Keg & Cask Beer LCA

A COMPARISON OF KEG & CASK BEER'S LIFECYCLE CARBON

CARBON ARCHITECTURE

THE VOICE OF BREWERS & PUBS

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Executive Summary

Casked beer has a 4% greater carbon footprint than kegged for every pint served

The UK government's legally binding commitment to reach net zero emissions by 2050 will require a significant shift in operations across the lifecycle of beer. Over 90% of the lifecycle emissions of both kegged and casked beer occurs prior to the product leaving the brewery. The purpose of this report is to carry out a comparative Lifecycle Carbon Assessment (LCA) of keg and cask beer so UK brewers and consumers can better understand the impact of their products.

To enable the comparison of the two packing formats, products which are available in both pack formats were chosen, meaning that in both upstream of packaging and the pre-packing processing the footprint is equivalent.

When looking at the reasons for the differences in emissions between the kegs and casks, a number were identified. Firstly, within the brewhouse greater emissions are produced by casked beer, primarily due to high energy baseloads and lower throughput. Secondly, once the product leaves the brewery, kegged beer has a greater carbon impact as kegs often travel greater distances than casks, due to their longer shelf life. Finally, at the point of sale, kegged beer requires a greater energy input to cool the product to serving temperatures, which are often 7°C cooler than casked equivalent, and greater carbon input to transport the beer from cellars to taps.

These differences in the lifecycle of the product almost cancel each other out. In the brewery and inherently within the cask's construction, a cask produces 2.9gCO_2e more carbon per pint than an equivalent kegged product. Outside of the brewery, kegged cooling and transportation increases it's footprint by an almost equivalent 3.0gCO_2e per pint. As a result, kegged beer has a 0.1% higher carbon footprint per pint brewed. However, due to additional waste at point-of-sale, casked beer has a 4% higher carbon footprint per pint served. The results for per pint brewed are represented in Table 1.

	LCA Area	Keg		Cask	
		gCO_2e/pint	% of total	gCO_2e/pint	% of total
	End of Life	0.35	0.4%	0.35	0.4%
	Point of Sale	3.18	3%	1.54	2%
	Transport	6.64	7%	5.28	5%
	Preparation and Filling	10.16	11%	12.12	13%
	Packaging Materials	12.17	13%	13.14	14%
	Brewing	31.34	32%	31.34	32%
	Malting	10.66	11%	10.66	11%
	Agriculture	22.17	23%	22.17	23%
	Brewed Footprint	**96.66**		**96.59**	
	Waste Footprint	0.00		4.20	
	Served Footprint	**96.66**		**100.79**	

Table 1: Carbon intensity of keg and cask beer by LCA area

Contents

Introduction

The UK brewing industry is evolving. Over the last 50 years, consumer preferences have shifted away from the traditional British beers, ale and stout, towards lagers and other lighter beers with the proportion of ale and stout to lager sold in the UK shifting from 99:1 to 25:75. Traditionally, these products were packed in casks, meaning that there has been an ongoing transition in pack formats, moving from casked products to kegged formats instead.

Kegging is a packaging method which stores highly carbonated beer in a pressurised container, with an extended shelf-life provided by methods such as pasteurisation or sterile filtration. Cask beer on the other hand, is unfiltered, unpasteurised, and stored at atmospheric pressure, where residual yeast remains alive allowing the fermentation process to continue after packaging and creating a 'live' product. Each method has its own unique characteristics that can affect the flavour, aroma, and mouthfeel of the beer.

In recent years, the UK brewing industry has taken steps towards becoming more sustainable. Brewing is an inherently energy intensive process and generally reliant on fossil fuels, thus being a major carbon emitter. Driven by corporate responsibility and regulatory requirements, British brewers are becoming more proactive in the reduction of their carbon footprints, setting targets and investing in environmental initiatives. Over a 10-year period from 2008 to 2018, the carbon intensity of the brewing industry fell from 0.98 to 0.70 tCO_2e/hl, with 284,194 tCO_2e emitted in the production of 408,850 Mhl.

There has been a consistent drive to increase knowledge within the industry, and the BBPA is committed to support its members by providing insight and carbon accounting tools to help with their footprints. The purpose of this report is to carry out a comparative Lifecycle Carbon Assessment (LCA) of keg and cask beer, providing a unique insight for UK brewers and consumers to better understand the impact of their products. This allows questions to be addressed with facts, and offers insight into the major contributing factors, so that brewers can focus their improvement measures in the right areas. The outputs of this report will also be valuable to the hospitality industry, who will be able to use the carbon factors generated in this study to estimate their scope 3 carbon footprints.

Problem Statement

The UK has made a legally binding commitment to be net zero by 2050. With approximately 300,000 tonnes of carbon produced by the brewing industry in 2018, there is a drive for carbon reduction in an energy intensive industry.

There is currently no available literature that makes a credible, comparative carbon life cycle analysis (LCA) of kegged and casked beer. Understanding the carbon impact of different packing formats will inform brewers and empower them to make sensible decisions when reviewing pack formats.

