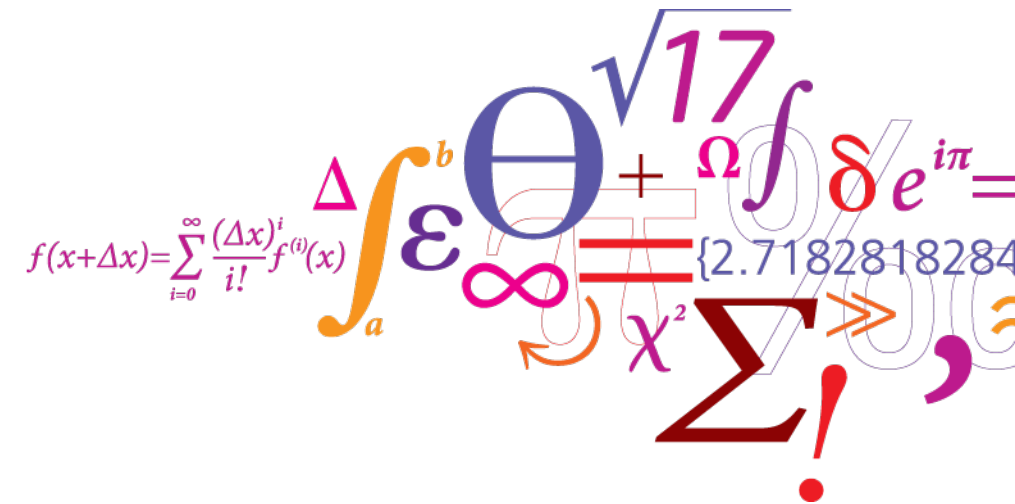


BIOECONOMY, SYSTEMS AND SOCIETY. WASTE VALORISATION IN THE FOOD INDUSTRY

EXAMPLES FROM THREE INDUSTRIES IN NORWAY AND DENMARK

Simon Bolwig, Anne Nygaard Tanner and Louise Strange

DTU Sustain Conference, 30 November 2018





EU DEFINITION OF BIOECONOMY*



The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles.

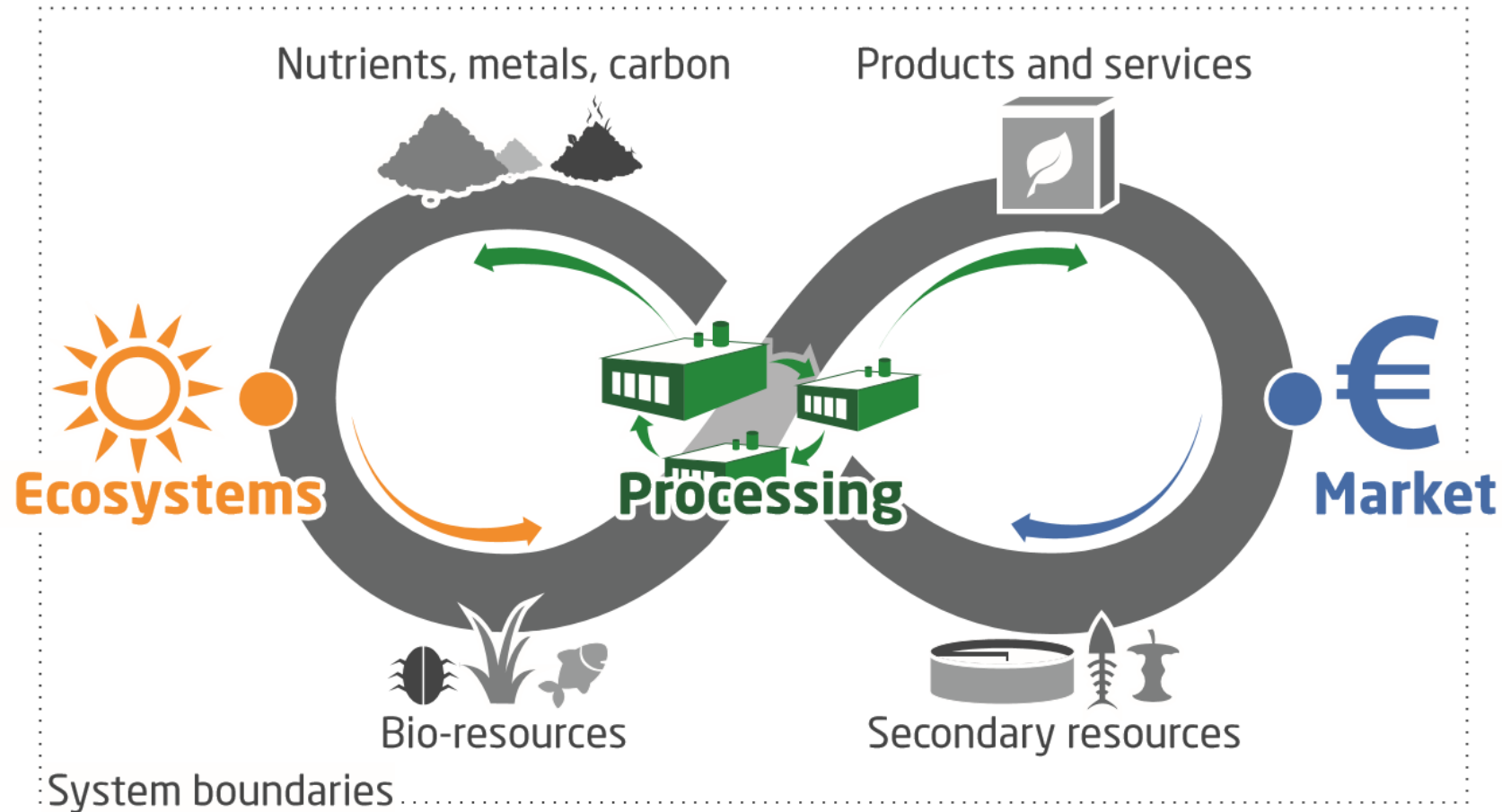
It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services.

