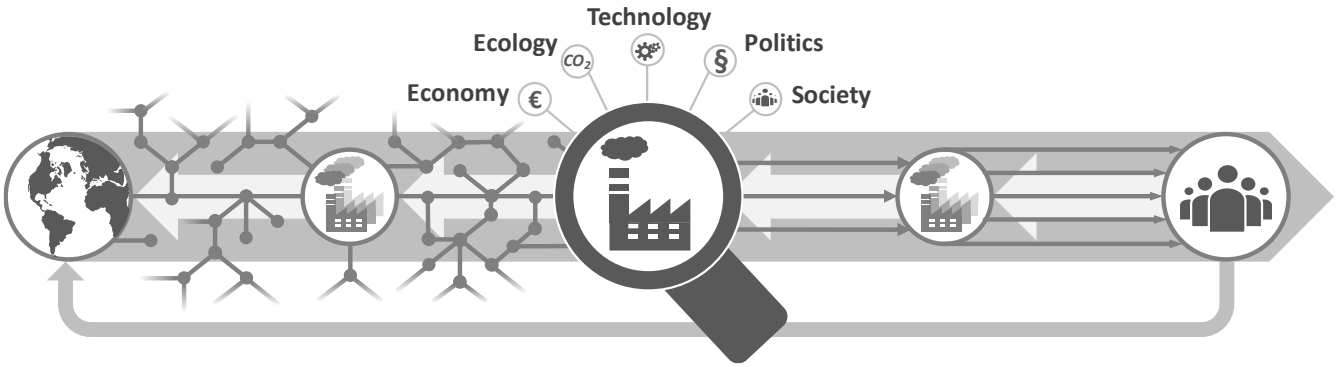
Karlsruher Institut für Technologie

Institute for Industrial Production (IIP)
Chair of Business Administration,
Production and Operations Management
Prof. Dr. Frank Schultmann

Seminar in Winter Semester 2024
Research Group "Sustainable Value Chains"



Designing the Bioeconomy

Background and objectives

The bioeconomy refers to an economic system that utilizes renewable biological resources—such as plants, microorganisms, and organic waste—to produce food, energy, products, and services. It integrates principles of sustainability and innovation to transform how we produce and consume goods, aiming to reduce dependence on fossil fuels and minimize environmental impact.

The bioeconomy offers a pathway toward sustainable economic growth by integrating biological knowledge with engineering and business strategies. It presents numerous opportunities and challenges that require a multidisciplinary approach to create a more sustainable future.

Designing bioeconomic concepts involves creating sustainable economic models that utilize biological resources and processes to produce goods, energy, and services. While the bioeconomy presents significant opportunities for innovation and sustainability, several key challenges such as resource availability, economic viability as well as supply chain and logistics must be addressed to develop effective and viable bioeconomic strategies.


Source: The bioliq® process turns straw into biofuels.

Preparation and assessment

Designing bioeconomic concepts requires a multifaceted approach that addresses technical innovations, economic realities, environmental sustainability, and social dynamics. During the seminar the students work in groups on assigned scientific topics. Some literature will be provided, but should be supplemented by the students' own research. Participation in the seminar includes the preparation of case studies and exercises, which are summarized in a seminar thesis as a research paper and presented at the end of the semester. The assessment of the work is based on both the written seminar paper and the presentations given, which must be in English.

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Topic A
Agri-PV for Biorefineries

The energy transition in Europe is characterized by the trend towards increasing investments in energy efficiency and fostering sustainable behavior around energy use. However, the investment decision for energetic renovation is inevitably influenced through the policy context. Especially for agricultural businesses, installing a large-scale solar system represents a big investment decision. Thus, unsurprisingly, these investments in renewables are often supported financially through subsidies and partially funded business models. The agricultural business will have to decide, whether a PV system can be compatible with their farming system, which Agri-PV system fits best, what scale to choose and how to finance the solar park.

In this topic you will work on the concept of an integrated biorefinery that uses energy from ist own PV/solar thermal park. In particular, you will study the question: What contribution can agri-PV make to biorefineries?