Methodology

To produce valuable insight into the difference in total lifecycle carbon between kegged and casked product a rigorous methodology was followed. This is described in detail below:

1. **Agreement of assessment boundary (with input from brewers).**
   To ensure an acceptable output, a clearly defined assessment boundary was required. As kegged and casked product is often a question of ale vs. lager, it was agreed that the assessment should be based around a product which was available in both kegged and casked formats.
2. **Identification of raw materials used for keg and cask formats.**
   To analyse the lifecycle carbon of beer in different pack formats, the difference in raw materials must be reviewed. The carbon associated with these can then be calculated.
3. **Review of process activities to be included.**
   A review was performed of the difference in the production of kegged and casked product. Kegged product has less human intervention, and higher volumes which tends to drive efficiency, but also requires additional processing to ensure shelf-life is maintained.
4. **High level carbon footprint model built to identify relevant emission sources.**
   A model which calculated the carbon footprint of both kegged and casked product was built.
5. **Raw material & activity data collated for all lifecycle stages within process boundaries**
   Data was collated from BBPA members to be inputted into the developed carbon model
6. **Calculation of GHG emissions throughout the supply chain.**
   The collated data was used along with the carbon model to calculate the carbon footprint of all lifecycle stages of kegged and casked product.

Assessment Boundary & Process overview

The first step in the creation of the carbon footprint model for keg and cask beer was to determine what was in scope. Defining the process boundaries allowed the creation of a fair comparison between the two packing types.

As this is a life cycle assessment, cradle to grave emissions were considered for both keg and cask. The following areas are included in the model and summarised in Figure 1

- Embodied emissions of beer, including raw materials and brewery processing
- Embodied emissions of packing materials
- Emissions associated with the packing process
- Transportation and storage
- Emissions at the point of sale, including differences in serve
- End of life disposal

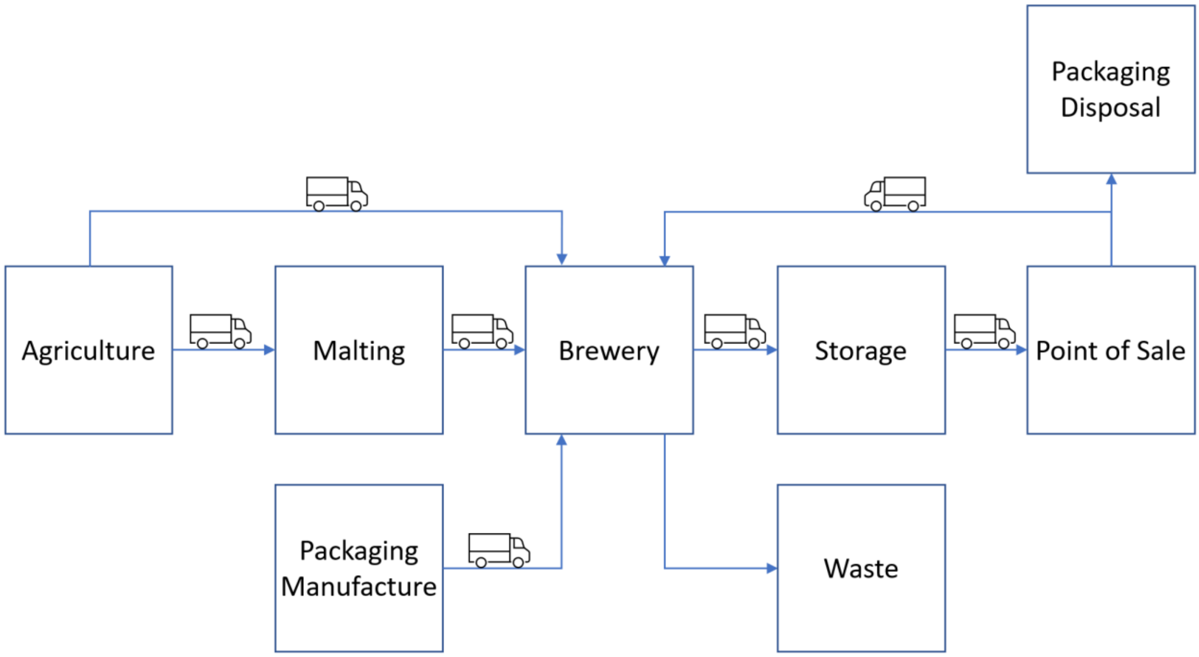

Figure 1: Block diagram showing the common steps of beer manufacture

At a high level, different beer styles are packaged in kegs and casks, with lager typically being kegged, and ale being casked. To ensure the built model reviews the packaging type and method, rather than the product, a product which comes in both formats was chosen. Since the same recipe is used, an accurate comparison of the packing format can be made.

This also means that the processing steps up to and including fermentation are identical. This is highlighted in the simplified block diagram shown in Figure 2.

Common Process Steps

In the carbon model, emissions up to fermentation are included as embodied emissions of beer. The key carbon contributors include agriculture, transport of raw materials, malting and brewing. Figure 2 below details the steps which are consistent across the two pack formats, however at the point of packaging, these diverge, with additional processing required for kegged product to give it an extended shelf-life.