To be successful, the European bioeconomy needs to have sustainability and circularity at its heart. This will drive the renewal of our industries, the modernization of our primary production systems, the protection of the environment and will enhance biodiversity.

* *Biomedicines and health biotechnology are excluded. Source: A sustainable bioeconomy for Europe: Strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy. EU October 2018*



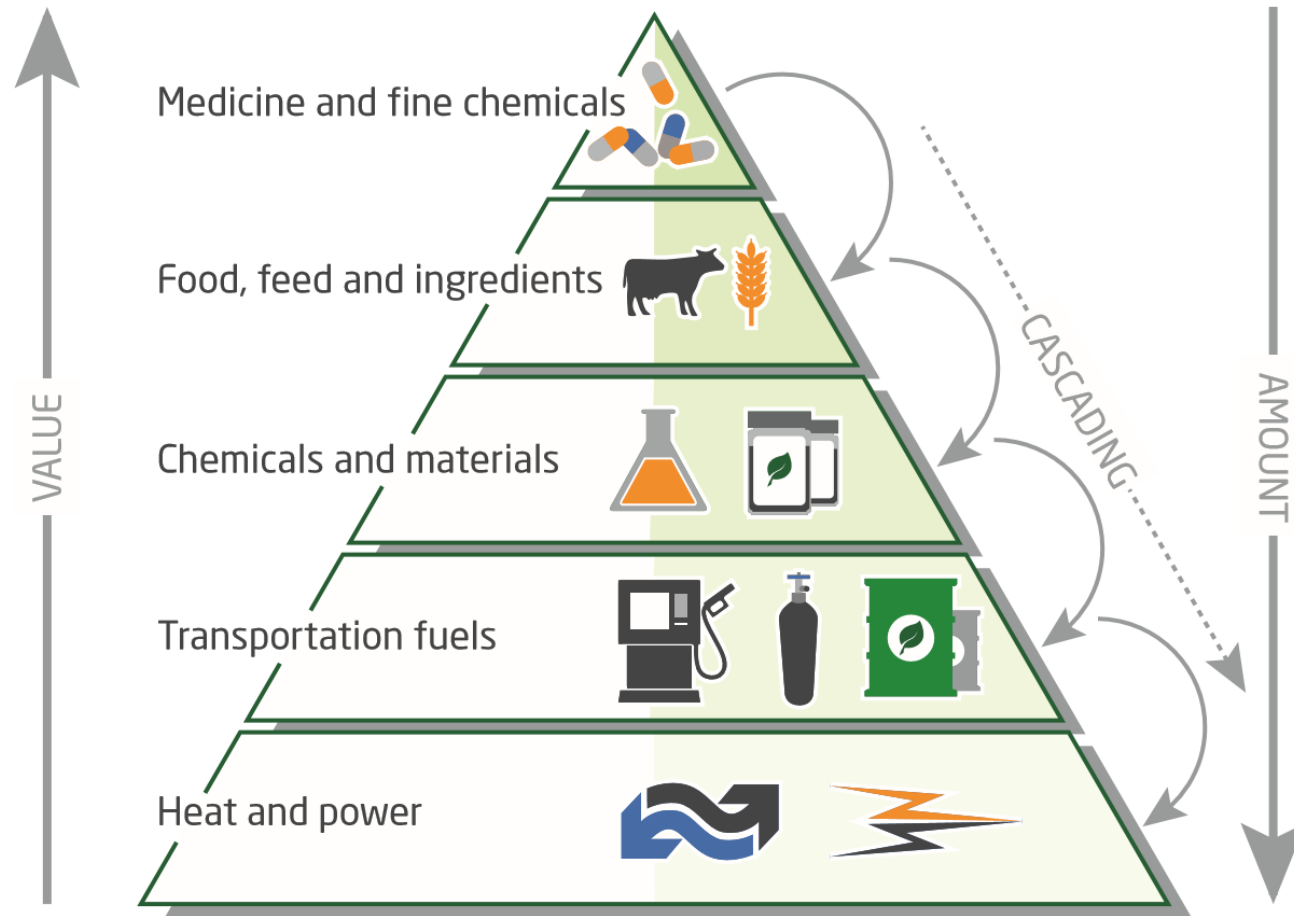
THE CIRCULAR BIOECONOMY - ECOSYSTEMS, TECHNOLOGIES AND MARKETS



Source: DTU Sector development project on bioeconomy 2018



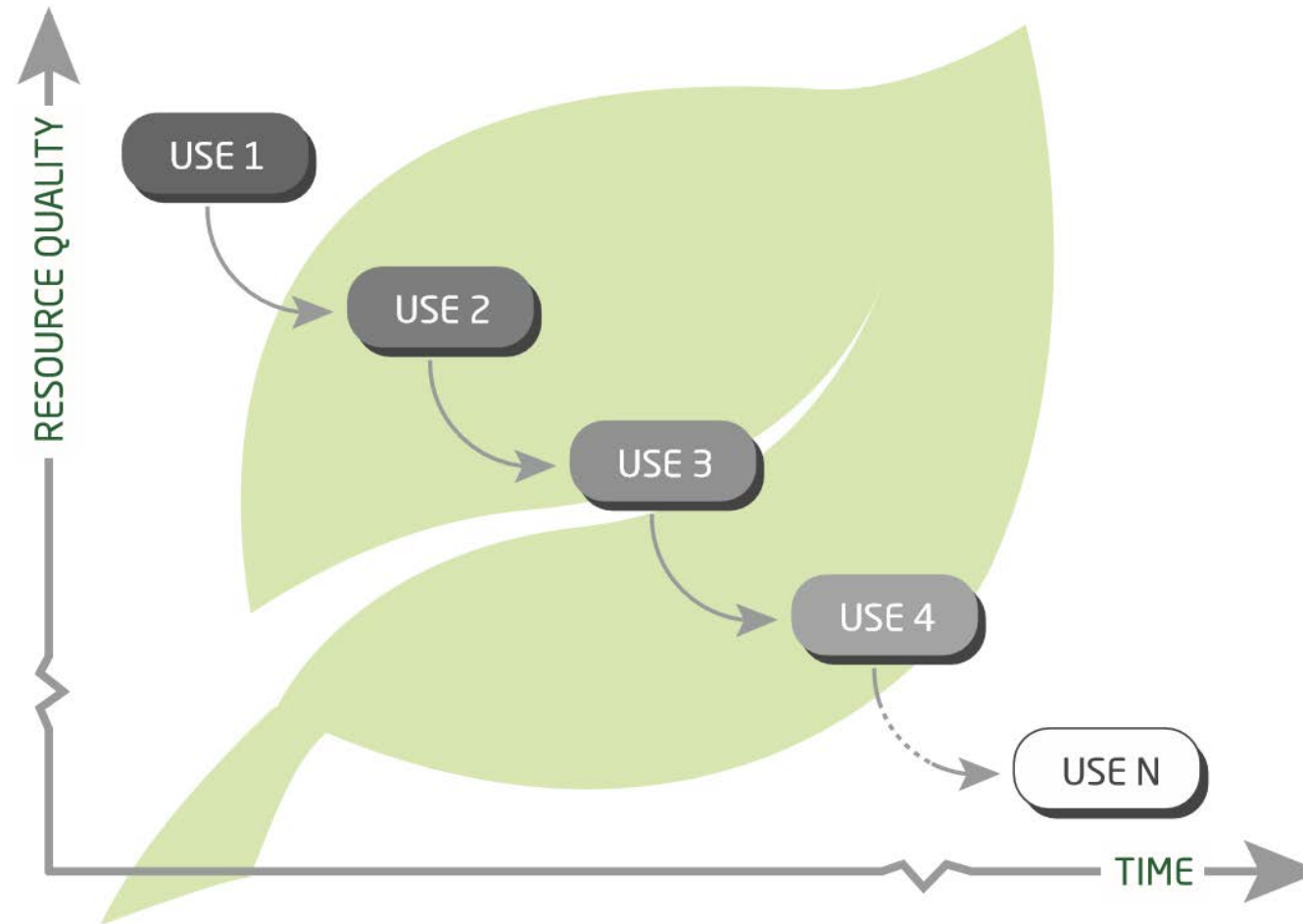
WASTE VALORISATION PYRAMID - CASCADING USE IN-VALUE



Source: DTU Sector development project on bioeconomy 2018



CASCADING USE IN-TIME



