2021

Circular Economy in the Brewing Industry

THE HISTORY, PRODUCTION PROCESS OF BEER & HOW CIRCULAR PRINCIPLES CAN BE APPLIED

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CONTENTS

This eBook thanks its conception to a combined passion for brewing and sustainability. Concepts that are dealt with in this eBook pertain to the origins of brewing, modern days brewing process and he issues that arise from this. Furthermore, trends that are happening in the industry today are discussed. This includes how breweries can and are using concepts of circular economy to not only serve their own bottom-line, but also improve the ecosystems for people and wildlife who occupy them.

1. A BRIEF HISTORY OF BEER BREWING

The emergence of beer can be traced back to beginnings of civilization and urbanisation during the Neolithic period. [1] The earliest chemical evidence of brewing with the use of barley go as far back as 4000 BC, but earlier discoveries are constantly being made by archaeologists. Beer brewing has been part of us for centuries. Its importance striking from scientific advancement, to the daily lives of people, the government, its economy and everyman's day-to-day life. What beer is today, can't be compared to what beer was 6000 years ago. At its inception, beer was only a grain-based, fermented beverage.[1] The beer we all love, and drink today is a hopped beverage obtained from liquified starch after fermentation with specific strains of yeasts. This sounds a lot more complicated, which it is. Beer, or brewing started from a humble origin.

In order to determine where the brewing of beer began, we must first set three prerequisites. Humans have been drinking fermented beverages ever since the Palaeolithic times, however these do not classify as 'brewing'. This started later on in human development. In 12.500 BC, the warming of our planet caused our last ice age to end. Through the centuries that followed humans began a transition from a nomadic, hunters and gatherers civilization, to stocking up supplies and settling in specific places and allowing larger groups to form ranging from 25 to 50. The earliest civilisations popped up in an area in the Middle East we now know as southern Iraq, Syria, Lebanon, Jordan, Palestine, Israel, Egypt, and parts of Turkey and Iran. Also called the Fertile Crescent, these small communities were possible due to the regular flooding's of the Euphrates, Tigris and Nile rivers, leaving behind an extremely fertile soil.[2]

From 5000BC the prerequisites necessary for brewing emerged: (1) the availability of specific grains, (2) a reliable and controllable fire / energy source, (3) pottery strong enough to be brewed in.[1] The human race was only able to get to this point by learning from past experiences, experimenting with new applications of tools, continuous exploring and a bit of luck. These early settlements started specifying to their needs, selecting specific animals and plants. The plants included grains such as wheat, einkorn and barley, as they formed a source for carbohydrates and protein. The cultivating of these grains quickly led to the experimentation and the eventual innovation working with grains. It is therefore no surprise that some of the oldest traces of grain-based fermented beverages originate from the Fertile Crescent and Egypt. The oldest evidence of fermented beverages comes from China, in the Henan Province. In a little village called Jiahu, a jar was found containing a mixture of rice, honey and fruit, dating back as early as 7000BC.[3]

From the start of recorded human existence when we still shared our planet with the mammoth, beer-like beverages have been part of our lives. As civilisations discovered beer-like beverages and the knowledge spread throughout the world, it affected civilisations differently.

[1] Franz G. Meussdoerffer, A Comprehensive History of Beer Brewing, (April 2009)

[2] National Geographic, 'Fertile Crescent', *National Geographic*, (April 2019)

[3] Patrick E. McGovern, Fermented Beverages of Pre- and Proto-Historic China, (December 2004)

Mesopotamia and Egypt

The first area of the Fertile Crescent to form civilisations and become relatively populous was Mesopotamia, an area we know today as Iraq and Kuwait. The biggest Mesopotamian civilisations were the Sumerian, Assyrian, Akkadian, and Babylonian.[4] Ancient Egypt experienced the same increase in civilisation due its intersection with the river Nile. Historic evidence shows that these Mesopotamian and Egyptian societies made extensively use of technology, literature, philosophy, religion, and legal codes. It is from these societies that the development of the first written texts emerged between 3300 – 3100BC.[1] These ancient documents already contained information about beer, showing its significance in day-to-day life. There are Mesopotamian documents specifically addressing ingredients that were used in the process. The texts mention 'bappir', which translates to beer-bread, 'munu' which means a malted cereal, 'titab' which is understood as a malted grain mash and talks about the use of a fermented mixture of herbs.[5] The importance of beer and other alcoholic beverages were for these ancient civilisations was immense. Alcoholic beverages were used to reach ecstasy and were poured at ceremonial banquets and as a spiritual exercise to try to reach unification with the gods. Beer was seen as a offering to the gods. The Mesopotamians believed beer to be part of the 'divine's diet', as it was for them. Besides ecstasy beer was also used in medicine and religious rituals. Brewing techniques improved drastically during this period of history. During the late Uruk period around 3100BC, there were approximately nine barley produced beers. By the time the new the New Babylonian Empire had come around in 500BC there were up to 70 different types of beer.[6]

Greeks and Romans

Under Alexander the Great's rule Greece conquered Egypt in 331BC, establishing the Ptolemaic dynasty.[7] This brought the introduction of wine along with it, quickly becoming a drink for the upper classes of society. Under the motivation of combatting the overconsumption, beer was taxed regulated by the state for the first time in history. Greek culture had a prejudice against beer. Whether one drank beer or not was seen as the distinction between barbarians and people of culture. Another cultural distinction was that wine was considered a drink of masculinity, while beer was a drink of effeminacy. There was also an underlying reason for the new regulations. The Greeks, and later the Romans too, were avid consumers and traders of wine. Upon discovery that Egypt was mainly a beer-drinking country, the Greeks decided change this as the suppliers of beer mainly consisted out of enemies, among which the Thracians and the Gauls.[1] Later on, the Romans took over this same prejudice and feeling of superiority over lower class beer-drinkers. The Romans encountered their own hostile, beer-drinking countries during their expansion in lands we now refer to as Germany and Britain. The irony of the Romans was that during this expansion of conquered land the troops required alcoholic beverages for morale. The regions of Northern Europe in which they

[4] Khan Academy, 'Ancient Mesopotamian Civilizations', *Khan Academy*, (January 2020)

[5] M. Civil, A Hym To The Beer Goddess and A Drinking Song, (June 1964)

[6] P. Damerow, Sumerian Beer: The Origins of Brewing Technology in Ancient Mesopotamia, (January 2012)

[7] Khan Academy, 'The Ptolemaic Dynasty, *Khan Academy*, (January 2020)

were fighting were without viniculture and therefore the Roman leaders required beer for their legions. In order to do so the Romans built breweries, of which the remains can still be found.