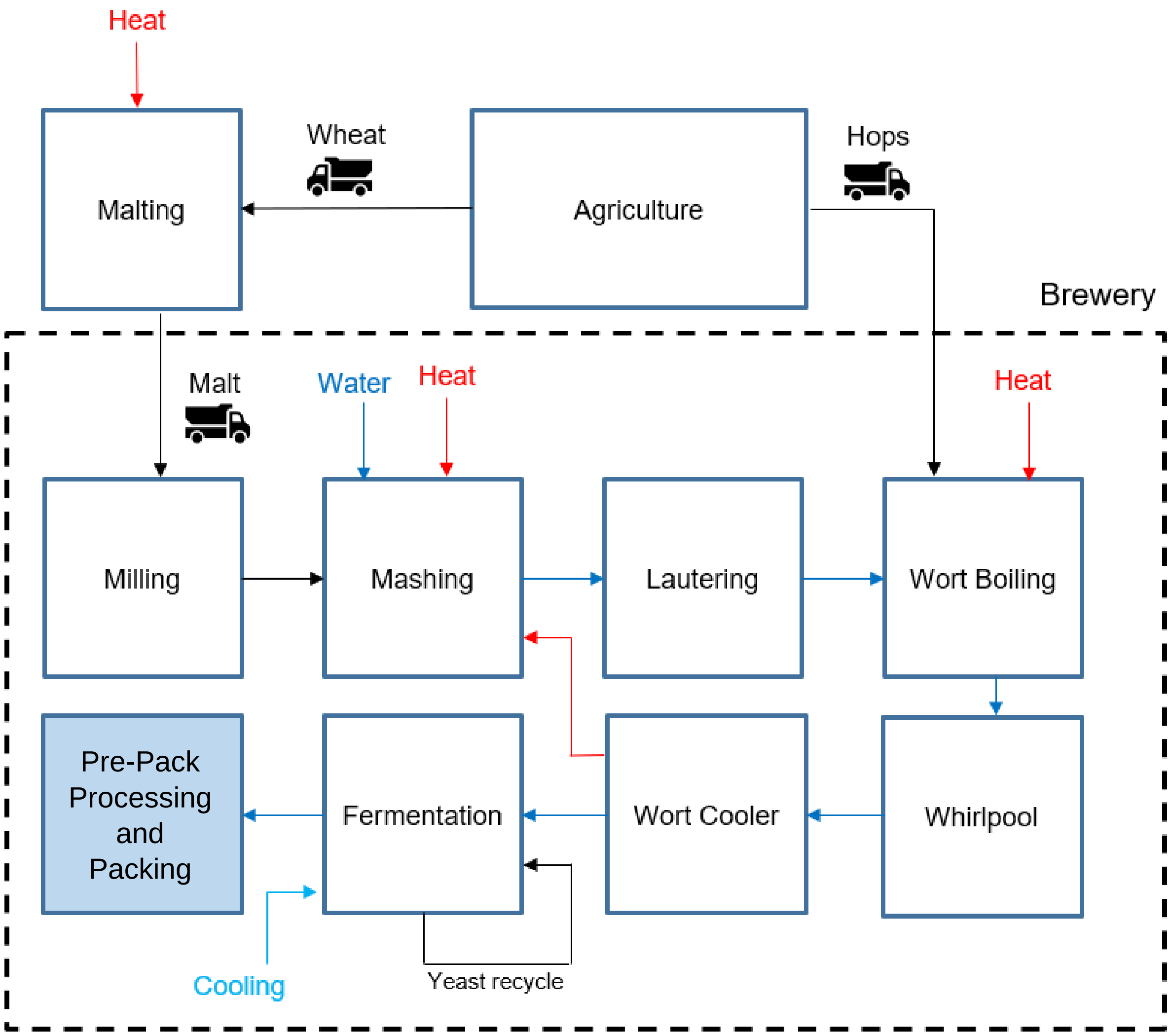

Figure 2: Block diagram showing the common steps of beer manufacture

Divergent Process Steps

Downstream of fermentation is when the processes differ. Maturation times will vary, however as the chosen product is constant, this is not considered as a variable within this analysis. Kegged beer undergoes additional processing in the form of sterile filtration or pasteurisation to extend shelf-life and maintain the desired product qualities. This analysis assumes that kegged product is treated using flash pasteurisation, a high-temperature, short-time (HTST) pasteurisation process that rapidly heats the beer to around 72°C for about 15-30 seconds before rapidly being cooled. This is an energy intensive process that is required for kegged beer but not for casks.

When kegs are filled, additional carbon dioxide is added, which has its own carbon impact while casks have no additional carbonation during filling. After the packaging line, the containers will be stored temporarily before they are distributed. Cask beer has to be stored chilled to preserve the live beer inside, whereas kegged beer can be stored under ambient conditions. There are also differences in the way that the containers are washed, which is reflected in their energy requirements.

Figure 3 and Figure 4 show the life cycles of kegs and casks downstream of fermentation, including brewery, point of sale and container production and disposal.

