THE ALCOHOL WE DRINK AND ITS CONTRIBUTION TO THE UK'S GREENHOUSE GAS EMISSIONS:

A DISCUSSION PAPER

WORKING PAPER PRODUCED AS PART OF THE WORK OF THE FOOD CLIMATE RESEARCH NETWORK

TARA GARNETT
CENTRE FOR ENVIRONMENTAL STRATEGY
UNIVERSITY OF SURREY

February 2007

CONTENTS

SCOPE AND PURPOSE

This paper looks at the alcohol we consume here in the UK. It considers whether we can quantify in 'good enough' terms the contribution that our alcohol consumption makes to the UK's total greenhouse gas (GHG) emissions.

The focus is on the main three categories of alcoholic drink; beer, wine and spirits. Each of these are explored in turn to see what we know about their life cycle impacts and whether there are particular life stages where the GHG impacts are particularly intensive. It also considers whether we might be able to generalise as to whether one particular beverage is more GHG intensive, per alcoholic unit consumed, than another.

Following this analysis, the options for emissions reduction are briefly considered. First the technological scope for improving efficiency is explored and here the focus is largely on drinks which can be and are produced in the UK. Wine is excluded from consideration since the vast majority is produced overseas. Next the discussion focuses on behaviour change. It looks at how much people drink, how this relates to current health drinking guidelines and how the overall greenhouse gas impacts of alcohol consumption might change were we to consume within the recommended limits.

Finally the paper presents some conclusions.

It should be stressed that in so far as is possible the focus of the paper is our consumption rather than the UK's production of alcoholic drinks. This is an important distinction to make since wine, for example, is almost entirely imported while most of the whisky we produce is exported.

Soft drinks and water are not included. This is potentially a substantial omission and it is suggested that further study in these areas would be helpful.

RESEARCH METHOD, GAPS AND QUALIFICATIONS

Most of the information presented here has been obtained from nationally published government information sources, from trade associations representing the alcohol sector, from overseas studies, from those few academic life cycle studies that exist and from a seminar held on the subject in October 2005.[1] Some of the figures presented are taken from publicly available documents while others rely upon personal communications with industry experts.[2]

At the outset it should be said that there is very little published academic literature focusing on the environmental (including greenhouse gas) impact of the alcohol sector. Fairly extensive database, journal and internet searches were performed with combinations of the following key words: beer, alcohol, carbon dioxide, wine, brewing, brewery, breweries, wine, viticulture, viniculture, greenhouse gas emissions, climate change, energy, spirits, whisky, vodka, gin, life cycle assessment and so forth. The journals searched included those with an environmental / life cycle analysis orientation as well as those more specifically concerned with brewing and

[1] FCRN alcohol seminar, held at the British Beer and Pub Association, London, October 2005
[2] See acknowledgements at the end of this paper

food technology. Those studies which this database search did show up tended to focus on the use of alcohol as an alternative fuel rather than on alcohol as a beverage. For certain parts of the alcohol life cycle, such as brewing or malting, there is some advice available on improving energy efficiency,[3] [4] some of it fairly old.[5]

Some brewing companies have published information about their energy use and CO_2 emissions as part of their environmental reporting procedures but the data are of limited value since the information supplied refers to just one particular part of the beer chain (as opposed to the whole life cycle). Moreover since the companies often produce and distribute internationally the averages given are bound to mask wide variations. Additionally they do not set out how the information was gathered nor what is or is not included in their calculations.

The report looks at the beer sector in more detail than at the wines and spirits sector. This is mainly because more information is available for beer since most of it is produced here in the UK. Most wines and many spirits are imported from a wide range of countries and as such there are holes in the information available.

It should also be noted in passing that very few people actually think of alcohol in terms of its environmental impact.[6] While this is true of many foods and drinks (with perhaps the exception of fruit and vegetables which are popularly associated with 'food miles'), this is a mind set which needs challenging, not just for alcoholic drinks but for all foods we consume.

---

[3] For example Galitsky C, Martin N, Worrell E and Lehman B. (2003). *Energy Efficiency Improvement and Cost Saving Opportunities for Breweries: An ENERGY STAR® Guide for Energy and Plant Managers*, Energy Analysis Department, University of California http://www.osti.gov/energycitations/servlets/purl/819468-BCeVpF/native/819468.pdf

[4] http://www.cleanerproduction.com/sectors/subsectors/BeveragesA.html

[5] *Achieving Energy Efficiency in the Maltings Industry*, Good Practice Guide 65, ETSU, 1993

[6] This observation is based upon the attitudes and comments of those people approached during the course of writing this paper and of more informal discussions with friends and colleagues.