In a first step, you will analyze the existing literature in order to identify the major Agri-PV systems that are available for built elements today. These systems will then be analyzed according to their compatibility with biorefineries. In a second step, the relevant business models for the selected Agri-PV systems for biorefineries are to be identified. How can the solar system be integrated with the biorefinery? How many m² of PV are needed depending on the energy production in the region? Which PV system is suitable for the specific plant? Finally, the analysis should conclude with a cost-benefit analysis on the viability of Agri-PV installations for biorefinery businesses.

Key aspects are:

- Agri-PV system differences and compatibility with agricultural management or building elements such as barns, greenhouses or biorefineries.

- Business models for PV in agriculture: Estimate the energy production of the solar plant in the region of the biorefinery in order to be able to select the size requirements and system.

- Investigate competition around Agri-PV systems in terms of land-use: food, feed, fuel, etc.

Within the framework of the seminar topic A, a maximum of three students will elaborate on the case study of a medium-sized biorefinery, which faces the challenge to use renewable energy for producing sustainable products. The plant is located in a rural area next to biomass supply locations.

Supervisor

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Topic B
From Catalyst to Product

The development and application of catalysts are fundamental to the advancement of chemical industries, playing a pivotal role in enhancing reaction rates, selectivity, and energy efficiency. The journey from designing a catalyst to delivering a final product encompasses a multidisciplinary approach involving chemistry, materials science, process engineering, and economic analysis. Understanding this journey is essential for driving innovation and sustainability in sectors such as pharmaceuticals, petrochemicals, and renewable energy.

In this seminar, you will delve into the comprehensive process of transforming catalyst concepts into marketable products. Specifically, you will investigate the question: How does the progression from catalyst development to product manufacturing contribute to sustainable industrial practices?

- **Catalyst Design and Development:** Investigate various types of catalysts, including homogeneous, heterogeneous, and biocatalysts. Explore methods of catalyst synthesis, characterization, and performance evaluation. Understand the role of catalysts in influencing reaction mechanisms and kinetics.
- **Process Integration and Scale-Up:** Examine the challenges of integrating catalysts into industrial processes. Evaluate scale-up strategies from laboratory to pilot and full-scale production.
- **Economic and Environmental Assessment:** Review techno-economic analyses (TEA) and life-cycle assessment (LCA) to assess the viability of catalytic processes. Explore regulatory factors and sustainability standards influencing catalyst deployment.
- **Case Study Application:** Focus on a specific catalytic process (e.g., biomass conversion to biofuels, or Poer-to-X concepts). Identify key challenges and innovations at each stage from catalyst to product. Propose optimization strategies for improving efficiency and sustainability.

Seminar structure: Within the framework of this seminar topic, up to three students will collaborate on developing a comprehensive review of a catalytic process from inception to product delivery. The seminar will involve: literature review, technical analysis, economic and environmental evaluation and the preparation of a keynote.

Presentation and Discussion: By participating in this seminar, you will gain a holistic understanding of how catalysts drive product development in the chemical industry. You will develop skills in interdisciplinary research, critical analysis, and strategic thinking, which are essential for addressing complex challenges in modern engineering and business contexts.

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Topic C

Planning Models in the Agri-Food Supply Chains: A Comprehensive Literature Review

The agri-food supply chain (ASC) includes all processes from agricultural production to the delivery of food products to the final consumer. Due to the complexity of these supply chains, especially for perishable products, planning models are crucial to ensure efficiency and reliability. Factors such as fluctuating demand, long lead times, and weather dependencies make optimizing these supply chains particularly challenging. Specialized planning approaches are necessary to manage these growing challenges. The aim of this seminar project is to investigate existing planning models for the agri-food supply chain and to identify their applications and limitations.