Celts and Germans

The knowledge of grain cultivation reached Northern Europe around 6000BC, after which the emergence of beer came similar to cultures that came before. There was a difference in the production process as the air-drying of soaked cereals would not result malt due to the wetter climate. The Celts developed a method during the malting process referred to as 'kilning', where the germinated barley is heated to develop the malty flavours.[8] The Celts emerged around 700BC in Central Europe. In the centuries that followed they expanded west to Gaul and Iberia, south to Italy, and eastbound into Greece, Hungary and Turkey. Although the Celts had significant experience when it came to brewing, they obtained far more during these conquests through Europe and beyond. The Celts found that all these countries were producing the same beverage from grain, just calling it differently. What they called 'zynthos' in Egypt, was called 'caelia' in Spain and 'cervesia' in Gaul.[1] Between 300BC and 100AD, the Celts power slowly diminished, and they were forced back into Central and North Europe. The Early Germanic tribes were scattered throughout the region of modern-day Germany. Each tribe had its own dialect; however they could understand one another. They also shared the same beliefs and mythology. Bar from the vast quantities that the Germanic tribes drank, not much is known about their brewing process. Evidence shows the tribes had similar issues to the Celts, not being able to dry the soaked cereals. The Germans found their own way round this. After the cereals were soaked, they were not dried. Instead, they were smashed and squashed. This resulted in a mash, which was then fermented using airborne yeast.[1]

During the third and fourth century AD, the Germanic tribes came in touch with the Romans. The Roman technology combined with the Germans love for beer would start the continued innovation of beer throughout the coming centuries and eventually result in the beer we know today.

The Truly Happy Man Has His Mouth Full of Beer – Egyptian Proverb.

[8] Keith Thomas, 'Kilning', *Beer & Brewing* (2020)

2. TODAY'S MARKET FOR BEER

Nowadays, beer is the fifth most consumed beverage in the world after tea, coffee, milk, and soft drinks. Globally, the average person drinks 24 litres per year.[9] The brewing industry is one of the oldest in the world and has an ancient tradition, yet it's also a dynamic sector open to innovation and developments as technology progresses.

This year, the global beer industry is projected to earn €576,891 million in revenue, of which €99,616 million will be generated by the US.[10] Beer is the alcoholic drink industry's biggest player in volume and value. That being said, it is a very concentrated market with 60% of all beer being produced by only five major players. Anheuser-Busch InBev is market leader with a share of 30%, followed by Heineken N.V. at 20%. Carlsberg Group, Molson Coors, Asahi Group, and China Resources Beer share third spot with 5% market share.[10]

Between 2020 and 2025 the global beer industry is expected to experience growth of 5.5%.[11] This growth is caused by certain trends in the industry[11]:

- Lifestyles are changing; the rate of consumption beer is increasing, the rapid pace of urbanisation, the increasing amount of disposable income per capita, and the continuous growth of beer among young members of civilisation.
- Craft breweries experimenting with beer; the introduction of new ingredients and flavours has spiked popularity for craft beers among millennials.
- Experts of beer; the continuously increasing popularity of craft beer has allowed for more people to understand what it is they like in their beers, becoming more aware of flavours.
- Leaders following the lead; the immense micro-brewery- generated demand for craft beers has caused such a big splash, all big industry leaders have now followed suit and are also playing into this trend by widening their product portfolio's.
- Low-alcohol option; no-alcohol and low-alcohol beers are becoming more popular as they cost less than regular beers and the market's interest in health-consciousness increases (especially in Europe).

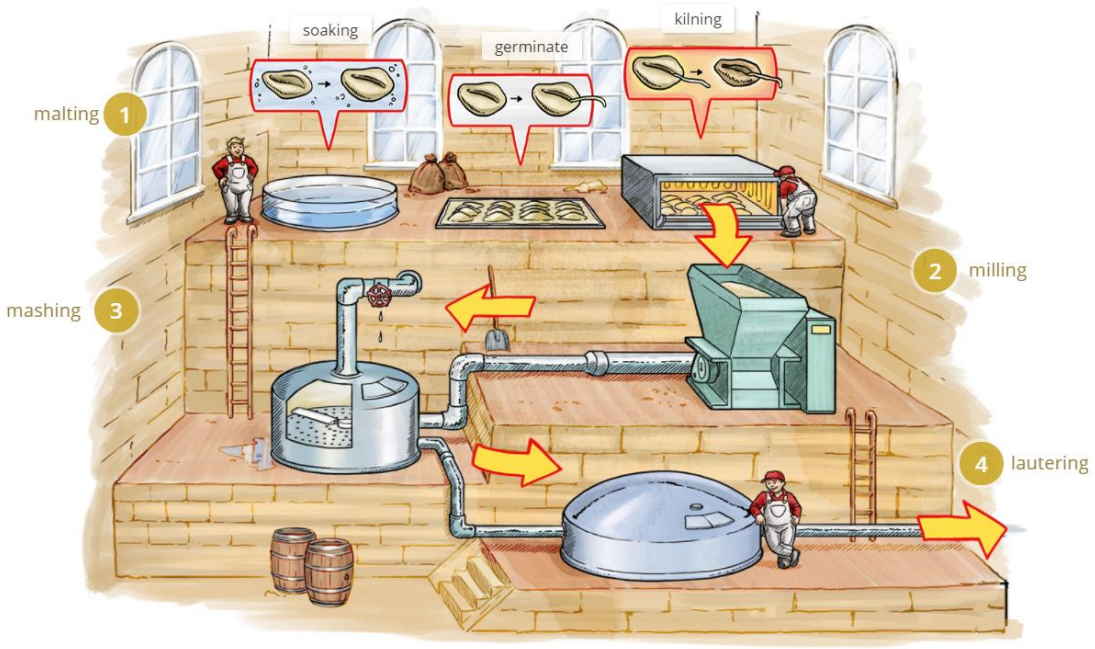
As the market becomes more aware of environmental changes and the impact businesses have, new challenges arise for the brewing industry. Issues pertaining to water consumption, waste generation, energy efficiency, emission management and environmental impact of the brewing process have all become topics of discussion and are experiencing increased attention from the big, and small players of the industry.