STRUCTURE

This paper is structured as follows:

PART ONE

Section one gives basic facts and figures about the UK alcoholic drinks sector.

Section two takes a look at trends in consumption. Taking beer, spirits and wine separately it looks at how our preferences have changed, at where the drinks are produced (in the UK or overseas) at where they are consumed, and at the associated packaging involved.

PART TWO

Section one looks at the beer production process. It examines how beer is produced, from the agricultural through to the malting, brewing and bottling stages, and explores what the environmental implications may be, providing data where possible. It also highlights data gaps and makes suggestions for further research.

Section two looks at spirits production, focusing mainly on whisky. Since the malting stage is similar to that for brewing the discussion begins at the point where the malted grain reaches the distillery. The environmental impacts up to and including the bottling stage are examined.

Section three looks at the wine sector, examining the agricultural production stage (viticulture), the wine making process (viniculture) and the bottling stage. Note that very little information is available on either viticulture or wine making.

Section four examines freight and personal transport associated with alcohol consumption. The three main types of alcohol are examined together since it is impossible (particularly for personal travel) to disaggregate such data that does exist.

Section five looks at energy issues relating to the place of alcohol consumption.

Section six discusses the findings of sections two, three, four and five. It asks whether one drink can be judged to be more energy intensive than another and also whether there are particular life stage hotspots for each of the drinks which are particularly GHG intensive.

PART THREE

Section one looks at what has been and is being done to improve energy efficiency and identifies areas where more work may be needed. The focus of this section is mainly on those life stages that have been identified as hotspots in section four. The emphasis is on UK production since the management, say, of wineries overseas is beyond the UK's control.

Section two looks at consumer behaviour. Specifically it asks how policies affecting *where* we consume alcohol, *when* we consume, and how much of it we consume affect the emission of greenhouse gases from this sector. It asks whether changes in what and how we consume alcohol might help reduce emissions from this sector.

PART FOUR
Here conclusions are presented and recommendations offered.

TERMINOLOGY, NOTES AND UNITS OF MEASUREMENT

As far as possible emissions are discussed both in terms of tonnes of carbon and CO_2. To convert from carbon to carbon dioxide the carbon figure must be multiplied by 44/12. To convert from carbon dioxide to carbon, the CO_2 figure is multiplied by 12/44.

Calculations are expressed in terms of the contribution our alcohol consumption makes to the UK's emissions of greenhouse gases as reported by Defra. These are reported to be 179 million tonnes of carbon equivalent (MTCe) for the years 2003 and 2004. [7][8] This most recent estimate is lower than previous figures which put emissions for 2003 at 181.6.[9] The differences between the older and newer data are reflect differences in methodologies. More specifically the 179 MTCe figure deducts carbon sinks from total emissions in line with Kyoto reporting guidelines. 179 million tonnes of carbon equivalent equates to 656 million tonnes of carbon dioxide equivalent (CO_2e).

Emissions from the full basket of greenhouse gases rather than carbon dioxide only are used as a background against which to measure the alcohol related contribution. Carbon dioxide accounts for the majority (85%) of the UK's total greenhouse gas emissions while nitrous oxides and methane contribute a further 6% each. Other gases (such as those used for refrigeration) make up the remaining emissions.[10] This report has deliberately not offset the atmospheric carbon absorbed by the growing barley, grapes and other crops against emissions generated during the alcohol production process and as such represents a distorted picture of emissions.[11] However, this is in our view a somewhat dubious line of thought since one has to consider what the land *would have been like* had barley not been growing on it. Since this land has been cultivated for a very long time and since (one hopes) it is unlikely to be concreted over in the immediate future, there cannot be said to be any sequestering effect additional to what was already occurring and what is likely to occur in the future.

Finally, since the focus of this paper is on the alcohol we *drink* as opposed to the alcohol we *produce*, strictly speaking alcohol consumption related emissions should be calculated at a percentage of total emissions arising from our total consumption. This is not what the DEFRA reported figures do. The 179MTCe which the UK reports to the Intergovernmental Panel on Climate Change is an estimate of the emissions we produce in the UK. In other words the figure does not take into account emissions embedded in imported goods or emissions arising as a result of UK related international freight or passenger transport. By the same token goods which are produced in the UK but destined for export markets are included in the 179MTCe figure even though from a consumption perspective they should be allocated to consumers overseas.