In this seminar, you will conduct a comprehensive literature review on planning models in the agri-food supply chain. The focus will be on models that support the planning and optimization of production and distribution processes for agricultural products. Specifically, you will analyze:

- **Strategic, tactical, and operational planning models:** What models are used at various stages of planning in the agri-food supply chain? What are the strengths and limitations of existing models, including their practical applications?
- **Perishable vs. storable products:** How do planning approaches differ for fresh and storable products?
- **Supply chain uncertainties:** What methods are employed to model and manage uncertainties related to demand, supply, and transportation?
- **Future research gaps:** Where is the room for improvement in modeling and optimizing agri-food supply chains?

Seminar structure: In this seminar, up to three students will work collaboratively on conducting an in-depth literature review focused on planning models in the agri-food supply chain (ASC). The goal is to explore and evaluate existing models for production, distribution, and supply chain coordination within the context of agri-foods, focusing particularly on perishable and non-perishable crop-based products.

Presentation and Discussion: Each group will prepare a seminar thesis to summarize findings and propose areas for further research. By the end of the seminar, students will:

- Acquire knowledge about the key factors influencing ASC planning, including perishability, demand uncertainty, and logistical complexity.
- Develop interdisciplinary research skills, combining aspects of supply chain management, economics, and operations research.
- Enhance their presentation and communication abilities through collaborative work and group discussions.

Supervisors

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Topic D

Workforce Scheduling for Agri-food Production and Supply Chain

Workforce scheduling in the agri-food supply chain (ASC) is critical in ensuring efficient production and timely delivery of food products to consumers. Optimizing workforce schedules is vital given the complexity of managing labor in this sector, especially for perishable goods. Factors like fluctuating demand, seasonality, strict deadlines, and compliance with labor regulations significantly challenge workforce management.

This seminar project explores existing models and approaches for workforce scheduling optimization in the agri-food sector, analyzing their applications, effectiveness, and limitations in enhancing productivity and reducing operational costs. This will involve a detailed literature review, analysis of current workforce management challenges, and an examination of optimization tools and techniques.

Topics to be covered:

- **Workforce Scheduling in Agri-food Supply Chains:** Investigate the specific demands of the agri-food sector, where workforce flexibility and availability are critical due to variable harvest times and perishable products. Examine the impact of workforce management on the overall efficiency of production and supply chains.
- **Optimization Models and Algorithms:** Explore various workforce scheduling optimization methods, including linear programming, dynamic programming, and stochastic programming. Compare the effectiveness of these models in the context of agri-food production.
- **Case Studies and Industry Practices:** Review case studies from the food industry and evaluate their effectiveness in optimizing labor costs while maintaining high production standards.
- **Future research gaps:** Where is the room for improvement in modeling and optimizing labor in agri-food supply chains?

Seminar structure: This seminar will be conducted with a group of up to three students. Each student will be responsible for a specific section of the review or analysis.

Presentation and Discussion: Each group will prepare a seminar thesis to summarize findings and propose areas for further research. By the end of the seminar, students will:

- Acquire knowledge about the key factors influencing workforce scheduling in ASC.
- Develop interdisciplinary research skills, combining aspects of supply chain management, economics, and operations research.
- Enhance their presentation and communication abilities through collaborative work and group discussions.

Supervisors

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Grading

The grading takes several parts into consideration. Both the active participation in the events and the presentation are included in the grade. However, the main part is the written seminar paper, which, like the presentation, is prepared in groups of up to 3 people. The total workload corresponds to 3 ECTS points.

Application

Please apply with a CV, a short letter of motivation and a current transcript of records. Master's students must enclose the final grade transcript from their Bachelor's degree. Please briefly answer the following questions in your letter of motivation:

- Why should you be a participant in this seminar?
- Do you already have previous knowledge?
- What is your favorite topic?
- What do you expect to learn?

If you wish, you can also specify the group members you would like to join in your letter of motivation. However, admission to the seminar is on an individual basis.

Dates

- Kick-Off event: End of October 2024 at the IIP (Westcampus, Geb. 06.33) in Room 103
- The day of final presentations will be agreed with the seminar participants at the Kick-Off event. The presentations are expected to take place at the end of July or beginning of August.
- Students are required to be present on all days of the event.

Contact for organizational questions:

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