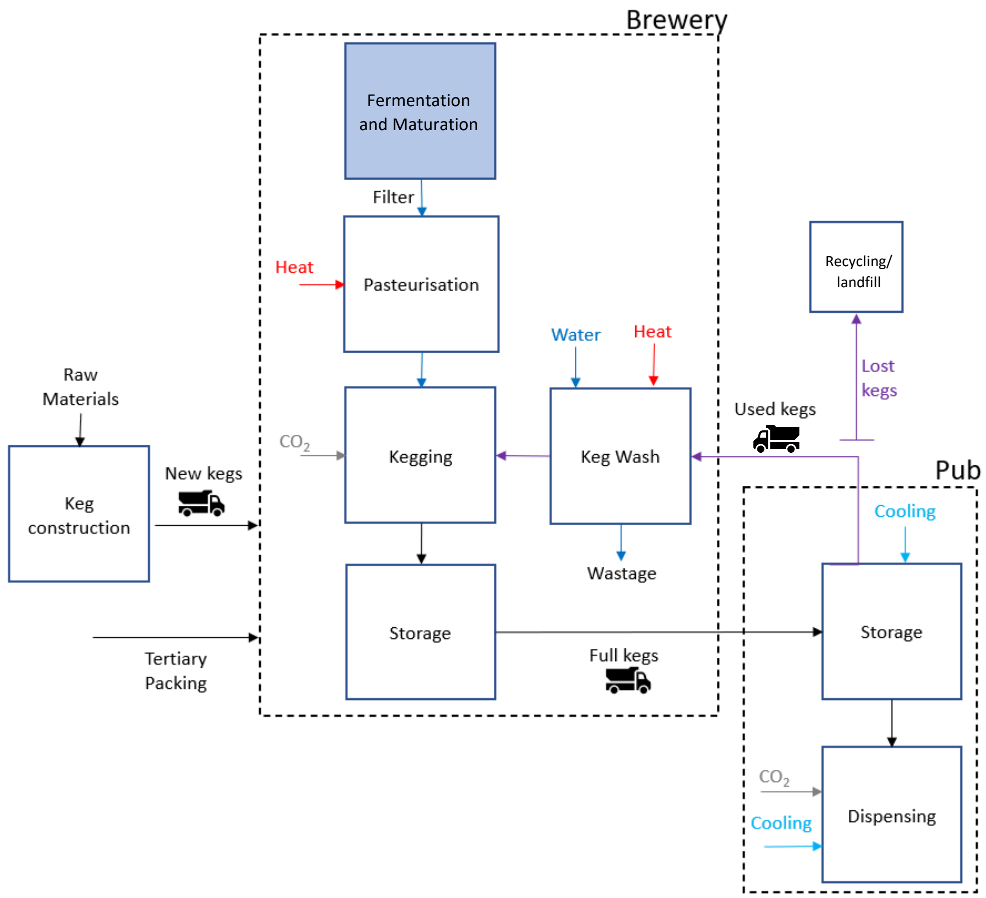

Figure 3: Block diagram of keg lifecycle

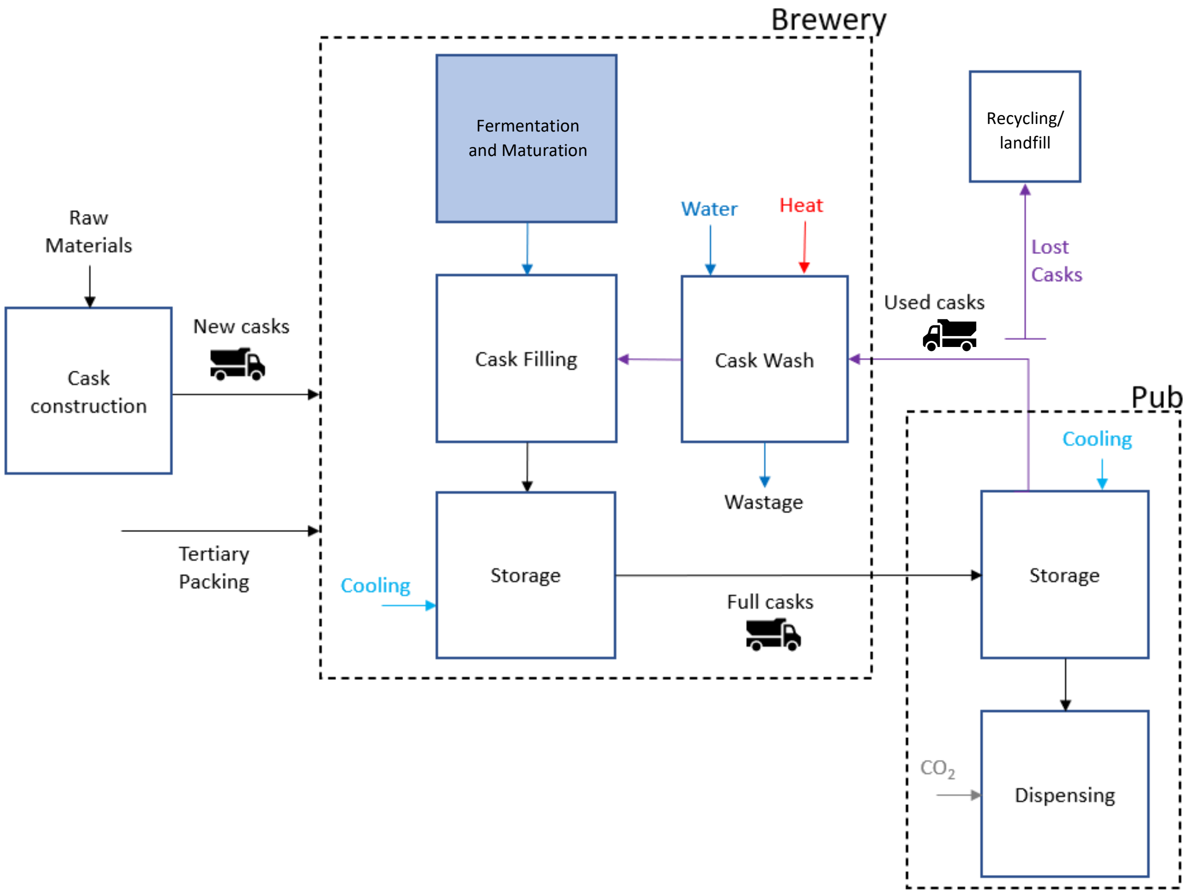

Figure 4: Block Diagram of cask lifecycle

Packaging Construction

The two container types have different embedded carbon emissions associated with their construction. Kegs and casks are both cylindrical containers made from stainless steel, but there are several key differences between the two.

Kegs are built with a single opening on one end, where a long narrow spear extends from the opening to the base of the keg. The spear serves 2 functions: to maintain desired pressure by adding gas to the keg, and to act as a channel for the beer to travel through. The spear, like the keg itself, is made of stainless steel. Figure 5 shows a 50l keg, cutaway to show the spear.

By contrast, common casks formats have two or more openings and no spear. The top face of the cask has an opening called the bunghole, with the second hole being the shive on the side of the barrel. At the brewery, a small wooden or plastic disk called a keystone is inserted into the bunghole to seal it and at the point of sale, the tap is hammered into the keystone. The shive, positioned at the top of the cask when it is in use, is used to control the amount of carbon dioxide present in the container. Shives are also typically made of plastic or wood. For the purpose of this analysis, both keystone and shive have been assumed to be made from plastic. When in use, casks are commonly laid on their side with the bunghole at the bottom of the circular face, demonstrated in Figure 6.

Both casks and kegs can come in a range of sizes, and the carbon emissions associated with a pint of beer within the container will vary slightly with the size of container used. For this analysis, the most commonly found sizes of 50 l (12.3 kg) kegs and 41 l (10.1 kg) casks were used. As these are similar in size, they will allow for a closer comparison of the pack formats.

Figure 5: 50l keg, cutaway [Wikipedia.com/keg]

Figure 6: 41l cask with shive & keystone labelled [Hanlonsbrewery.com]

Packaging Transportation

Casks and kegs are part of a circular supply chain. Once the container is empty, the keg or cask is returned to the brewery to be cleaned and refilled. The containers continue in this cycle until they either fail or are lost. At this point, the brewery will have to purchase a new container, which is where the embedded emissions of the container enter the lifecycle. There is also some carbon associated with the end-of-life treatment of the containers. Responsible parties will recycle their spent containers although some will end up in landfill.