---

[7] http://www.defra.gov.uk/environment/statistics/globatmos/kf/gakf05.htm
[8] Note that since the time of writing this report, the figures have been revise upwards to
[9] *UK Greenhouse Gas Inventory 1990-2003: Annual report for submission under the Framework Convention on Climate Change*, National Environmental Technology Centre, Harwell, Oxon, April 2005
[10] UK Emissions of Greenhouse Gases - Latest figures, Defra http://www.defra.gov.uk/environment/statistics/globatmos/gagginvent.htm
[11] Scotch Whisky Association, personal communication, 13/6/06

Very few studies have actually sought to quantify consumption related UK emissions. An input-output analysis published by the Carbon Trust report estimates consumption related carbon emissions to be 176.4 MTC.[12] If an extra 15% were added to this figure to take into account the other greenhouse gases[13] the total comes to 202.9 MTCe, or around 13% higher than production-only figures suggest.

Another study published by the World Wide Fund for Nature concludes that consumption related carbon emissions are about a third higher than the reported emissions production figure or 203 MTC, to which one again one would need to add the other greenhouse gases.[14]

Since a universally agreed methodology has not been arrived at for quantifying UK consumption related emissions, the Defra published production figure of 179MTCe is used instead. It should however be borne in mind that as our 'true' consumption related emissions are likely to be higher than the emissions we actually produce, so the contribution made by the alcohol we drink is likely to be a little lower than what it is calculated to be here in this report.

Finally, a note on alcohol measurements. Volumes of alcohol are given in the literature either in volumes of alcohol as drunk, or in litres of pure alcohol. The alcoholic strength of the beverages we consume is measured in terms of its ABV (alcohol by volume). Thus a wine with an ABV of 12%, will contain 12% of pure alcohol. The ABV of drinks varies both by alcohol type (beer versus spirits versus wine) and within alcohol types - beer strengths can range from less than 3% to 9% or 10%). A 'unit' of alcohol contains 10ml of pure alcohol. The number of units in a drink can be obtained by multiplying the volume of the drink in millilitres by the % ABV and then dividing it by 1000. So a 150ml glass of wine with an ABV of 12% will contain 150 x 12 / 1000 =1.8 units. More than one might think.

Acronyms and abbreviations

ABV	Alcohol by volume
BBPA	British Beer and Pub Association
CCA	Climate Change Agreement
Ce	Carbon equivalent
CO_2e	Carbon dioxide equivalent
EU ETS	European Union Emissions Trading Scheme
FAB	Flavoured Alcoholic Beverage
GHG	Greenhouse gas
GNS	Grain neutral spirit
GWP	Global warming potential
HGV	Heavy goods vehicle
HL	Hectolitre
LCA	Life cycle analysis/assessment
LGV	Light Goods Vehicle
LPA	Litres of pure alcohol
MTC	Million tonnes of Carbon

[12] *The carbon emissions in all that we consume*, The Carbon Trust, London, January 2006 http://www.carbontrust.co.uk/Publications/publicationdetail.htm?productid=CTC603

[13] it may of course be that our imports are fairly 'carbon heavy' in which case less than 15% should be added. Of course the reverse may also be true.

[14] *Counting consumption CO_2 emissions, material flows and Ecological Footprint of the UK by region and devolved country*, World Wide Fund for Nature, Godalming, Surrey, 2006

SEEC	Spirits Energy Efficiency Company
SWA	Scotch Whisky Association
WRAP	Waste Resources Action Programme
WSTA	Wine and Spirit Trade Association

SUMMARY

Data overview

There has been little analysis of the environmental impact of alcoholic drinks along the whole of their life cycle particularly as regards their contribution to greenhouse gas emissions.

For beer, while good data exists for energy use at the malting and brewing stages, for agricultural impacts and for those arising from the transport and the retail of beer (as well as consumption at home) the data are scant. Agricultural stage emissions have had to be calculated using a wide range of different (and possibly incompatible) sources.

As regards spirits, data are available for malting (for Scotch Whisky) and for distilling energy use and emissions. However the overall picture for spirits is unclear since not all spirits are made solely or even partly from barley and as well as whisky, a wide range of other spirits, many imported, are consumed. Data on production processes overseas do not appear to be readily obtainable. Imports and exports feature largely in the spirits sector and this confuses the picture further.

For wine, the situation as regards data is even more patchy. A few life cycle analyses exist but since wine is imported into the UK from perhaps twenty different countries, each with their own climatic conditions and production systems, it is hard to generalise from those few studies that exist.