[9] L. Fillaudeau, Water, Wastewater and Waste Management in Brewing Industries, (December 2006)
[10] Statista, Beer Worldwide, *Statista*, (November 2020)
[11] Mordor Intelligence, Beer Market: Growth, Trends and Forecasts, *Mordor Intelligence* (January 2020)

3. THE BREWING PROCESS

The magic recipe that makes beer what it is today did not fall from the sky right into our lap, it took centuries of experimenting, tasting and perfecting. There is no one 'golden rule' to producing beer, every brewer has his or her tricks and like painters, their own signature style.

Generally, most brewing processes follow these steps.



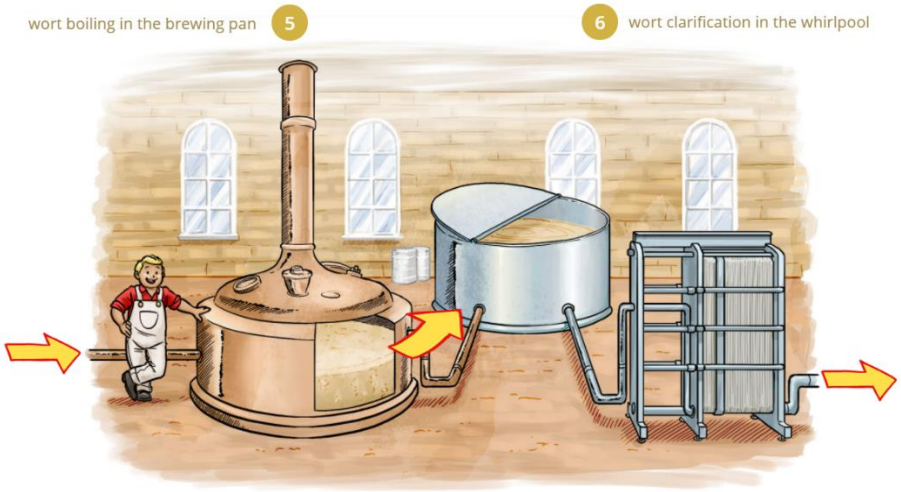
The first step of the brewing process is referred to as *malting*. Fresh barley gets soaked in water and put into germinating boxes which causes enzymes to form called amylase. This enzyme is essential because it allows for the starch to separate. At the perfect time, the germinating process is put to a halt and the malt is heated at 80° Celsius. This drying process is also called kilning and results in a malt with a slightly sweet taste.[12]

The next step is the *milling* of the malt. This is important as it will allow for the malt to mix better with water. Once the malt has a flour type consistency it gets pushed on into the mash tun where it dissolves in water. This step is called *mashing*. The starch dissolves and sugar, protein and tannin are resealed. The end-product of the mashing process is a malt extract.[12]

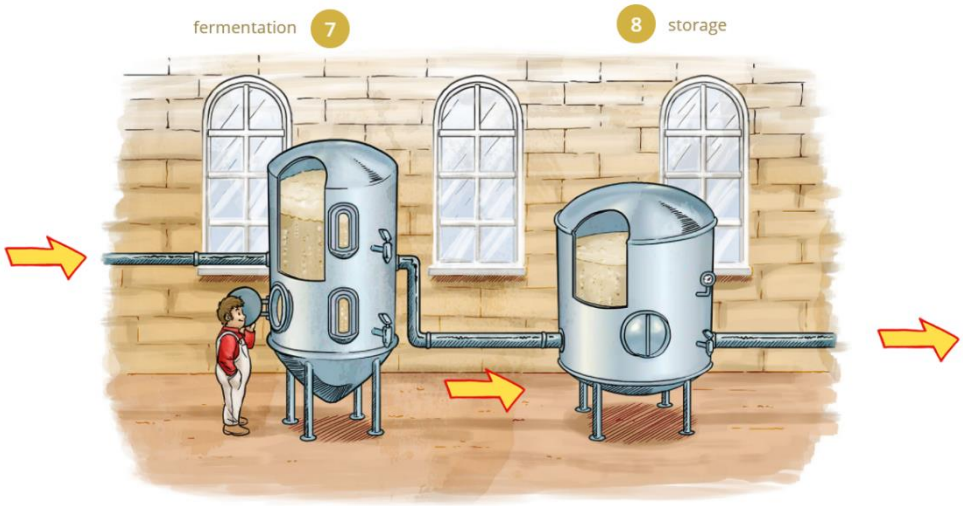
The fourth step of the brewing process is called *lautering*. The lauter tun is essentially a big filter, used to separate the 'wort' from the solid spent grains. The grains have served their purpose and are discarded. The wort will form the foundation for the beer we are making.[12]

[12] Braeu Am Berg, Brewing Simply Explained: from Fresh Barley to the Finished Beer, *Braeu Am Berg*, (2016)

Now that we have our wort we can move onto the next step, *boiling* the wort. While the boiling takes place, hops are added to the mixture. The type and amount of hops will result in different flavours. The more hops, the bitterer the beer will be. The boiling of the wort causes water to evaporate and become more concentrated, deactivating the malt enzymes. By his point, the protein and tannin in the mixture have become 'trub' at the bottom of the concentrated wort. The trub is separated from the wort before moving on.[12]