The amount of beer that is left in the bottom of the container when it is sent back to the brewery differs between casks and kegs. Since cask beer is unfiltered, sediment accumulates at the bottom of the cask, known as ullage. This sediment is undesirable to consumers and is left in the cask as wastage. As kegged beer is filtered, the entire keg can be used. The difference in waste has a substantial impact on the total carbon emissions of each packaging type when looking at CO_2 per pint served, as more wastage means more beer must be brewed.

Point of Sale

Once the containers have been transported to their point of sale (pubs, bars and restaurants), they are stored in a cooled cellar. Some kegged beers are served below cellar temperatures and require additional cooling upon dispensing. This is done by a beer chiller and cooling jackets within the dispense line (often known as a python). Beer gas is added to kegs during dispense to maintain keg pressure and to push beer out, through the spear and into the pub's beer lines. Beer gas consists of either carbon dioxide or a mixture of carbon dioxide and nitrogen. Casks do not necessarily require beer gas, as often beer is pumped by a hand pump or beer engine, which is a manual job performed by the bartender. Modern pubs however will often have gas powered diaphragm pumps to assist and make the hand pull easier, particularly if the cellar is located a long distance from the point of service.

Model Construction & Results

The following section details how the model was constructed, and summarises the results that were produced, this is split out into the areas previously identified.

Agriculture & malting

The Global Feed LCA Institute (GFLI) has developed a database for the agriculture and feed sector which provides environmental impact data for feed products from cradle-to- gate. This tool was used to determine the carbon impact of UK dried wheat at the farm gate as 344.90 $kgCO_2e/t$.

According to the Maltsters Association of Great Britain, 14.7 kg of barley is used to make 1 hl of beer. Using this assumption, barley farming contributes 3.9 $kgCO_2e/hl$ brewed. The Maltsters Association also states that 1 tonne of malt is produced from 1.3 tonnes of barley and requires around 750kW of gas and 150kW of electricity. This means that 1 hl of beer brewed demands 8.49kW of gas and 1.8kW of electricity for malting, equivalent to 1.88 $kgCO_2e$. Table 22 summarises agriculture and malting emissions.

Agriculture & Malting		
Barley Production	3.90	$kgCO_2e/hl$
Malting	1.88	$kgCO_2e/hl$

Table 2: Carbon intensity of agriculture and malting

Brewery

To determine brewery emissions data was collected from a BBPA member who produces beer in both kegs and casks. Table 33 shows the annual energy consumption and carbon emissions of this brewery.

