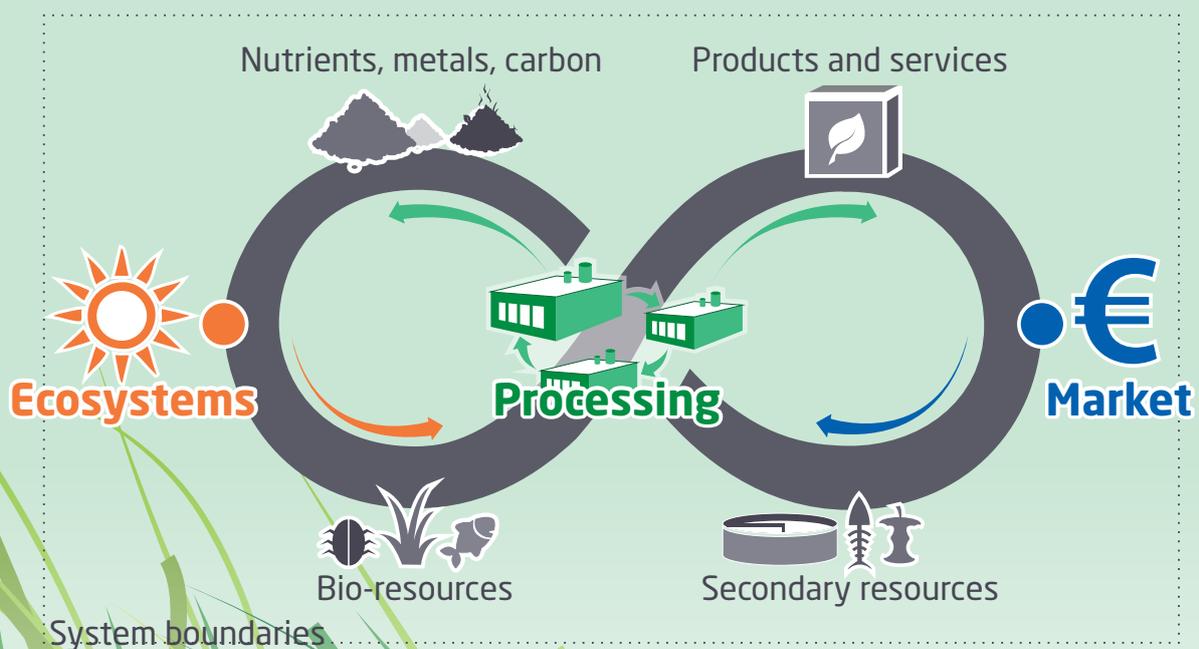


THE ENGINE ROOM OF THE BIOECONOMY

TOWARDS A SUSTAINABLE AND CIRCULAR BIOECONOMY IN DENMARK

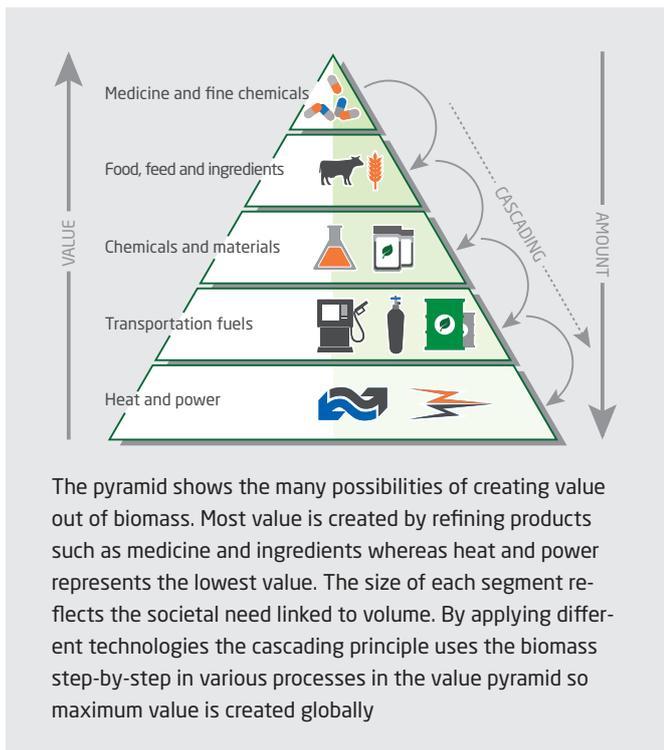


This is a summary of the findings and conclusions of DTU's sector development report "The engine room of the Bioeconomy". The report pinpoints a number of trends within the bioeconomy and provides four recommendations for the Danish public and private sector to become an international leading hub in the development of a sustainable and circular bioeconomy. Technologies, cascading use and overall understanding of bioeconomic systems are essential to develop a dynamic and sustainable bioeconomy. It is evident that this cannot be done without collaborating closely within the EU and therefore the ultimate goal is to create solutions that move the entire Europe towards a more sustainable and circular bioeconomy.

DTU's sector development report "The engine room of the Bioeconomy" shows that sustainable bioeconomy has the potential of being a key solution to many of the challenges Denmark, Europe and the world face today; growing population, climate change, scarce resources and ecosystems under pressure. However, it is a complex task to fulfill this potential.

To unfold the potential of a sustainable bioeconomy insistence on circular, holistic and systemic approaches are required. We therefore strongly support the ambitions of the European Union as set out in the Bioeconomy Strategy (2018), the Blue Growth Strategy (2012) and FOOD 2030 (2016) and the Standing Committee on Agricultural Research (SCAR) 4th Foresight Report. A sustainable and circular bioeconomy requires **research, development and application** of new **technologies and processes** that can unlock the full potentials of the biomass, as well as research and development of the **systems** they are part of (figure 1 front page).

Denmark has a strong position when it comes to being first to market with new technologies and solutions within bioeconomy, and Danish universities have internationally recognized research environments. Danish companies produce efficiently and sustainably. We are a pioneer in bio-based life science, fermentation, ingredients, high value products, use of side streams and high-efficiency use of biomass and biogas for energy production. Denmark can show real examples of industrial symbiosis and cascading use of bio-resources for many purposes and thus become an international demonstration site with the right network of actors, investments in technology and infrastructure and systemic change.