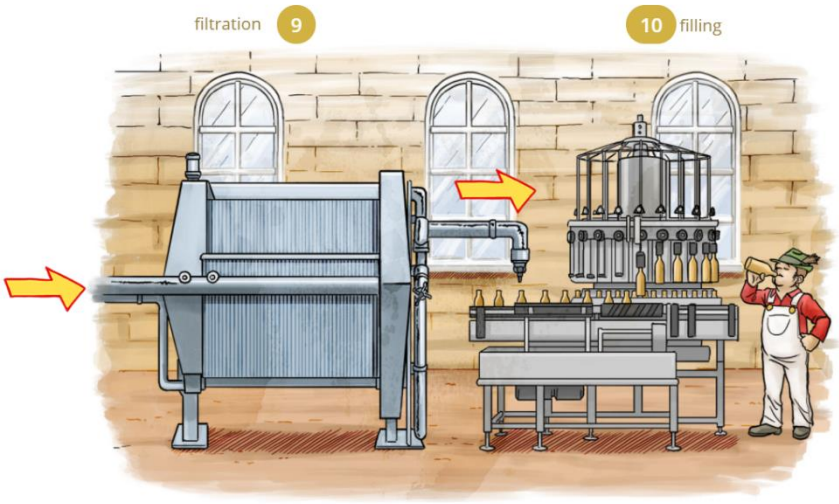


The sixth step is the *clarification* of wort. The wort continues on into a whirlpool that will rotate the liquid. The rotations cause any leftover trub to be centred in the middle of the pool, allowing for the clear wort to be tapped away from the outside. The clear wort is transported to a wort cooler, where it needs to be cooled to a temperature between 10° and 20° Celsius.[12]



Step seven of the brewing process is *fermentation*, the creation of alcohol. Once cooled, the clear wort goes into the fermentation tank. This is where brewing yeast is added, which causes a chemical response in the malt sugar creating carbon dioxide and alcohol. Once the fermentation is complete, the wort has almost fulfilled its journey in becoming beer. A second fermentation need to take place. The eight step of the process, *storage*. Depending on the type of beer being made, the freshly brewed, almost-beer rests in the storage tank ranging from three weeks up to three months. This second fermentation is what makes the solution clear and gives the beer its characteristic colour.[12]

Step number nine entails the filtration of any unwanted substances left in the beer after the first and second fermentation phases. This consists out of protein, yeast particles and resin from the hop. Once filtered out, the beer will get its final, clear transparency.[12]



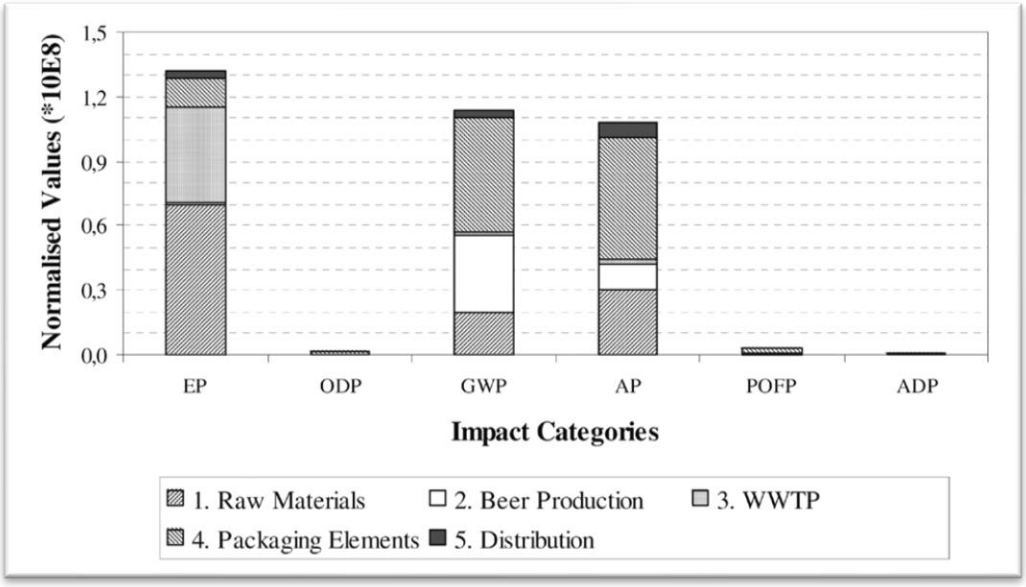
To complete the beer brewing process only one step remains. Step 10, *filling*. Depending on the brewery either cans or bottles are used to house the finished beer, until it finds the way to its eager consumer.[12]

4. ENVIRONMENTAL IMPACT

Besides the carbonated, hoppy and bitter drink loved by many, the beer brewing process also has other outputs. These cause a negative effect to occur within the environment. Producing and selling beer requires all sorts of inputs, such as raw materials, machinery, packaging materials and of course transportation. There inputs require energy, fuel, capital, and create waste which have a negative effect on the environment.

These impacts differ per phase of the product life cycle of beer. The total process can be divided into five different stages: production and transportation of raw materials, beer production, wastewater treatment at the brewery, production and transportation of packaging, and distribution to customers.

The relative impacts for each stage are shown in the figure below which was calculated for beer production in the Galicia region of Spain[13]:



From this analysis, the stages identified to have the most harmful impact to the environment are:

- Raw material production and transportation
- Beer production
- Production and transportation of packaging.

The figure also highlights the main LCA categories implicated by beer, namely Eutrophication potential (nitrogen, phosphorus, contributing to nutrient pollution), Global Warming potential (CO2 equivalents contributing to climate change), and acidification potential (sulphur dioxide, nitrogen oxide contributing to acid rain).

[13] A. Hospido, Environmental Analysis of Beer Production, (February 2005)

A similar picture is confirmed in a more recent LCA study for beer brewing in the UK[14]. Although the methodology used was different, it again confirmed that the main hotspots in the life cycle of beer are the raw materials (especially malted barley) and packaging (notably glass bottles).

Raw material production and transportation

Besides being beer's main ingredient, barley is also the most polluting agricultural input needed for production. This is because barley cultivation emits pollutants to land and water and into the atmosphere. Malted barely generates 57% of the total Global Warming potential emissions of all raw materials, with liquified carbon dioxide at 11%, light fuel oil at 10%.[14] Once produced, the raw materials need to be transported to the brewing plant. The emissions and therefore environmental impact generated by this differs, depending on the proximity of the raw material production plant to the brewing plant.

Beer production

Raw materials used during the beer brewing process contribute from 24% (glass bottles) to 39% (steel cans) of the total greenhouse gases emitted. This is mainly due processing of barley malt, which is very energy intensive.