Source: DTU Sector development project on bioeconomy 2018



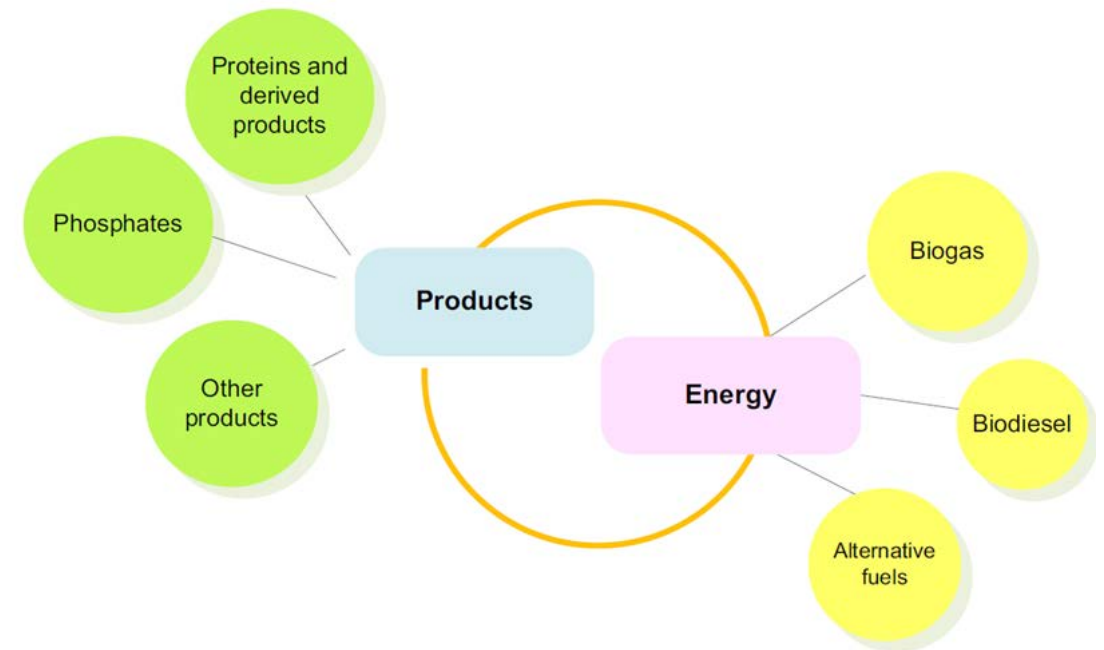
WHY FOCUS ON THE BIOECONOMY

The biobased economy cuts across sectors and industries and includes production of **renewable biological resources** as well as the use of **side-streams** and **rest products** to produce **high-value products** within food, feed, biobased materials, chemicals, cosmetics, medicinal goods, energy.

The precondition for the bioeconomy is new **knowledge**, new **technologies**, new **business models**, and new **value chains**.

Relevant **competences** include, among others, those within the natural and engineering sciences, life cycle analysis, and socio-economic analyses of value chains, innovation, industrial strategies, institutions and policies.

We should consider the **whole value chain** when developing new technologies, business models and policies



Valorisation potential of animal by-products and derived products. Source. Valta et al (2015)



GLOBAL CHALLENGES AND BIOECONOMY

- **Zero hunger** – More and cheaper nutrients from of our seas and landscapes
- **Responsible consumption and production** - consume less, prevent waste, reuse, recycle
- **Climate action** – substitute fossils with renewables; reduce land use emissions
- **Job creation** - local, rural and coastal development
- **Life on land** - reduce need for agricultural lands by using bio-resources more efficiently
- Strengthen **industry and innovation**
- **Affordable and clean energy** - waste-based bioenergy, free up land for advanced biofuels

