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Technology Innovations and Business Models for Valorisation of Industrial Waste Biomass in Sparsely Located Enterprises

A close-up photograph of several green hop cones (briars) resting on a light-colored wooden surface. The hop cones are in various stages of maturity, with some showing more developed, papery bracts.

Circular economy cases and their business models in Norwegian brewing and distilling industry

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This is in the report for the WP 1 deliverable T 1.1.1 of the SYMBIOMA project (Technology Innovations and Business Models for Valorisation of Industrial Waste Biomass in Sparsely Located Enterprises. Case: Industrial Symbiosis for Valorisation of Waste Biomass from Food and Beverage Industries) (Project No. 352)

1 Breweries and their business models in Norway

There are 10 breweries and approximately 150 microbreweries in Norway. Approximately, half of these breweries are in the Norwegian NPA area which consists of six counties: Troms and Finnmark, Nordland, Trøndelag, Møre og Romsdal, Vestland and Rogaland. In the last years, home brewing has also expanded considerably.

In the period from January 2019 to January 2020, sales statistics show a total sale of 231 million litres of Norwegian brewed beer, and out of this, 10.3 million litres were brewed by microbreweries (data from The Norwegian Brewery Association, www.drikkeglede.no).

Currently, basically all malt for brewing is imported to Norway. Lindberg et al. (2016) estimate that this adds up to a total of 55 000 tons annually. They further explain that of this amount, the quantities consumed by home brewers is approximately 500 tons, to microbreweries 1 000 - 1 500 tons, while the rest is utilized by the larger breweries. Waste related to brewing is estimated to be approximately 17 000 tons, mainly in the form of Brewers Spent Grain (BSG) - i.e., dried spent grain (Lindberg et al., 2016)¹.

BSG is mainly utilized as feed, and the farmers themselves pick up the spent grain directly at

¹ Lindberg D., Aaby K., Borge G. I. A., Haugen J-E., Nilsson A., Rødbotten R and Sahlstrøm S., Kartlegging av restråstoff fra jordbruket, Nofima, Rapport 67/2016.

the brewery, immediately after the brewing (see example Figure 3). Of special consideration for the utilization as animal feed is the moisture content. Since spent grain has a high moisture content, it gets mouldy easy and has a very short shelf life, if not dried or frozen.

Lindberg et al. (2016) estimate that spent grain totals about 31% of the original malt weight, meaning that the total volume of spent grain in Norway is 17 000 tons. The report also explains that BSG consists mainly of the outer parts of the grain, and cell walls of the aleurone layer and the endosperm, but the chemical composition varies with the type of malt (barley) and the type of beer produced. In addition to the carbohydrates, BSG also contains about 15-24% protein, and 1-10% fat (Lindberg et al., 2016).

The total production area for barley in the Norwegian NPA region is 42540 hectares (SSB, 2018, www.ssb.no/jord-skog-jakt-og-fiskeri/statistikker/korn/aar-forelopige), and basically all this barley is utilized as feed. However, there is a growing interest in producing barley for malt in all parts of the Norwegian NPA region (Halland et al. 2016)².

² Halland H., Thomsen M and Dalmannsdottir S. (2018) Dyrking og bruk av korn i Nord-Norge. Kunnskap fra det Nord-Atlantiske prosjektet Northern Cereals 2015-2018. NIBIO rapport, Vol. 4, Nr. 86.



Figure 3 Spent grain used as feed for goats. Photo: Anette Tjomsland, NIBIO

Other ingredients used in the brewing process include hops, yeast, and herbs, fruit, or berries. Smaller amounts of these ingredients are also left after the processing. There are recent examples in the literature that yeast from the brewing is reused for the functioning of a spa, and that the same brewery has plans for using it in soap production (Bertella et al. in press)¹. In the beverage production, it is estimated that on average, beverage manufacturers use two litres of water per litre of finished product (data from The Norwegian Brewery Association, www.drikkeglede.no).

In its current stage, brewing results in two main streams: beverages for human consumption (mainly alcoholic), by-products which is subdivided into food and agricultural applications (Figure 6).

1 Bertella G., Halland H., Martin P. and Reykdal Ó., (in press), Book Chapter: Sustainable value: the perspective of micro-breweries in peripheral northern areas.