In addition to the energy use, the processing of malted barley causes a significant wastewater discharge. Such wastewater has a high organic content which is hazardous if released to the environment without treatment. Most countries require such wastewater to be treated which requires further inputs and energy. Typical values for wastewater from breweries before treatment are shown in the table below[14]:

Typical Ranges Of Brewery Pre-Treated "End-Of-Pipe" Wastewater Effluent

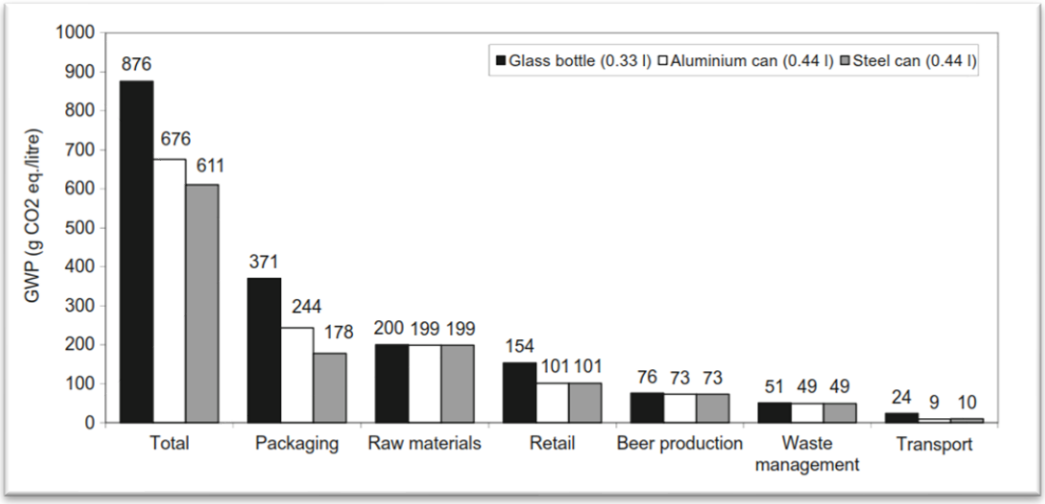
PARAMETER	TYPICAL RANGES
BOD	100 - 400 ppm
pH	6-9
TSS	50-500 ppm

BOD – Biological Oxygen Demand; pH measures acid/alkalinity; TSS – Total Suspended Slids

[14] D. Amieyo, Life Cycle Environmtental Impacts and Costs of Beer Production and Consumption in the UK, (March 2015)

Packaging production and transportation

Packaging is a hotpot for environmental impact, contributing between 35 % (steel cans) and 55 % (glass bottles). This is due to CO2 emissions created from the production of these packaging materials. Packaging is the second largest lifetime cost contributor, ranging from 8% (steel cans), to 13% (glass bottles), to 19% (aluminium cans).[14]**Fout! Bladwijzer niet gedefinieerd.** The figure below shows the difference in Global Warming potential (CO2 equivalents) for glass, aluminium and steel



cans.

Once produced, the packaging is transported to the brewing facility. Depending on the proximity to one another, the emissions created by this differ. At the end of a beer's product life, it gets disposed of. The packaging will also contribute to the global waste problem.

This UK study concluded that beer in steel cans (kegs) has the lowest impacts for five out of 12 impact categories considered: primary energy demand, depletion of abiotic resources, acidification, marine and freshwater toxicity. Bottled beer is the worst option for nine impact categories, including global warming and primary energy demand, but it has the lowest human toxicity potential. Beer in aluminium cans is the best option for ozone layer depletion and photochemical smog but has the highest human and marine toxicity potentials.[14]

Summarising notes

Beer production itself only generates a small portion of the total environmental impacts generated. The largest percentage is created by the production and disposal of packaging materials. Following this, the second most polluting stage within the life span of beer is the harvesting and transportation of barley cereals. A third important impact is caused by the wastewater produced in the brewing process which needs to be treated before it can be released to the environment, usually via the sewer system. Improvements are necessary in regard to these aspects of the brewing process to achieve a sustainable future for the industry.

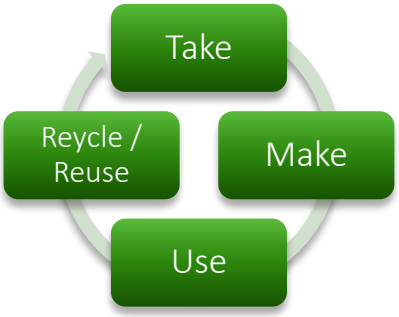
5. RETHINKING THROUGH CIRCULARITY

Traditionally, our economy and our business models have always been linear. The idea is based around the taking natural resources, making products, and disposing of these after use. It can be considered a straight line, take-make-dispose.[15]

Although this way of doing business has worked great for companies and has led them to significant economic prosperity, it has also created its own problems. Our fossil fuels are diminishing, and industry has and still is causing irreversible damage to our planet such as pollution, contamination and global warming.

The Circular Economy

Linear business has to adapt. It has to adapt its shape in order to incorporate functions and activities that prevent these negative impacts from doing business. Business needs to modernize, focussing on more than just economic prosperity and taking the social and ecological effects of business into account. Rather than doing business in the traditional, straight-line, linear way, business models should adapt and transform into a circular shape. A shape that will allow for the prevention waste and pollution, keep materials and products in use, and use green energy.[15]



The main principles of circular business models is to take products and materials from the economy (not from nature), create more value through extension of product and materials lifespans, looking beyond just serving the end-customer and also taking the ecological and social impacts into account.[15]

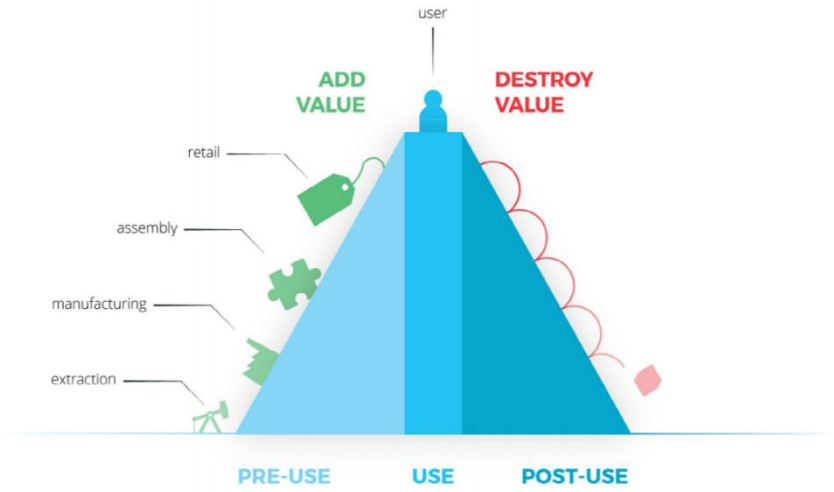
Circular economy is all about transforming these traditional, straight-line business models, bringing both 'ends' together, closing loops sustainably. Loops can be closed through slowing resource loops through the design of long-life goods and product life extension, through recycling (resulting in a circular flow of materials), or through narrowing loops and focussing on reducing resource flows. For this to be possible collaboration between companies, consumers, institutions and governments is required.