Total Brewery		
Gas consumption	9,000	MWh
Electricity consumption	4,000	MWh
Carbon Emissions	2,400	tCO_2e

Table 3: Sample brewery consumption and emissions

Assuming flash pasteurisation at 72°C, the energy requirements for pasteurisation was determined to be 1.09 kWh/hl. It has been assumed that for most breweries heat is provided by steam, giving an equivalent gas consumption of 1.7 kWh/hl. Data from The Carbon Trust estimates the specific heat and specific electrical energy for keg cleaning and filling by monitoring the consumption of keg washing equipment at 5 breweries. The average results are shown in Table 44.

Keg Cleaning & Filling (minus flash pasteurisation energy)		
Heat energy	4.0	kWh/hl
Electrical energy	0.6	kWh/hl

Table 4: Average specific heat and electrical energy of keg cleaning & filling

These values given in Table 4 were converted to carbon intensity using the UK government conversion factors[www.gov.uk]. The amount of CO_2 added to the kegs was also calculated using data from a BBPA member brewery. At this site, approximately 16,000 kg of CO_2 was used to pack 100,000 hl of beer, equating to 0.28 kg/hl. The carbon factor of CO_2 is 1.20 $kgCO_2e/kg$ to account for the energy demand in production and transport of the gas, giving a carbonation intensity of 0.34 $kgCO_2e/hl$. The carbon intensity of the kegging line is summarised in Table 5.

Keg Line Carbon Intensity		
Pasteurisation	0.31	$kgCO_2e/hl$
Cleaning & filling	1.14	$kgCO_2e/hl$
Carbonation	0.34	$kgCO_2e/hl$
Kegging total	**1.45**	**$kgCO_2e/hl$**

Table 5: Carbon intensity of the kegging process

Cask washing is a slightly more energy intense process than keg washing. Casks are cleaned in a different way to kegs as they are not capable of holding compressed liquid so they must be cleaned through spraying water and or detergent into the central hole. Like with keg washing, information was collected from the cask washers at several sites to gauge steam and electricity consumption on a per cask basis. The results are shown in Table 6.

Cask Cleaning & Filling		
Specific heat	6.8	kWh/hl
Specific electrical energy	0.7	kWh/hl

Table 6: Average specific heat and electrical energy of cask cleaning & filling

There are additional energy requirements for casks as they need to be stored chilled. This was calculated from industry benchmarks to be 0.91 kWh/hl. The carbon intensity of the casking line is summarised in Table 7.

Cask Line Carbon Intensity		
Cleaning & filling	1.96	$kgCO_2e/hl$
Cold storage	0.18	$kgCO_2e/hl$
Casking total	**2.13**	**$kgCO_2e/hl$**

Table 7: Carbon intensity of casking process

Using the carbon factors in tables 5 and 7, the total carbon emissions associated with kegging and casking at the sample brewery are 264,942 $kgCO_2e$ and 290,280 $kgCO_2$ respectively. Subtracting these numbers from the total brewery emissions gives the embedded carbon emissions of the beer for all the parts of the process that are identical for the two packaging types which, when divided by the total brewed volume, yields the respective carbon intensity, 5.52 $kgCO_2e/hl$. Table 8 summarises the carbon intensity of the brewery for both kegged and casked beer.

	Units	Keg	Cask
Brewing	$kgCO_2e/hl$	5.52	5.52
Preparation and filling	$kgCO_2e/hl$	1.45	2.13
Total	**$kgCO_2e/hl$**	**6.97**	**7.65**

Table 8: Carbon intensity of keg and cask beer at the brewery

Packaging materials

It was assumed that kegs and casks last have an average lifetime of 10 years and are in circulation for 10 weeks at a time. If each container is refilled after these 10 weeks, this equates to 5 fills a year, or 50 fills across the container's lifetime. For this assessment, container sizes were standardised to 50 litre kegs and 40.9 litre casks.

A 50-litre keg is made from 13.2kg of stainless steel (12.3kg body and 0.9kg spear). The carbon emissions associated with this much stainless steel is 40.9 $kgCO_2e$. Assuming 50 uses across the keg's lifetime, the emissions per fill would be 0.818 $kgCO_2e$. The plastic keg-cap is single-use and would be purchased new for each fill, having a carbon impact of 0.065 $kgCO_2e$.

A 40.9 litre cask includes 10.1kg of stainless steel for the body, along with a plastic shive and keystone, each assumed to be 20g. The steel body of the cask has a footprint of 31.3 $kgCO_2e$, which over the course of 50 uses equates to 0.626 $kgCO_2e$ per fill. Shives and keystones, also which are not reused, have a footprint of 0.065 $kgCO_2e$.

Kegs and casks are transported with plastic locator boards, shown in Figure 7. These locator boards vary in size, but for this model are assumed hold 6 containers and weigh 7.25kg. If these boards are reused 20 times their lifecycle carbon footprint would be 0.188 $kgCO_2e$ per single container transported. A summary of packaging carbon is shown in Table 9.