For all three alcoholic drinks, data on energy use and GHG emissions relating to consumption (particularly in pubs and other licensed premises) and to transport are patchy-to-non-existent. The data presented here is very much based on estimates and assumptions. Further work on alcohol related transport and on energy use in the hospitality sector is very much needed.

Alcohol and its contribution to the UK's greenhouse gas emissions

It is estimated here that our consumption of alcohol here in the UK accounts for 1.5% of the UK's total greenhouse gas emissions. This figure relates to the alcohol we consume and not just to the alcohol we produce. In other words it includes imports but excludes exports. This figure is likely to be an underestimate for a number of reasons which are articulated more fully in the main body of the report.

Key life stage impacts

Consumption stage emissions (largely relating to drinking out of the home in pubs, clubs and restaurants) are responsible for the bulk of beer related emissions, followed by transport. For wine transport dominates followed by the consumption stage - the refrigeration of white wine in the home or consumption in restaurants and other premises. For spirits, the impacts are fairly evenly distributed along the whole of the supply chain. As for alcohol as a whole, the average contribution made by consumption stage emissions (as for wine, above) is 38% of the total while transport contributes a further 26%. Packaging stage emissions account for only 13% of total alcohol related emissions although this figure could be an underestimate. Moreover, for drinks packaged in small bottles the importance of glass related emissions will be relatively greater.

While the relative importance of different life stages does vary by alcohol type, there is at present little to choose between them in terms of their overall environmental impact. Spirits appear to be marginally lower in their carbon intensity followed by wine and finally beer but the differences are minor and are easily accountable for by inaccuracies and margins of error in the data.

Trends in consumption and the greenhouse gas implications

Certain trends in what and how we drink suggest that the greenhouse gas impacts of the alcohol sector could increase. These include the growing preference for drinking bottled and canned (instead of draught) beer and for drinking beverages which need to be consumed cold, such as white wine, lager and, increasingly cider.[15] We are also seeing the development of global brands, and concentrated production and distribution structures, leading to increasing reliance on transport. While concentration in the sector means that we have fewer, larger but probably more energy efficient breweries, it is unlikely that these efficiency savings can offset growing transport related carbon emissions. For wines it may also be the case that the growing preference for new world wines which need to be transported long distances is also contributing to wine related emissions. Without a full life cycle analysis of old versus new world wines (and of course there will be huge variation within both the new and the old world) it is not possible to say anything at all conclusive here. Finally it is important to note that we are, on average, drinking more and more each year. Unless efficiency gains can outweigh the growth in absolute consumption the net result is more alcohol related greenhouse gas emissions.

Action to reduce emissions

Fairly considerable efforts are being made at the malting, brewing and distilling stages to improve energy efficiency and reduce emissions. This reflects the relatively high cost of energy for these industries and their responsibilities as set out in the Climate Change Agreements (CCAs) and the EU Emissions Trading Scheme (ETS). There is also a considerable amount of activity underway to reduce packaging related impacts. However, for the main areas of concern as regards GHGs – transport and the hospitality industry – very little is being done to address emissions.

Another approach to reducing emissions is to examine what would happen to emissions if we simply drank less. It is concluded that were individuals to consume at levels in keeping with Department of Health alcohol guidelines, an overall 18% in overall alcohol consumption could be achieved. Were we to consume as we did in 1970, overall consumption would fall further still, by 40%. Of course if we were to drink less beer, say, we might compensate by drinking more orange juice or Coca Cola (or spend the money saved on some non food item). While the possibility of a rebound effect is a very real one, it is important to consider the case for reduced consumption in the context of an overall framework of reduced consumption – in all areas, food and non-food.

Conclusion

This paper has tried to show that the contribution made by the alcohol sector to the UK's greenhouse gases is significant and, given continued concentration in the

[15] For example Bulmer now promotes its Bulmers Iced which is served at 2℃ while advertisements for Magners show the cider being poured over ice cubes.

industry and its increasingly internationalised structure, is likely to grow. There is a mismatch between government policies - mainly the Climate Change Agreements which seek to address brewing and malting emissions - and the most problematic areas of concern, these being transport and the hospitality sector. It is recommended that further work be undertaken in these last two areas to assess more accurately their impacts and also, more importantly, to examine ways in which these impacts may be reduced. Finally there is little recognition that alcohol over-consumption carries with it environmental, as well as health burdens. This is a connection that needs to be made more specific.