[15] Board of Innovation, 'Circular Business Models Explained', *Board of Innovation*, (2020)

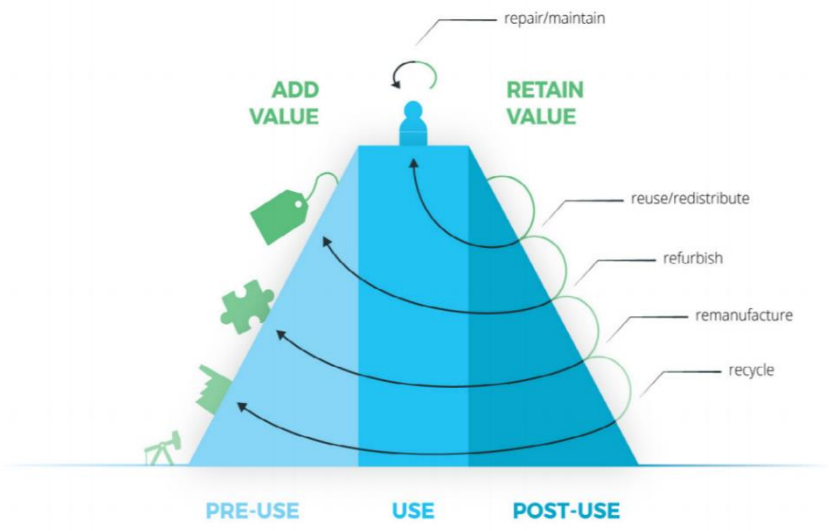
The Value Hill

In a traditional linear economy, a product keeps increasing in value from the moment the raw material is harvested, all the way to when the end-product in bought by the customer.

From this point, the product starts to lose its value. In this economy, the goal is to sell as many products as possible. This leads to manufacturers designing their products to intentionally have shorter lifespans.[16]



The goal of circular business is to maintain the value of a materials and products for as long as possible, striving to make them last forever. Similar to a linear business model, value is added to a product as it moves up the hill. The difference lies in what happens when the product starts moving downhill.



Products are designed to have a longer lifespan. This is achieved through designing with reusing materials, refurbishing products, remanufacturing component, and recycling leftover waste in mind. This way value is added to a product, even while moving downwards on the value hill.[16]

There are three ways to use the value hill as a business tool:

- Circular design, designing products and materials for longer use with the aim of long-term value retention.
- Optimal use, supporting better usage and product productivity during a products lifespan.

[16] E. Achterberg, Master Circular Business with the Value Hill, (September 2016)

- Value recovery, capturing value at the end of a products lifespan.

Circular Economy and the Beer Brewing Process

An age-old tradition that has been part of human progression for 6000 years. Originally a drink of the gods, today everybody's drink. Beer brewing has attached itself to us and we to it. Beer is part of human society and has nestled itself in our culture. Alcoholic drinks are used to define an occasion in many cultures. Of all alcoholic beverages, beer is the most versatile, normalised in many situations. Watching a game of football, having a barbeque, hanging out in the pub at the end of a long week.

In today's world, environmental friendliness is already important, and this will only increase as time passes, driven by an increasing demand for sustainable goods from the public and rules and regulations. Still, many businesses believe sustainability is a risk to their competitiveness. Some CEOs only see obstacles, such as the costs of new equipment and innovation, increased complication with finding sustainable suppliers, and a lack of demand for higher-priced, sustainable goods. These CEOs can't see through these barriers. What they need to is to adjust their gaze.[17]

From a short-term perspective, sustainable business practices can be seen to cost more than they contribute. However, companies striving for long-term financial stability through sustainability have proven otherwise. A study conducted by Harvard Business Review followed 30 large corporations to analyse impact of introducing sustainable practices. The research yielded impressive results as the companies found that sustainability became the driver behind technological and organisational innovation. In the long-run, environmental friendliness lowers costs and create opportunities. The corporations manage to decrease costs due to reducing the amounts of inputs needed to run operations, increased revenue by creating higher quality products from properly sourced materials, and even identified new markets and created new business for these.[17]

The global quest for sustainability is out of its baby shoes but remains in its infancy. Sustainability is transforming the competitive landscape and is driving businesses all around the world to rethink their business models, products and services, technologies and processes. Beer brewing, a process that has undergone many changes over human history, now needs to make further steps forward as a mature industry.

[17] R. Nidumolu, Why Sustainability is Now the Key Driver of Innovation, Harvard Business Review, (September 2009)

As stated in the section on environmental impacts above, the most harmful aspects of the beer brewing and selling process are raw material transportation, brewing operations, packaging production and packaging transportation.

This results in the output of:

- Greenhouse gas emissions
- Wastewater
- Packaging materials that need to be disposed of

Ways to address these negative impacts using circular thinking approaches are described below.

Greenhouse gases

The image below illustrates the proportion of greenhouse gas emissions generated by every stage in the lifecycle of beer.