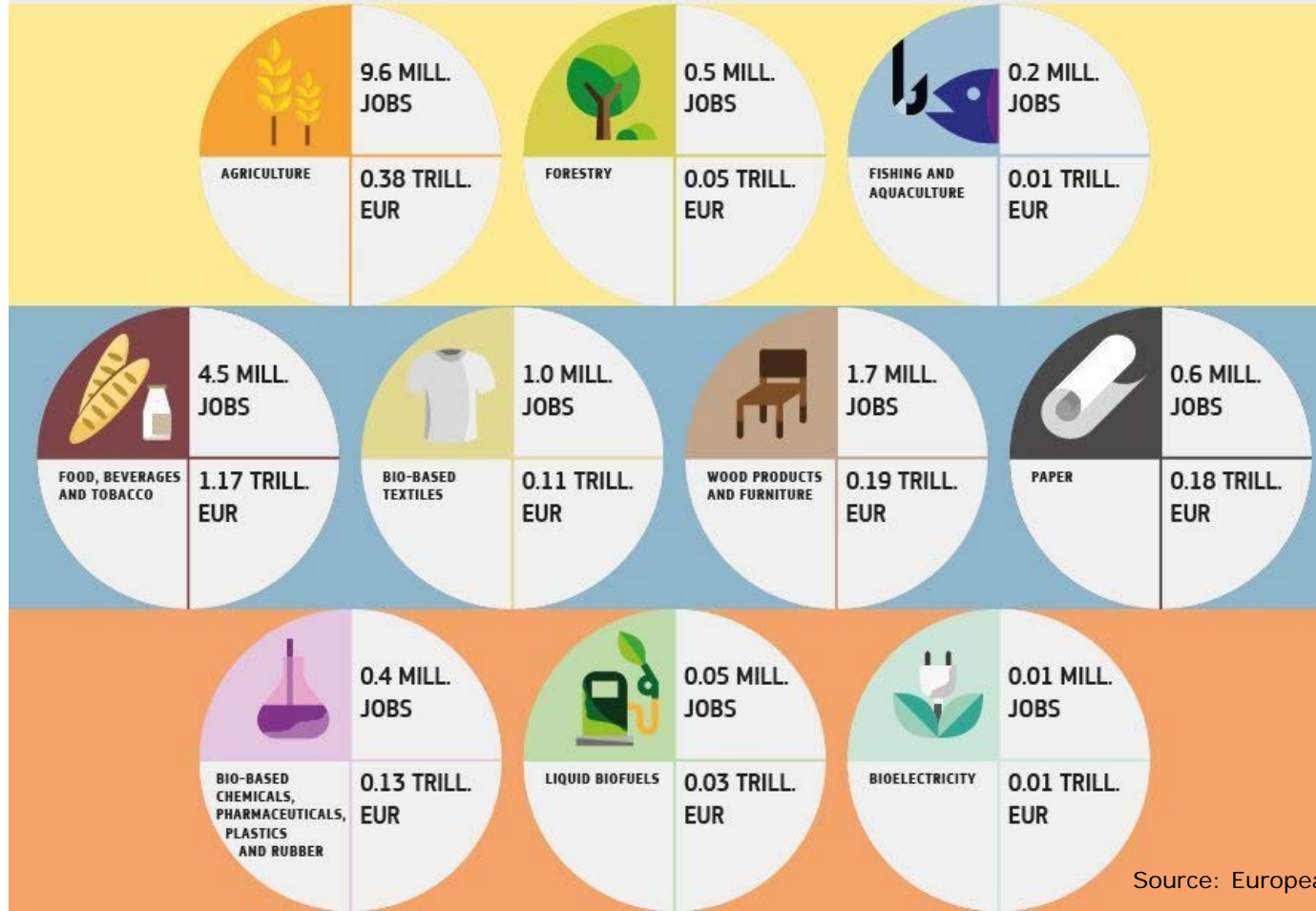
SUSTAINABLE DEVELOPMENT GOALS



BIOECONOMY

EMPLOYMENT
TURNOVER

18.6 MILL. JOBS
2.2 TRILL. EUR





FOOD INDUSTRY CASE STUDIES FROM NORWAY AND DENMARK



BREWERY

- 32 breweries in Denmark and Norway ranging from micro to global brewery.



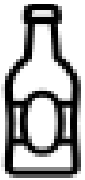
SLAUGHTERHOUSE

- Danish Crown (DK) and Danish Crown Ingredients (DK)
- DAKA (DK)
- BHJ (DK)
- Nortura (NO) and Norilia (NO)



DAIRY

- Arla Foods Ingredients (DK)
- TINE (NO)