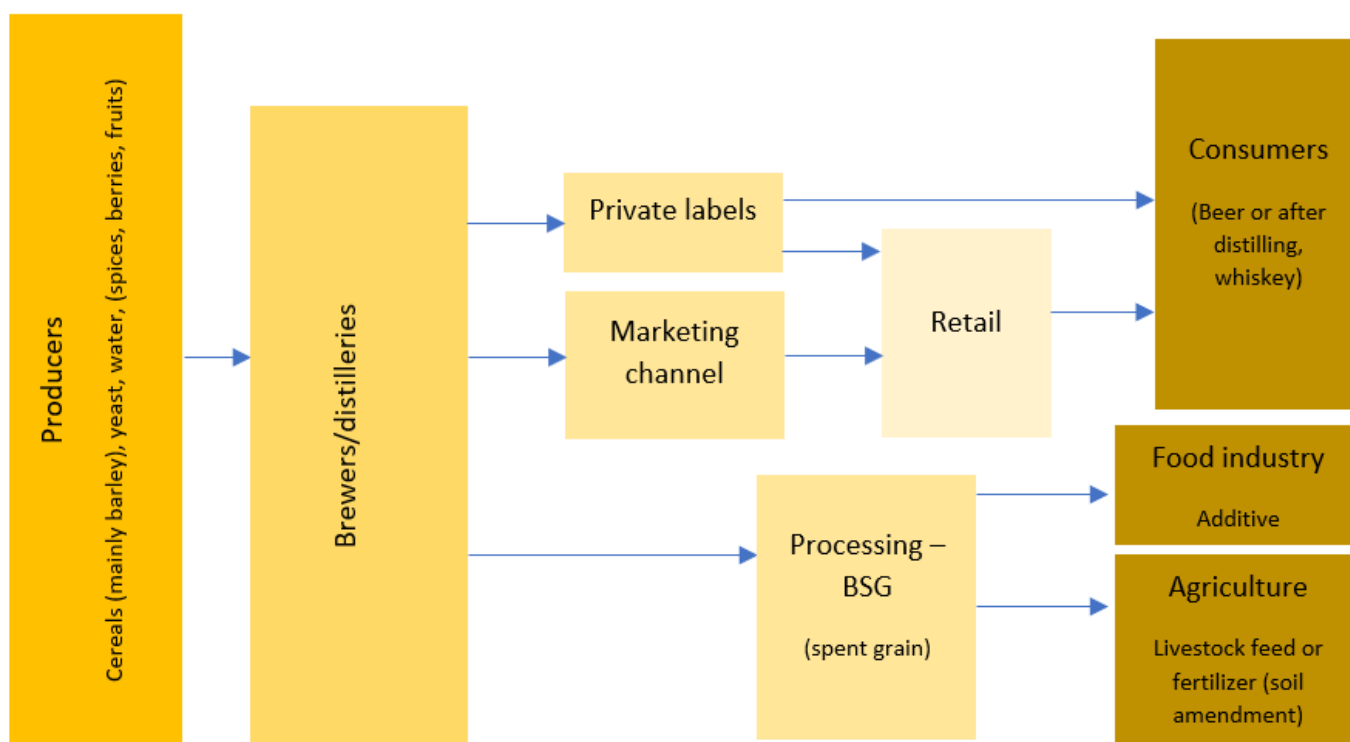
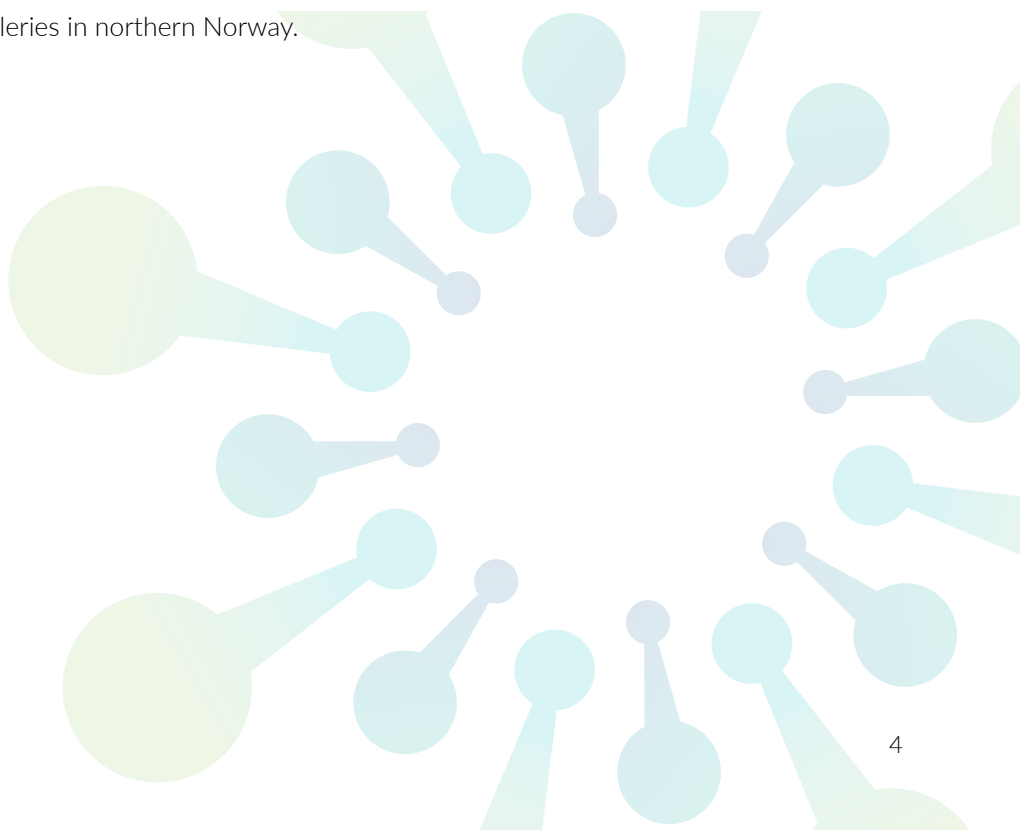