The generation of greenhouse gases starts with agricultural suppliers. This 17% comes from the cultivation of barley, hops and other ingredients used in the brewing process of beer creates emissions. Once the ingredients arrive, they are malted. Brewing activities result in 14% of total emissions created due to the amount of heating required and the machinery used. Packaging is the biggest source of greenhouse gasses due to industry intensive production of glass, aluminium and steel and paper and the effort that goes into disposal. Transportation of the finished beer creates 14% of emissions, however this is different for most breweries depending on distance to consumer. Finally, in order to make the beer ready for consumption it needs to be chilled in fridges. This produces relatively low emissions due to refrigerators becoming more energy efficient with every generation of product.[18]

Solution → Reduce GHG emissions from barley cultivation through 'conservation agriculture'

[18] J. Williams, 'What Can a Beer Company Do To Meet the Sustainable Development Goals', *Earthbound*, (September 2018)

Conservation agriculture consists of a range of better farming practices that substantially reduce the GHG emissions and other negative impacts of crops. Reducing fertilizer use to the minimum required (precision application) is a keyway to reduce emissions given the intensive energy demand of producing artificial fertilisers. Reducing tillage is another way to cut emissions from soil. Such good practices also tend to increase water retention and increase soil fertility. Related to this, increased energy efficiency in drying the malted barley and the use of renewable energy for this would further contribute to reducing thew impact of the agricultural raw materials.

Solution → Use renewable energy, electric equipment and machinery in breweries and for transport

Rather than using conventional thermal energy sources (fossil-fuels, nuclear), replacing this with renewable energy can have a massive impact on greenhouse emissions generated from operations in a brewery. In fact, renewable energy sources produce nearly no greenhouse gases nor other kinds of polluting gasses, except for relatively small amounts needed to produce and maintain the infrastructure E.g., solar cells, windmills, storage facilities. Since this also requires government action in terms of enabling policies and infrastructure provision, moving to 100% renewable energy across all aspects of the life cycle will take time. Breweries can of course take many steps on their own initiative. Combined with electric transportation of the finished product, and the creation of a low/zero carbon footprint beer is the prize awaiting the leaders.

Packaging materials

As shown in the figure, and also confirmed by the UK life cycle analysis study above, packaging is the single largest contributor to GHG emission and to the overall life cycle impact of beer. This comes from the life cycle of bottles, cans, and kegs that are used to contain, store and from which beer is served. Added to these materials is the paper, carton and plastics used to label products, to protect in transit, and to present them to consumers. Impacts are seen in the production of the raw materials and in turning these into useful products. Of course, the packaging is often also the most visible public impact due to littering and household waste collection.

Beer companies are consequently significant contributors to the GHG and global waste problem through their choice of packaging. Fortunately, there are options available to change this. Which specific solution they choose will be partly related to national policies and the market into which they are selling.

Solution → Use raw materials with high % recycled or alternative material content

In markets where there are mandatory deposit and return schemes for glass, these are generally the option with thew lowest overall impact, as long as each bottle is returned and reused at least 3 times. These schemes only tend to work when there is an obligation for all companies to do this E.g., in the Netherlands, as this ensures a level playing field.

If glass bottles are only used once then aluminium cans are a better option. Bottles and cans can also have recycled content as a more sustainable option, though here aluminium can be 85% reused whereas for glass it is about a third. For paper and carton there are 100% recycled options available already and there are non- fossil fuel feedstocks that can be used for plastic films used in packaging.

Water use and wastewater

Beer is made from water, 95% in fact. The brewing process requires a lot of water to be used in the product and simultaneously generates a lot of water waste. In a Manual published by the Brewers Association shows that for every barrel of beer produced in the USA, seven barrels of water are required, or a water efficiency ratio of 1:7.[19] Not every brewery uses the same technology or practices, so the manual also advises that many brewers were already achieving a water ratio of just over 1:4 in 2010 and the leaders better still. As with GHG emission the size and type of packaging has an influence on water use with Smaller packages (330 ml bottles) tend to require more water use per little of beer than larger packages (kegs). Similarly, larger breweries were able to achieve better efficiency ratios than smaller ones.

Wastewater generated by breweries amounts to about 70% of the water that came into the facility. Aside the question of the cost of product water, an increase in water efficiency also reduces the volume of wastewater a brewery produces and has to treat. This both reduces the stress on water resources from industry and makes the wastewater cheaper to treat before it is returned to the environment (directly or via the sewers).

Solution → Increase water efficiency, and re-use wastewater for non-product purposes

It should be clear that investing in water efficiency is a win-win-scenario. This means investing in new technology, in maintenance, and in ensuring that staff are aware of good housekeeping practices in the brewery. As well as decreasing the pollution it will also reduce energy use. Secondly, requiring less water for brewing means the costs associated with this will be reduced.

Reuse of treated wastewater is a further option that can be implemented. Due to hygiene regulations this can usually only be used for non-product related tasks in a brewery, such as truck, or floor washing or gardening. Water can be harvested from rooftops for these purposes too.

[19] Brewers Association, Water and Wastewater: Treatment/Volume Reduction Manual, Brewers Association, (May 2019)

6. INDUSTRY LEADERSHIP

The biggest beer companies in the world are[10]:

1. Anheuser-Busch InBev
2. Heineken N.V.
3. Carlsberg Group
4. Molson Coors
5. China Resources Beer

Most of these companies are engaged in programmes to increase the sustainability of their production processes and report about progress achieved on an annual basis in public CSR or sustainability reports.

AB-InBev

Ab-InBev has set its own sustainability goals it wants to achieve by 2025. Ab-InBev wants 100% of their farmers, stretched across five continents, to be skilled, connected and financially empowered. Besides improving the quality of life of farmers and increasing productivity, more skilled workers also allow for more environmentally friendly agriculture practices. Water is the main ingredient of beer, and of life. Ab-InBev is working closely together with the Word Wide Fund (WWF) and The Nature Conservancy (NTC) to ensure that the communities it works with have a stable, clean source of water. The third goal relates to circularity. Ab-InBev is striving for all packaging to either be returnable or made from recycled plastics by 2025, reducing waste generation and reducing pollutants that would otherwise be created from the production of new packaging. The goal is to improve the recycling and return rates around the world. When it comes to energy use and greenhouse gases, Ab-InBev is predicting to have a 25% reduction in total CO2 emissions across the value chain and fulfil all its energy requirements from renewable sources.[20]

