

Group 6: Clean Chemical Production

Group 6 focused on innovations in clean chemical production -- the development and scaling of methods to produce chemicals using sustainable, environmentally friendly processes that reduce or eliminate the use and generation of hazardous substances.

Objectives:

1. Achieve **net neutral CO₂ emission economy** by 2050
2. Ensure **90% of countries** across all economic growth stages are using **clean technologies** by 2050
3. **Reduce engineering, prototyping, and deployment** of engineered organisms by **1000x** by 2035

Key bottlenecks:

1. Insufficient **feedstock availability** for large-scale production of bio-based chemicals
2. **High cost** of bio-based processes compared to traditional petrochemical routes
3. Limited **scalability** of current fermentation and biomanufacturing methods
4. Lack of efficient **CO₂ utilization technologies** for chemical production
5. Inadequate **infrastructure** for lignocellulosic biomass processing

Some interventions participants expressed interest in:

1. Create gene modules, organisms, assay and molecular biology technologies that are open-source, free to use and commercialize, and easy to access
2. Develop higher-yield plant seeds
3. Run large-scale experiments on engineered gene modules across various organisms and share the dataset publicly
4. Develop organisms and chassis that are easier to model and predict
5. Generate massive datasets spanning the central dogma and protein synthesis across many types of organisms

Patterns:

1. **Feedstock innovation** was a recurring theme. Participants discussed the need to move beyond sugar-based fermentation and explore alternative feedstocks such as CO₂, methane, and lignocellulosic biomass. Proposed interventions:
 - a. Developing gas fermentation organisms and reactor systems
 - b. Engineering microorganisms that can efficiently use waste biomass
 - c. Improving plant seeds to increase yield and fix more carbon
2. **Data generation and sharing** was seen as critical for advancing the field. Proposed interventions:
 - a. Building platforms for data sharing and incentivizing organizations to contribute data

- b. Developing computational models to predict scaling from small to large production volumes
- 3. **Sustainability and circular economy** concepts were a part of a couple interventions:
 - a. Developing zero-waste bioprocesses
 - b. Designing new types of polymers with improved degradation properties

Key points of disagreement and uncertainty:

1. **Feasibility of bio-based alternatives:** There was debate about the feasibility of replacing petroleum-based products with bio-based alternatives at a significant scale by 2050. Some participants were optimistic about reaching 20% replacement, while others were more skeptical due to the current low cost of petroleum-based products and theoretical limits on sugar-based alternatives.
2. **Impact of reducing fermentation test costs:** The group disagreed on the potential impact of reducing fermentation test costs. While some saw it as a game-changer that could dramatically reduce bioproduct costs, others argued that material costs would limit the overall cost reduction to 30-50%.
3. **Timeline for protein function prediction models:** There was uncertainty about the timeline for developing an accurate protein function prediction model. Some were skeptical about achieving 90% accuracy by 2035, comparing this achievement to achieving nuclear fusion, in terms of how difficult, unlikely, and transformative it would be.
4. **Scalable non-model organisms:** The group had mixed views on the impact of developing scalable non-model organisms that grow on waste. Some saw it as a potential solution to feedstock limitations, while others worried it might increase R&D costs without significantly reducing production costs.
5. **Doubling plant seed yields:** There was disagreement about whether doubling plant seed yields would significantly contribute to achieving net-neutral CO₂ emissions by 2055. Some argued it would help, particularly in replacing jet and diesel fuels, while others felt it would be insufficient given the scale of the challenge.

Other points:

- **Policy and regulatory hurdles** were mentioned as important factors in discussion, but explicitly ruled out of discussion due to being “outside the scope” of the conference; participants decided to focus on scientific and technical challenges
- The group discussed the need for **improved measurement and analytics tools** to better understand and optimize bio-based production processes at various scales.