BREWERY - SPENT GRAIN I

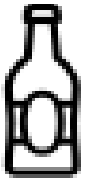


Main findings

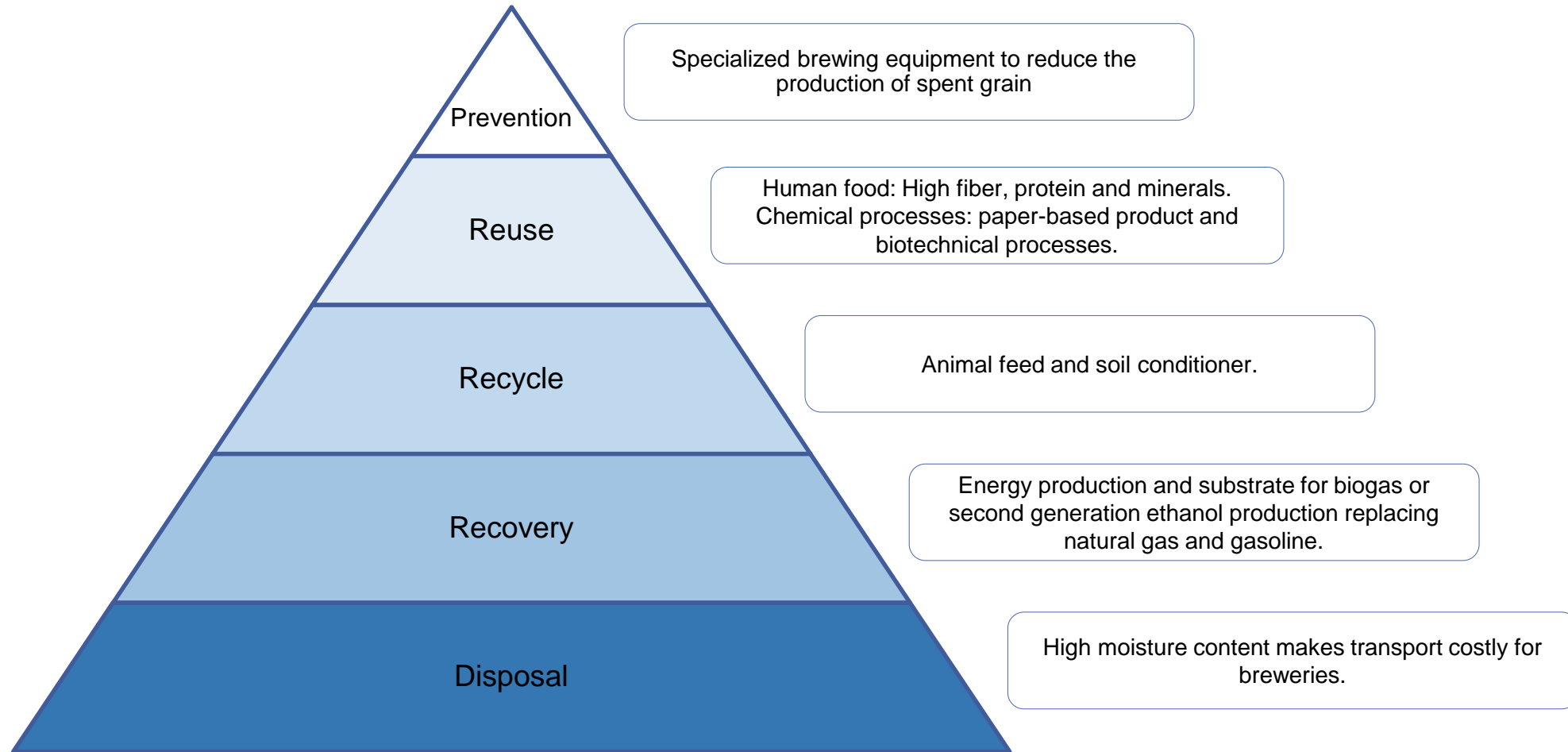
- Multiple case study of 32 breweries' utilization of the waste product spent grain from beer production.
- Spent grain is currently mainly used for animal feed. Research shows high technical potential for value added products
- Spent grain could provide producers with value and thereby competitive advantage through promotion of sustainable production (branding value) and they could obtain a higher price for the spent grain itself.
- The Nordic brewery industry has not yet developed a clear vision of the bioeconomy in relation to organic residues. Keeping the traditional approach.

Challenges:

- Brewers focus on product development and cost reduction. The spent grain side stream is considered a hassle. Most is given away for free. Brewers have little interest in or knowledge of spent grain processing.
- Difficult to be first-mover for small breweries due to small volumes and lack of finance.
- Valorization requires careful and quick handling before further processing. No attempt to pre-process (e.g. dewater)
- Successful implementation requires strong collaboration with downstream processors with the right knowledge and technology to valorize spent grain - e.g. feed producers and ingredients producers.
- Need for demonstration projects for spent grain valorization (beyond lab scale).