Heineken

Besides the green bottle being the most recognisable face in the industry, Heineken also has plans to make the business greener. The first area it aims to do so is water management. Heineken has been reducing water-use at its breweries, treating its wastewater before discharge, and investing in projects in water-scarce areas. To reduce its energy use and pollution, Heineken has set a goal to cut 80% of its emissions by 2030 and source 70% of its energy requirements from green energy. It hopes to do so by implementing sustainable practices throughout the business, from using solar power to electric transportation**,** to smart cooling solutions and efficient waste management. Another important area to Heineken is sustainable sourcing, obtaining raw materials from local and

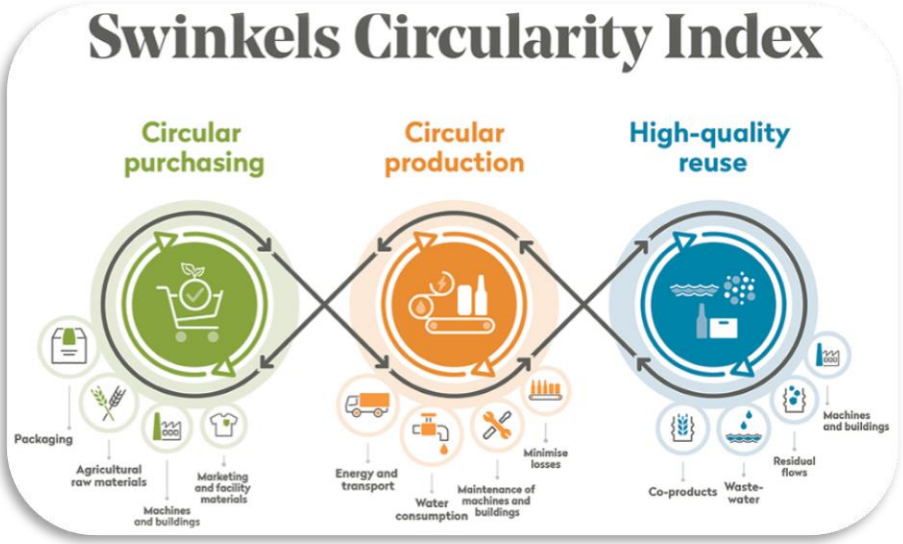
[20] AB-InBev, 2025 Sustainability Goals, *AB-InBev* (January 2021)

sustainably cultivated farmers. Finally, Heineken is helping its communities around the world through direct local contributions, shared-value projects, and its foundation 'Heineken Africa'.[21]

[21] Heineken, Our Sustainability Strategy and Achievements, *Heineken* (December 2020)

Swinkels

Although not one of the largest companies globally, Swinkels is an important player in the Netherlands, several other European countries and Ethiopia. It has shown itself to be one of the more ambitious companies in terms of circularity, working together with the Ellen MacArthur Foundation there have developed a circularity index for beer breweries.



The index consists of three systems: circular procurement, circular production and high-quality reuse. These systems help breweries link sustainability to their operations, gain insight into crucial processes, and make adjustments wherever necessary. On top of that, it's also a great way for breweries to create their own sustainability reports. The main goal of the circularity index is to make sustainability more accessible, encouraging all breweries within the industry to follow suit.[22]

This is the first example to date of a brewery that is trying to apply comprehensive circular approaches to their business. By their own reckoning Swinkels still have a long way to go. They scored 40% on the index in 2019. And hope to reach 50% in 2020.

Concluding notes

The beer brewing industry has committed itself strongly to a range of sustainability measures in the past 5-10 years. These can be seen as steps towards developing a circular economy approach for the industry. It is clear that all beer brewers have a long way to go before a truly circular approach is in place, if indeed this is feasible. What is sure is that in striving in this direction these companies will dramatically increase the sustainability and hence also the public acceptability of their product. In many cases it is expected that this will also have positive returns on their bottom line as well through efficiencies, improved reputation, and marketing benefits. A selection of innovations that contribute to circularity are presented in the next chapter, ranging from relatively small initiatives such as

[22] Swinkels, Swinkels Circularity Index, *Swinkels Family Brewers* (January 2021)

biodegradable ring pulls on cans (Saltwater brewery) to more fundamental changes such as using waste bread as a raw material (Adnams Brewery) to lowering the temperature in brewing (AB InBev).

7. THE SUSTAINABILITY DRIVE

AB InBev

Ab InBev has created a new method for brewing. Rather than boiling the liquid at the end of the process, the beer is brought to just below this temperature and injected with CO2 bubbles, producing the same result. This new method reduces CO2 emissions (5%) and waste use (0.5%).

Heineken

In 2020, Heineken announced that all beer for its country of origin, The Netherlands, will now be brewed using 100& green energy. This was made possible by clever use of wind turbines and solar panels. The goal to continue on this path and be 100% in The Netherlands by 2030.

Carlsberg Group

Through the Danish partnership for Resource and water-efficient Industrial food Production and working together with universities and technology providers, Carlsberg has created a state-of-the-art brewery that runs at half the water usage and reuses 90% of its waste water.

Marks & Spencer / Adnams Brewery

Using leftover breadcrusts from Marks & Spencer's sandwich production, Adnams Brewery has created a range of ales and fruit beers. The collaboration benefits both, as it creates value from a waste stream and turns it into a product. It also shows how sustainability can unite different industries.

Saltwater Brewery, America.

In a fight against the devastating effect the six-pack ring has on the environment and animal welfare, the Saltwater Brewery designed and created a 100% biodegradable, edible six-pack ring. The ring is made from of barley and wheat ribbons can be eaten by animals.

Toast Ale, Belgium.

Based on a 7000-year-old brewing technique, the Brussels Beer Project created 'Toast Ale' using fermented bread. 44% of bread is wasted. The Toast Ale repurposes this as raw material reducing waste, while simultaneously reducing its operational costs.

De Bierfabriek, Rotterdam

De Bierfabriek is creating a new brewing facility with the goal of brewing more sustainably. The factory will select suppliers based on circularity, implement the best brewing practices to save water and energy, instal 3400 solar panels, and provide their used grains to local farmers as feedstock.

New Belgium Brewing Company, America.

The New Belgium Brewing Company reduces, reuses and recycles its waste. It relies on green energy to brew, minimises packaging use and carries our regular waste audits. Because of this, the brewing company is able to divert 99.9% of its waste from landfill.

Let's cheer to the future of sustainable beer!

Thank you for reading my e-book. Best wishes, Dirk.

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