Embodied Emissions of Packaging Materials		
Keg (inc. spear & seal)	0.88	$kgCO_2e$/keg
Cask (inc. shive & keystone)	0.76	$kgCO_2e$/cask
Locator Boards	0.19	$kgCO_2e$/keg (cask)

Table 9: Carbon intensity of packaging materials

Figure 7: Plastic locator boards holding casks for transport [bandbattachments.com]

Transport

Distance travelled will be highly dependent upon the product, with some beers being extremely local and others global. High level assumptions were made for the average distances that containers are transported during each stage of their life cycle. These emissions will have a wide degree of variation depending on where the container is manufactured and how far the product is transported from the brewery to the regional distribution centre (RDC), and from the RDC to point of sale (POS). For the sake of this assessment, the following assumptions were made:

	Units	Keg	Cask
Manufacturer to Brewery	km	1700	1300
Brewery to RDC	km	250	150
RDC to POS	km	24	24

Table 10: Assumed distances for each journey

Most container manufacture occurs in Europe, for a keg the transport distance from manufacturer to the brewery is based on the keg being produced in Zaragoza, Spain, and filled in The Midlands. For casks, this journey is assumed to be from Munich to The Midlands. Both these journeys also include a 55km ferry journey. Using standard carbon factors for articulated vehicles and vehicle ferries, the inbound transport for kegs and casks to breweries was determined to be 3.22 $kgCO_2e$ and 2.47 $kgCO_2e$ respectively for each container.

The journey the locator boards would take from manufacture to brewery was estimated as 200km. Assuming transport by articulated vehicle, this equates to 0.91 $kgCO_2e$ per keg/cask. The journey from manufacturer to Brewery only happens once, so these emissions are averaged over the lifetime of the packaging. The results of this are found in Table 11.

Once the containers are filled, they are transported to an RDC, before completing their journey to point of sale. It was assumed that kegs, on average, travel slightly further than casks due to an increased number being transported internationally (Table 10). As with the inbound journey, the carbon impact of the outbound journey was estimated using assumed distances along with standard UK government GHG Conversion Factors. The return journey must consider the that the emptied containers make from the pub back to the brewery. The estimated carbon impact of these journeys for both kegs and casks are shown in Table 11.

	Units	Keg	Cask
Manufacturer to Brewery	$kgCO_2e$/container	0.11	0.95
Brewery to RDC (& back)	$kgCO_2e$/container	0.47	0.28
RDC to POS (& back)	$kgCO_2e$/container	0.63	0.43

Table 11: Carbon intensity of keg and cask beer for each transport stage

Point-of-sale

Both keg and cask beer are stored at around 12°C in refrigerated cellars before and during service at pubs, while kegged beer is cooled further to 4°C as it is served. The electrical energy required is summarised in Table 12.

	Units	Keg	Cask
Cellar Cooling	kWh/hl	0.24	0.20
Additional Cooling	kWh/hl	0.29	0

Table 12: Electrical Energy for keg and cask beer cooling at POS

When the beer is dispensed from kegs, an equal volume of beer gas is injected into the container to displace it, and as this occurs under pressure, a significant mass of gas is required. Cask dispense does not necessarily always use beer gas for dispense, often this is manually done via a beer engine, however many modern pubs use beer gas to operate diaphragm pumps which assist bartenders in pulling the beer through the lines, particularly in operations where cellars are a large distance from the pump. Table 13 shows a summary of the point-of-sale carbon impact.

	Units	Keg	Cask
Cooling	$kgCO_2e$/hl	0.10	0.05
Dispense Carbon	$kgCO_2e$/hl	0.46	0.23
Total POS	**$kgCO_2e$/hl**	**0.56**	**0.27**

Table 13: Carbon intensity of keg and cask beer at POS

End of life

Organic waste generated during the brewing process has carbon emissions associated with its treatment. These emissions are treated as embodied emissions of beer and are therefore the same for cask and keg beer. Assuming that, on average, 50% of trade effluent goes to anaerobic digestion, while the other 50% is disposed directly to the environment, the carbon intensity of brewing waste was calculated using standard organic waste factors, with results shown in Table 14.

Embodied emissions of beer - waste		
Recovered waste emissions	0.71	gCO_2e/hl
Landfill waste emissions	50	gCO_2e/hl

Table 14: Carbon intensity of brewery trade effluent disposal, by disposal method

The same calculations were carried out for the end-of-life treatment of the packaging materials. The average recycling rate for steel and plastic in the UK are 76.4% and 44.2% respectively. Using standard end of life factors, the disposal emissions of kegs and casks were calculated. The emissions for the containers and spears have been averaged out across their lifetime, assuming 50 uses. The results of these are shown in Tables 15 and 16. The differences in end-of-life emissions between casks and kegs are therefore relatively negligible.

	Units	Landfill	Recycle
Container	gCO_2e/keg	0.52	4.0
Spear	gCO_2e/keg	0.04	0.29
Seal	gCO_2e/keg	0.1	0.19
Total	**gCO_2e/keg**	**0.65**	**4.48**

Table 15: Carbon intensity of keg waste, by disposal method

	Units	Landfill	Recycle
Container	$gCO_2e/cask$	0.42	3.28
Seal	$gCO_2e/cask$	0.2	0.38
Total	**$gCO_2e/cask$**	**0.62**	**3.66**

Table 16: Carbon intensity of cask waste, by disposal method

Carbon per pint brewed

Kegged beer has a greater carbon footprint than casked, but only by 0.1%.