The project has uncovered six important trends with a number of company cases to illustrate how they experience challenges and opportunities associated with the various trends:

Trend 1: Cascading use and more products based on the same raw materials and processes

The concept of cascading use of bio-resources is essential to optimize the use of raw materials and closing the loop so any bio-resource is re-used together with valorization of possible valuable substances from by-products or side streams. The cascading principle links value chains across different sectors. It requires access to biomass, side streams, technology and market and involves many different actors in the primary production, logistics, processing and marketing.

Trend 2: Growing pressure on the resources of the Earth

Growth of the world population makes it increasingly difficult to find available land. There is a need for greater yield of the raw materials produced; production of aquatic raw materials; and production of food that is completely disconnected to traditional cultivation of land.

Trend 3: Bioeconomy can mitigate climate change

Agriculture and the food industry have the opportunities to improve the green bottom line. This applies to areas such as production and management of organic waste, emissions of CO₂ and other greenhouse gases such as methane. Bioeconomy is a key factor in making the world able to live up to the objectives of the Paris Agreement.

Trend 4: Bioeconomy creates business and local development

Companies with growth potential within bioeconomy are located where the availability of raw materials is present, whether it is animal or vegetable, land or water-based biomass. This is often in rural areas. Bioeconomy can create many new businesses and jobs.

Trend 5: Biological resources needs to be quality assured and traceable

Food safety and traceability of biomass is very important for full utilization of the biological raw materials. Technical solutions for traceability is developing rapidly.

Trend 6: Technology development requires adaptation of public regulation

Biobased production is subject to comprehensive regulation, with good reason. Regulation must be developed and adapted in line with development of new technology to unlock the potential of the biomass. Similarly, companies and researchers should consider the regulatory environment in which new technology is developed.