BREWERY - SPENT GRAIN II

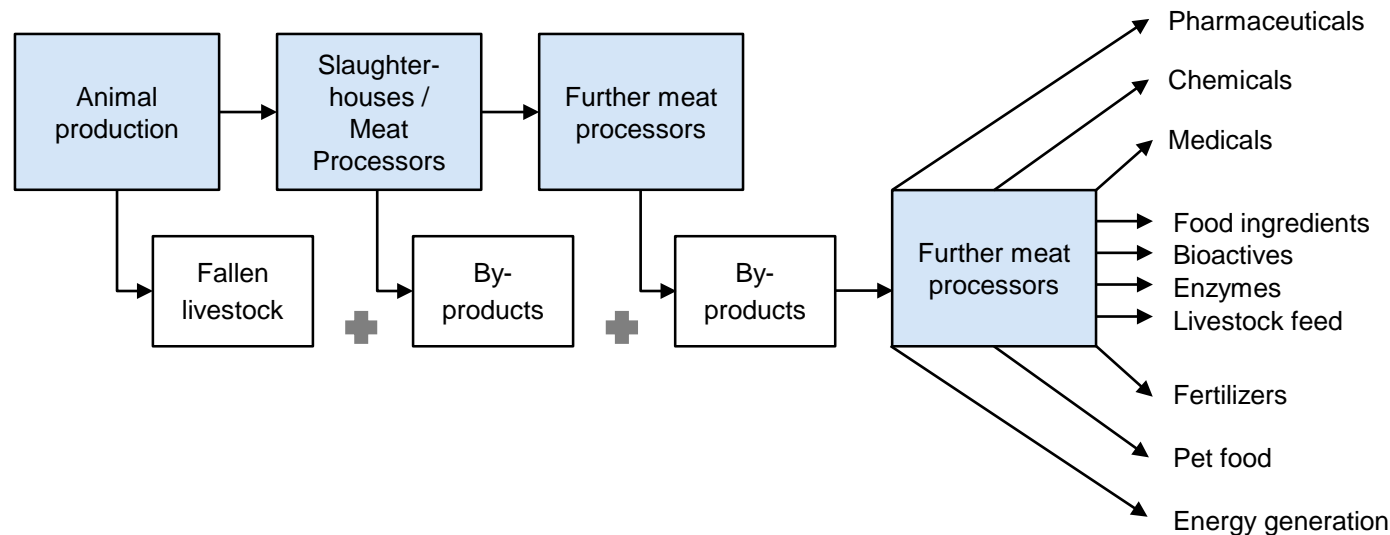




SLAUGHTERHOUSE - ANIMAL BY-PRODUCT

Main findings

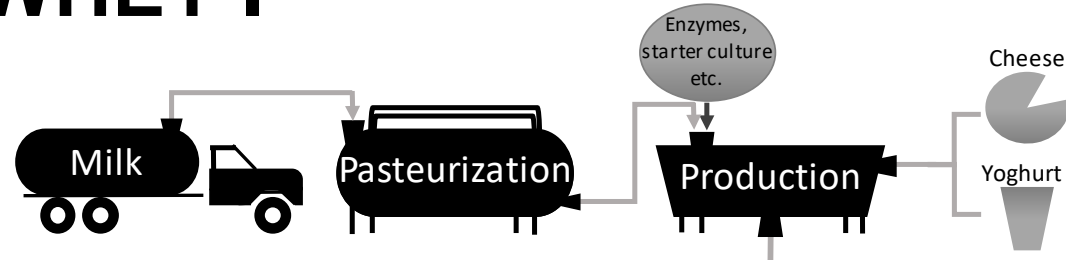
- Volume is +20 million tons in the EU.
- Decreasing volume of ABP due to increased export of 'low quality' parts (e.g. pigs ears)
- Industry is based on few but large companies/plants.
- Long history of mergers and acquisitions (Denmark).
- Internationalization and establishment of subsidiaries to handle ABP (Denmark).
- Institutional changes, especially EU regulation relating to food safety (mad cow disease) and trade barriers, have large impact in firm strategies in the value creation process.