PART ONE: ALCOHOLIC DRINKS IN THE UK

1.1. BASIC OVERVIEW

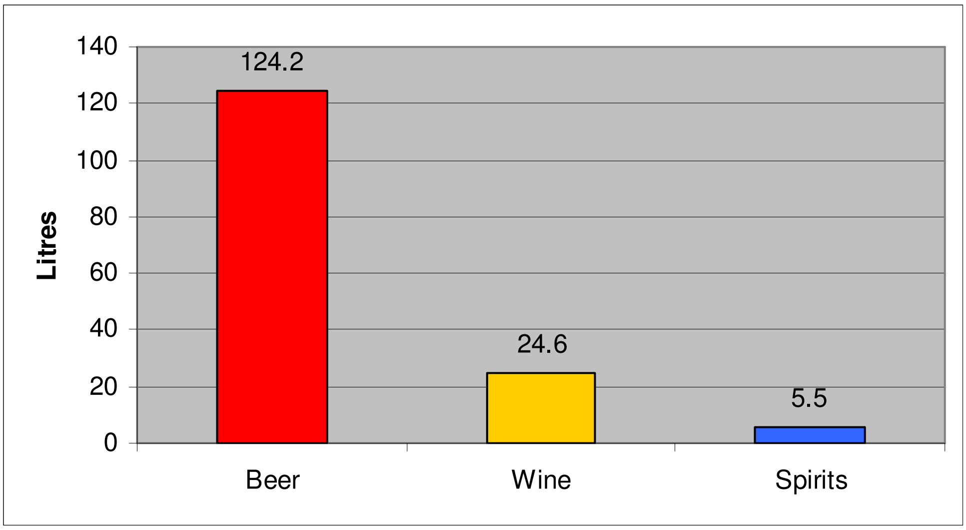
1.1.a. How much do we drink?

The amount of alcohol we drink in the UK is increasing. The average person drinks the equivalent of 9.1 litres of 100% pure alcohol a year.[16] If only those aged fifteen and over are considered, the quantity rises to 11.2 litres.[17]

The 9.1 litres figures represents a 40% increase on the 5.4 litres we consumed, on average, in 1970. Although we may not yet have officially reached the all-time high of 11 litres per capita (of all ages) achieved in 1900 it has been suggested that unrecorded consumption could add another 2 litres to figures recorded after 1995,[18] in which case we are indeed now on a par with turn of the (twentieth) century drinking levels. This increase in alcohol consumption partly has been partly driven by the move to higher strength products.

Figure 1 below shows the average annual volume of different types of alcohol at average alcoholic strengths per person aged 15 and over.

Figure 1: Average annual alcohol consumption per person aged 15 and over – volume / year



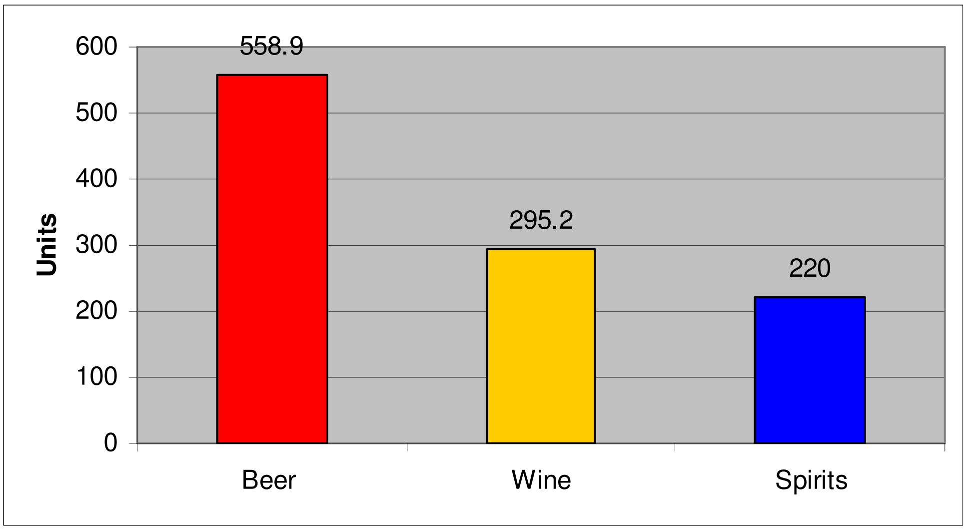
Source: BBPA Statistical Handbook 2004.
Note: figures are based on average ABVs. Alcohol content assumptions are: 4.5%ABV for beer, 12% ABV for wine and 40% ABV for spirits.

Figure 2 shows the same information expressed in terms of units of alcohol drunk.