By the term 'bioeconomy' we refer to the definition stated in the Updated Bioeconomy Strategy, 2018 - 'A Sustainable Bioeconomy for Europe' which underlines that the bioeconomy 'covers all sectors and systems that rely on biological resources...' and 'includes and interlinks: land and marine ecosystems and the services they provide'.

Building on the trends described above DTU provides four recommendations on how Denmark can become a leading player in the creation of a sustainable and circular bioeconomy. With these recommendations we also want to position Denmark as an active player in the development of a sustainable and circular bioeconomy in Europe and preferably also outside Europe.

Recommendation 1: Strategic initiatives and cooperation between private and public sectors

Bioeconomic value chains are complex. Access to biomass, side streams, technology and market includes many systems and players within primary production, logistics, processing, marketing, asset management, etc. However, public support programs are often divided into classic domains such as energy, food, health and environment. The Danish innovation system should include programs and funding that reward partnerships, value chains and synergies between sectors. Research and development across disciplines, including life cycle analyses, digitization, technology assessments as well economic, regulatory and institutional analyses should be promoted.

Recommendation 2: Denmark as test center for a circular bioeconomy

Denmark has the chance to become the first country with a real circular bioeconomy where every bioresource is used and

re-used sustainably and effectively. To create well-functioning innovation, it is important to focus on the demand side and not just on the supply of technology and knowledge. Through political regulation and deregulation, niche markets can be created where new bioeconomic products can get foothold. Denmark should work on developing a virtual platform for bioeconomy that can provide small and large players easy access to new technologies, knowledge and networks. Research in and application of process and production technologies for cascading use of biomass and side flows is crucial. Local initiatives where process and production technology creates higher value for the local bioresources and side streams are needed. Finally, there should be a greater focus on demand for bioeconomic technologies, products and services, e.g. through public procurement policy, incentive regulation, certification and standards at both national and international level.

Recommendation 3: Build bioeconomy on existing Danish strongholds within health and climate

Side streams from the large Danish food industry have the potential to be refined into ingredients and products with health properties. Danish research environments and companies have the expertise to make this area central. Denmark also has a strong position within climate and environment. Bioeconomy can help protect the climate by replacing fossil raw materials with sustainable, renewable, biobased solutions, reduce the amount of waste, utilize more parts of the raw materials as well as new raw materials from e.g. the sea. Moreover, CO₂ and other greenhouse gases can be utilized as resources in production. Together with other EU countries, Denmark should work towards putting bioeconomy high on the climate agenda.

Recommendation 4: International dissemination of Danish bioeconomic solutions and new global business opportunities

Bioeconomy addresses global challenges, and Denmark can play an important role through its position within research, technology and production. The bioeconomy can help create the next generation of global companies providing new solutions within, for example, ingredients, feed, materials, etc. One of the instruments is the European programmes, and Denmark should prioritize increased Danish participation in programmes such as Horizon Europe and the Bio-Based Industries partnership. Furthermore, we should have ambitious efforts to establish Danish knowledge and technology cooperation in developing countries and working actively with the UN's goals to bring Danish knowledge and expertise into play for "people, profit and planet".

About DTU sector development projects

Sector development projects are one of the tools that DTU employs to cooperate with the business community and authorities to identify research and development needs in a sector or industry. A sector development project extends from an initial identification of ideas over the lobbying in relation to private and public funding sources to specific collaborations with companies and authorities. The result is a report with interdisciplinary challenges, tendencies and recommendations.

Finally, the report contains a catalogue of projects where DTU's researchers are helping to create the basis for more bioeconomy in Denmark and the rest of the world.

Interviewed companies/authorities/research institutions and workshop participants:

Confederation of Danish Industry, Danish Agriculture & Food Council, AquaGreen, Arla, Beyond Coffee, Biomar, Capnova, Daka Denmark, The Green Investment Fund, Fermentation Experts, Guldborgsund Kommune, INBIOM / Agro Business Park, KMC, The Ministry of Environment and Food of Denmark, Nature Energy, Nordic Sugar, NIRAS, Novozymes, SEGES, Unibio and Ørsted

Participating departments from DTU:

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