantage simply by building more and larger facilities.

Instead, the United States could seek to leapfrog scale with efficiency by developing greater continuity, modularity, and mobility in bioprocessing.

This could allow the country to build flexible manufacturing capabilities that serve multiple markets and production needs without requiring every technology to have its own large-scale dedicated facility.

Mr. Billy Hagstrom, CEO and Co-Founder of Bluestem Bioscience, offered a related example, describing efforts to reduce the “capital charge” of a demonstration and eventual commercial plant by leveraging existing infrastructure and digital tools such as digital twins and AI-enabled procurement.

The idea complements the discussion of distributed feedstocks and regional ecosystems: rather than reproducing a centralized petrochemical model, the United States could develop a more distributed, coordinated, flexible, and digitally enabled biomanufacturing architecture.

Ms. Roberts Chapman also asked the group to consider the full continuum of bioeconomy markets, including agriculture, animal health, and companion animal applications, rather than focusing exclusively on pharmaceuticals and very large industrial applications. Different markets operate under different regulatory requirements, potentially creating opportunities to develop and demonstrate technologies across a graduated regulatory spectrum.

## 11. Create a level playing field and durable market demand

Ms. Alina Meltaus, Chief of Staff of the National Security Commission on Emerging Biotechnology (NSCEB), noted that legislation has been introduced in both the House and Senate addressing strategic financing and scale-up infrastructure across product sectors, particularly bioindustrials with less commercial demonstrability than biopharmaceuticals.

She challenged the group to consider whether federal legislation and financing could provide sufficient demand signals to attract private capital and generate commercial work orders, or whether additional government action would be needed as a first mover.

At the same time, Ms. Meltaus emphasized that federal action alone cannot solve the problem. Industry can potentially play an important role in creating demand signals, commitments, and other mechanisms where federal jurisdiction is limited or ineffective.

Therefore, alignment among government, industry, and research institutions is foundational; federal policy cannot be treated as the sole solution.

Dr. Zullo also raised a national-security dimension to scaling the bioeconomy. If critical biological inputs to the U.S. food system are produced offshore, the issue extends beyond economic competitiveness, making domestic production capacity relevant to supply-chain resilience and national security.

## POTENTIAL AREAS FOR FURTHER DEVELOPMENT

The discussion generated a substantial list of challenges and opportunities, but Ms. Wince-Smith closed by asking participants to take the next step: turn aspirations into concrete recommendations.

The objective for the bioeconomy initiative is to document the barriers to scale, and, importantly, identify what can actually be done to overcome them, who needs to act, and how the pieces can work together as a system.

Several potential areas for further development emerged:

The discussion surfaced a number of potential areas for further development. While distinct, they point toward a common challenge: strengthening the U.S. pathway from biological discovery to competitive commercial production. One useful lens for considering potential interventions is their ability to reduce the time required to reach market and improve the economics of doing so.

- 1. Build an end-to-end U.S. commercialization and scale-up pathway.** Connect basic research, startups, pilot and demonstration facilities, first commercial plants, and deployment into a more coherent pathway. This includes strengthening the physical and institutional infrastructure needed to move technologies through successive stages of development and clarifying the roles of government, industry, universities, national laboratories, and regional ecosystems along the way.
- 2. Integrate biology, process engineering, and manufacturing from the outset.** Strengthen the science and engineering of scale-up, including biological measurement, process modeling, process intensification, digital tools, and manufacturing methodologies. Develop technologies with manufacturability and commercial economics in mind from the beginning, rather than treating scale-up as a downstream step after biological discovery.
- 3. Build a national learning and readiness system for biomanufacturing.** Develop stronger approaches for assessing commercialization and biomanufacturing readiness across technical, manufacturing, market, and economic dimensions. At the same time, create mechanisms to systematically capture and share successful and unsuccessful scale-up experience, including appropriate approaches for sharing precompetitive data and lessons across industry, government, universities, and national laboratories. Together, better readiness measures and a stronger learning system could reduce trial and error and improve decision-making at critical stage gates.

4. **Build the physical and economic foundation for competitive U.S. biomanufacturing.** Expand regional and distributed biomanufacturing infrastructure by building on existing agricultural, energy, transportation, university, laboratory, and industrial assets. Explore modular, flexible, and process-intensive approaches that can reduce capital requirements and improve production economics. Develop financing and public-private mechanisms that address the capital intensity of physical infrastructure as well as the operating costs and risks associated with early commercial production.
5. **Strengthen the institutional infrastructure and market conditions of the engineered bioeconomy.** Develop the standards, measurement, testing, certification, classification, and data infrastructure needed for an increasingly engineered bioeconomy. In parallel, identify mechanisms through which industry and government can create credible market and demand signals for emerging bio-based products. These institutional and market foundations can help give investors, producers, and customers greater confidence in new technologies and products.
6. **Identify cross-sector platforms and pathways for scale.** Look across the bioeconomy for technologies, manufacturing capabilities, and infrastructure that can serve multiple markets or enable advances in one sector to accelerate commercialization in another. A more deliberate approach to identifying these “lily pad” opportunities could allow scale, experience, and infrastructure developed in one application to reduce the risk and cost of entering another.
7. **Learn from and replicate successful models.** Identify federal, regional, and institutional models that have successfully moved technologies toward scale, understand the conditions that enabled their success, and determine which elements could be replicated or adapted elsewhere. Pair this with systematic examination of technologies and companies that stalled or failed to reach commercialization to identify recurring barriers and opportunities for intervention.
8. **Build a national science of scale-up.** Treat scale-up as a scientific and engineering challenge in its own right. Expand shared capabilities for process development, measurement, modeling, continuous fermentation, downstream processing, and other technologies that can reduce the cost and risk of moving from laboratory discovery to commercial production.
9. **Create stronger industry-university-national laboratory pathways.** Develop standardized partnership agreements, clearer points of entry, and mechanisms that allow companies and startups to access national laboratory and university capabilities more quickly. Explore hub-and-spoke models that allow national laboratories to serve as non-competing technical partners for startups and larger industrial companies.

10. **Use the national laboratories as commercialization and national-security assets.** Identify areas where national laboratories can help overcome technical and supply-chain chokepoints and connect their capabilities more systematically to industry, startups, universities, and strategic government priorities.

## WHAT'S NEXT

The next stage of the Initiative will be to test, refine, and prioritize these ideas across the remaining working sessions. Participants are encouraged to provide additional case studies, examples, and recommendations, with particular emphasis on identifying specific actions and responsible actors rather than broad aspirations.

You can do that via the following Microsoft Form, which will help the Council consolidate feedback:

[Council on Competitiveness Bioeconomy Working Session 1 | Additional Data Collection – Fill out form](#)

If you have additional questions, concerns, or trouble with the survey, please email [Mike Nelson](#) and [Ann McMahon](#) from the Council on Competitiveness.