The results of the model are displayed in Table 17 and Figure 8. When normalised against pint brewed, kegs have a 0.1% higher carbon impact than casks. This is not a significant difference, despite the various differences in the processes.

LCA Area	Keg		Cask	
	gCO_2e/pint	% of total	gCO_2e/pint	% of total
End of Life	0.35	0.4%	0.35	0.4%
Point of Sale	3.18	3%	1.54	2%
Transport	6.64	7%	5.28	5%
Preparation and Filling	10.16	11%	12.12	13%
Packaging Materials	12.17	13%	13.14	14%
Brewing	31.34	32%	31.34	32%
Malting	10.66	11%	10.66	11%
Agriculture	22.17	23%	22.17	23%
Total	**96.66**		**96.59**	

Table 17: Carbon Intensity of keg and cask beer by LCA area

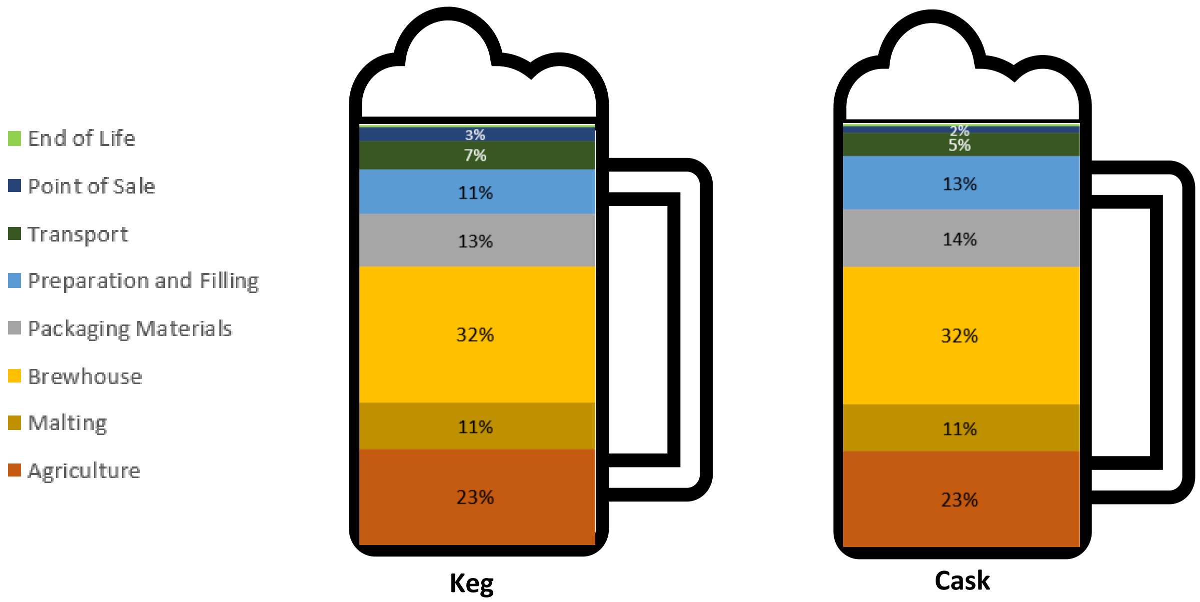

Figure 8: Graphics showing relative carbon intensity of each LCA area

Carbon per pint served

Since casks contain live, unfiltered beer, there is a certain amount of sediment that accumulates at the bottom of the cask. The sediment thick bottom layer is not desirable for consumption so is typically left in the cask and eventually washed out. On average 3 pints of beer will be wasted from each cask because of this. In a 40.1 litre keg, this is equal to 4% of the total contents of the cask. Therefore, the carbon impact per pint served actually is 4% higher than the carbon impact per pint brewed for cask beer. Kegs on the other hand, have much reduced ullage due to their design, with minimal wasted product left over from point of sale. Due to lack of data, it has been assumed that 100% of the contents within the keg is consumed, monitoring of wastage when kegs return to breweries will allow for greater accuracy, however is likely to be less than the 4% increase seen in casks. Carbon per pint served is summarised in table 18.

	Units	Keg	Cask
Total Emissions	gCO_2e/pint brewed	96.66	96.59
	gCO_2e/pint served	96.66	100.79

Table 18: Carbon impact of kegged and casked beer per pint brewed and per pint served

Conclusions & Recommendations

Under the parameters described in this model, the difference in carbon impact between kegged beer and casked beer is negligible. However, when considering the additional wastage that comes with cask beer, the difference becomes more significant.

The results of this model demonstrate that cask beer has a 4% greater carbon impact than kegged beer. Brewers and pub owners can use this information to better understand the impact of their products make informed decisions when deciding on what products they should focus their attention on when it comes to decarbonisation plans.

It should be noted that the results of this study are heavily based on some key assumptions made about the process. In reality, the results will vary for each individual case based on brewing recipe, brewery type and transport distances, as well as other parameters which have been assumed for this model. As an example, to allow for accurate comparison of pack type, the same beer was compared across the two formats which is brewed at final gravity. Kegged product however is far more likely to be brewed at high gravity, leading to reduced energy and carbon.

A natural future addition to this work would be to make a comparison to other on and off-trade pack formats (cans and bottles of different sizes), to allow brewers, the hospitality industry and ultimately end consumers to make more informed decisions.

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