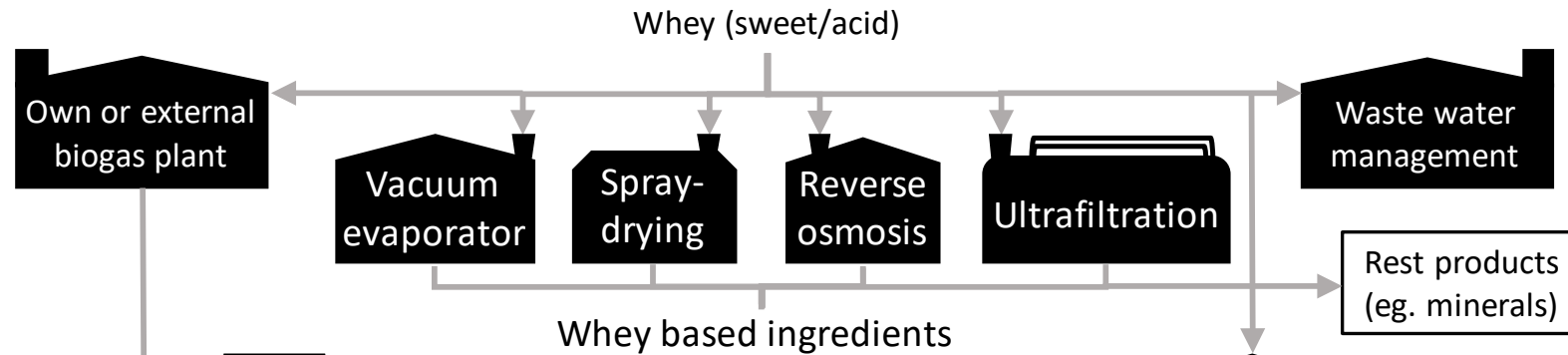


DAIRY - WHEY I

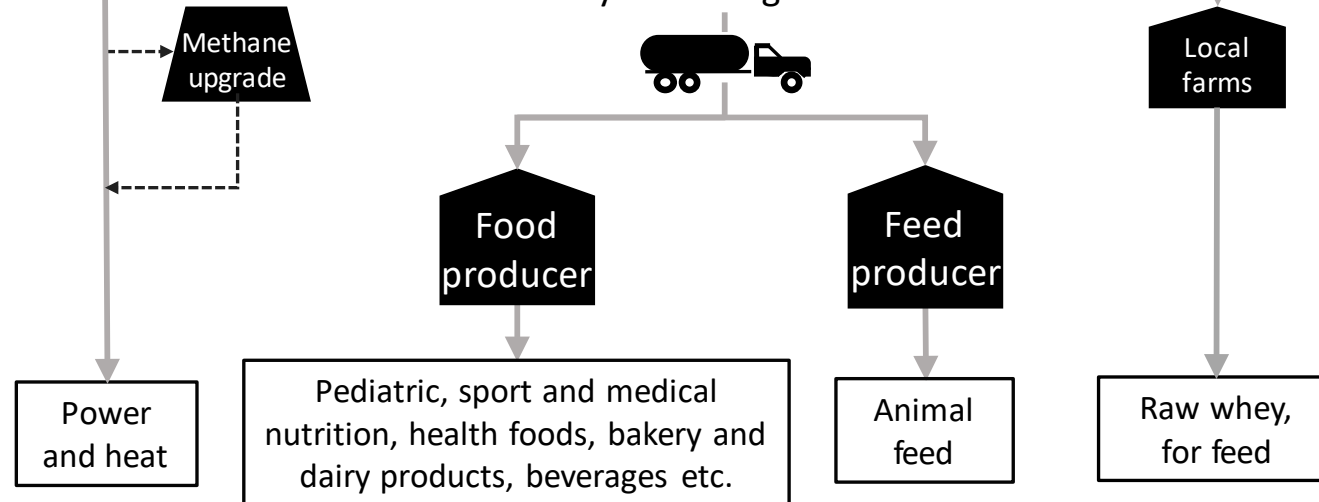
Cheese and yoghurt production



Whey processing



Applications of whey based ingredients



End use



DAIRY - WHEY II



Main findings

- Whey is a by-product of cheese and yoghurt production.
- Analysis of two main types of whey: sweet whey (large volume and use) and acid whey (small but increasing volume).
- High protein and mineral content makes whey suitable for human consumption.
- High commercial potential for whey-based products due to a fast-growing global market for functional and nutritional food ingredients. Based on sweet whey.
- Technical valorization options for acid whey - animal feed, nutritional products, bakery products, and beverages. But options are not used by industry in neither Denmark nor Norway. Acid whey is mainly used for animal feed and biogas.
- Nutrilac by Arla Foods Ingredients is a new whey protein, which enables the use of acid whey in high-value products.
- Fewer and more specialized dairy plants resulting in spatial concentration of specific side-streams.
- Regulations and tariff barriers limit valorization possibilities (Norway)
- Economies of scales in whey collection, processing and marketing (Denmark)
- Import of sweet whey raw material from neighboring countries (Denmark)
- Long-term learning effects (Denmark)
- Economies of scope in development of whey products (one resource → multiple products / ingredients)



SUMMARISING FACTORS OF WASTE VALORISATION ACROSS INDUSTRIES IN DK AND NORWAY



Factor	Denmark	Norway
Waste valorization patterns	<p>Advanced processing and products in dairy (high) and ABP (medium)</p> <p>Traditional use of spent grain in brewing (feed)</p>	<p>Bulk commodities in dairy and animal by-products; relatively low value added in dairy and animal by-products</p> <p>Traditional use in brewing (feed). Some disposal due to scattered farms.</p>
Internationalization	<p>High internationalization in dairy, meat and brewery industry. Dairy has lead firm position in value chains. Foreign direct investment by dairy.</p>	<p>Dairy depends on Danish company for access to ingredients market. 'Captive supplier' of whey intermediate products. No global breweries. Low level of internationalization in meat industry.</p>
Geography	<p>Short distances make collection and distribution of products and waste resources easier and cheaper.</p>	<p>Geographically dispersed farms and plants. High transport costs.</p>
Industrial structure, firm organization, and R&D	<p>Generally large plants (dairy, ABP). Has grown substantially through mergers, acquisitions, joint ventures and investments in processing capacities (dairy and ABP). Many small and medium sized breweries.</p> <p>Subsidiaries to handle R&D and marketing capabilities related to by-products in dairy and ABP. Lack of R&D projects in spent grain valorization (brewing).</p>	<p>Generally small plants oriented towards domestic market (dairy, ABP). Many small and medium sized breweries.</p> <p>No separate R&D department in dairy. Depends on Danish dairy for technological upgrading in whey processing. Lack of R&D projects in spent grain valorization (brewing).</p>
Political and economic context	<p>Easy access to EU markets. Export oriented agricultural sector. Liberalized national market.</p> <p>Dynamic global ingredients market is a key driver for dairy and ABP valorization.</p>	<p>General strong regulation and protection from foreign products. Not member of EU. Domestic market oriented industry.</p> <p>Dynamic global ingredients market, but not utilized by domestic industries (dairy and ABP).</p>

THANK YOU FOR LISTENING

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