



# Implementing Sustainable Production Compatible with Reduced Costs

Workshop at Recovery Biological Products XX, Sunriver, OR, USA,  
June 2-7, 2024

## Executive Summary

This workshop brought together experts from biopharmaceutical manufacturing, regulatory bodies, and academia to discuss how sustainable production can be achieved without increasing costs. Participants emphasized the importance of standardized sustainability metrics, the integration of circular bioeconomy principles, and the promotion of a cultural and structural shift toward environmentally responsible manufacturing.

## 1. Introduction

The workshop focused on identifying strategies to implement sustainable production practices in biopharmaceutical manufacturing while maintaining or reducing production costs. Discussions centered on three main themes: defining and measuring environmental impact, designing sustainable processes, and integrating circular bioeconomy principles into bioprocessing—particularly through downstream manufacturing improvements.

## 2. Metrics for Assessing the Environmental Footprint

A consistent framework for measuring the environmental footprint of bioprocesses remains a key need. Participants highlighted the importance of developing quantitative and comparable metrics that capture both direct production impacts and broader societal effects of biopharmaceuticals.

Core metrics discussed included:

Power consumption: Tracking energy use and identifying opportunities for renewable sourcing.

Water usage: Quantifying total usage and exploring strategies for reuse and recycling.

Plastics and materials: Reducing reliance on single-use components and assessing lifecycle impacts.

Hazardous waste generation: Minimizing waste and ensuring responsible disposal practices.



Process mass intensity and carbon release metrics: Standardizing reporting to better link process design to emissions.

Life cycle analysis (LCA): Using LCA frameworks to provide a holistic view of environmental impact from raw materials to end-of-life.

The workshop noted that a standardized framework is still missing, particularly in aligning process-level metrics with global sustainability benchmarks. Organizations such as NIIMBL (National Institute for Innovation in Manufacturing Biopharmaceuticals) in the U.S. could play a pivotal role in developing and harmonizing such frameworks across the industry.

### 3. Improving the Environmental Footprint of Bioproduction

Improvement in sustainability depends not only on technology but also on organizational and cultural shifts. The workshop emphasized two complementary directions:

Bottom-up approaches: Promoting awareness, training, and engagement at the operational level to encourage environmentally conscious decisions.

Top-down approaches: Leveraging incentives, business strategies, and regulatory frameworks to embed sustainability into decision-making.

Key drivers include investor expectations, evolving regulatory requirements, and cost-saving opportunities derived from more efficient resource use.

### 4. Implementing a Circular Bioeconomy in Bioprocessing

Circular bioeconomy principles—reduce, reuse, and recycle—offer a pathway to reconcile sustainability with cost reduction. The discussion highlighted several opportunities for advancement:

Multi-use vs. single-use systems: Evaluating when reusable equipment is environmentally and economically preferable.

Regulatory influence: Advocating for clearer regulations supporting validated reuse and material recycling.

Technology for recycling: Investing in R&D for polymer recovery and recycling technologies tailored to bioprocess materials.

Circular economy for plastics: Encouraging industry collaboration to create closed-loop recycling systems.

Co-location of recycling technologies: Positioning recycling facilities near manufacturing sites to cut logistics costs and carbon emissions.

Better differentiation between SU (single-use) and SS (stainless steel) systems: Developing tools to quantify trade-offs and guide design choices.



Government incentives: Calling for policy support and financial incentives to encourage adoption of circular manufacturing models.

## 5. Conclusions

The workshop underscored that sustainable production compatible with reduced costs is achievable through coordinated action in metrics development, process redesign, and circular economy implementation. Success depends on collaboration between industry, academia, and regulators to build a shared sustainability framework and incentivize innovation throughout the biopharmaceutical value chain.