Figure 4 Value chain of brewing and distilleries in northern Norway.



1.1 Case 1: Whiskey producer in northern Norway

The company is a micro distillery that started up 5 years ago. Their main beverage products are whiskey and gin, but a big portion of their income comes from other activities related to tourism. The amount of waste is currently very small, about 750 kg of spent grain per week, and smaller amounts of yeast, pot ale, and some remains of herbs/berries. Today, essentially all waste is discarded directly because of logistical problems. There have however been some attempts on using spent grain as sheep feed and for producing local crispbread. Currently excess energy in production is not utilized, but they see a potential for utilizing it in the future.

1.2 Case 2: Microbrewery in northern Norway

The company has been producing beer for two years. In 2019 they produced 10 000 litres and the plan for 2020 is to triple their production. In addition to brewing, tourism is also a part of their business model. In 2020 they estimate that they will have about 11 tons of spent grain, where the main portion will be given to farmers as feed for sheep and cows. In addition, they made a contract with a local bakery that will use spent grain to produce crisp bread. They are also experimenting with producing their own planting soil mixing sheep manure, spent grain, and soil.

2 Future opportunities for waste handling:

- Food additives, example crisp bread.
- Agricultural applications, such as livestock feed or soil amendment.
- Feed for fish.
- Potential for utilizing excess heat energy from production.

3 Bottlenecks / challenges for efficient waste handling:

- Collaboration /common projects.
- Distance / location concerns, including logistics.
- Shelf life of spent grain: it easily moulds if not utilized directly, gets frozen, or dried.
- Fewer farmers that can utilize BSG for feed.
- Farmers might need specialized technical equipment for feeding with spent grain.

Example of valuables from by-products:

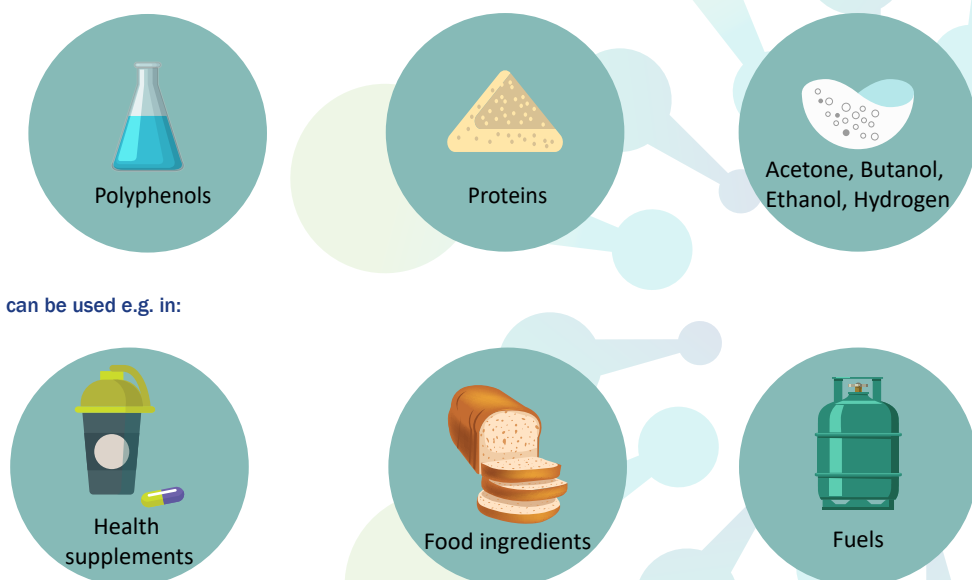


Figure 5: Valorisation possibilities of brewing and distilling by-products

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The project is being implemented by the following partners:

Lead partner



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Other partners



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The logo for Luleå University of Technology (LUT) features a large, stylized blue letter "L" on the right. To its left, the words "LULEÅ", "TEKNISKA", and "UNIVERSITET" are stacked vertically in a blue, all-caps sans-serif font.

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