---

[16] *Statistical Handbook 2004* British Beer and Pub Association, London, 2004.
[17] Since between 20-27% of aged 22-15 year olds drink around 10 units of alcohol a week, this section of the population are probably best included.
[18] *Alcohol per capita consumption, patterns of drinking and abstention worldwide after 1995*. Appendix 2, European Addiction Research, 2001, 7(3): 155-157

Figure 2: Average annual consumption per person aged 15 and over / units / year



Source: BBPA Statistical Handbook 2004
Note: alcohol content assumptions are: 4.5%ABV for beer, 12%ABV for wine and 40% ABV for spirits.

Compared with other European countries, UK *average* consumption figures are in fact moderate. However, in contrast with elsewhere in Europe, the UK's consumption trends are moving steadily upwards - elsewhere they are mostly in decline. The UK pattern of drinking also differs from most other European countries. We tend to 'binge drink,' with the figures showing that Britain and Ireland are both top of the league table in this respect.[19] The term binge drinking is not clearly defined but is commonly taken to mean the consumption of more than twice the daily recommended maximum units of alcohol in one sitting (i.e. more than six units for women and eight for men).[20]

1.1.b. What do we drink and how is this changing?

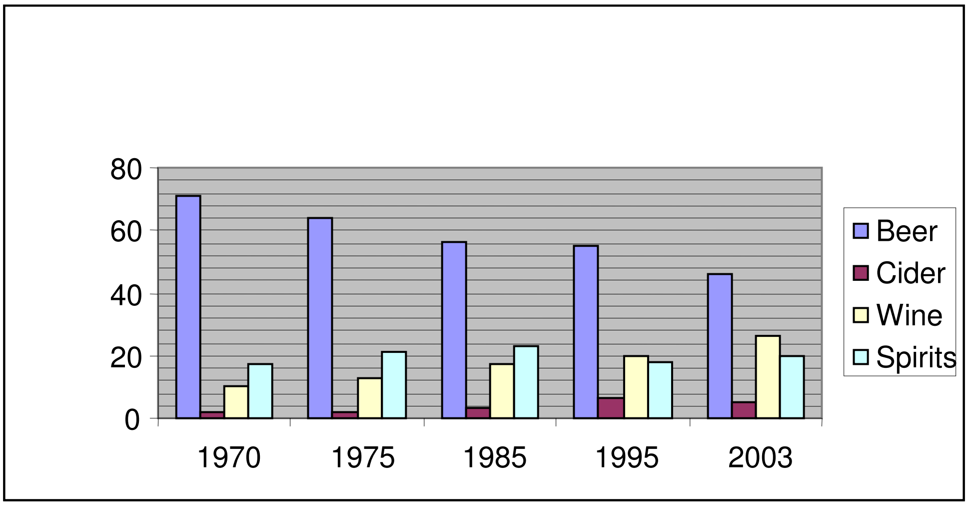
The British Beer and Pub Association holds detailed statistics on how our drinking patterns have changed.[21] While in terms of sheer volume, we drink more beer than any other alcoholic beverage, this is largely explained by the fact that its alcohol content is relatively low and it is consumed in larger quantities. However even by this measure, there has been a clear decline in beer (and cider) drinking and a rise in the consumption of wine, coolers and (to a smaller extent) spirits.

Measured by alcohol content beer still has the largest individual share of the alcohol market at 46.3% in 2003 but the figures below, showing consumption levels at five year intervals, illustrate a decline. Wine's share, by contrast, is steadily increasing.

---

[19] *Alcohol Consumption and Harm in the UK and EU*, Institute of Alcohol Studies, March 2005 http://www.ias.org.uk/factsheets/harm-ukeu.pdf
[20] *Alcohol Harm Reduction Strategy for England*, The Strategy Unit, London, March 2004 http://www.strategy.gov.uk/downloads/su/alcohol/pdf/CabOffce%20AlcoholHar.pdf
[21] *Statistical Handbook 2004* British Beer and Pub Association, London, 2004.

Figure 3: Share of UK alcohol consumption by alcohol type – units



Source: Statistical Handbook 2004 BBPA

As highlighted, wine consumption is increasing and the UK is now, together with Germany, the world's largest importer of wine.[22] [23] White wine accounts for 48% of consumption and red and rosé wine for 52%, meaning that there is roughly a fifty-fifty split between wines that are served chilled (this has implications for energy use as is discussed below) and those that are not. The trends suggest that white wine is growing in popularity over red. [24]

---

[22] International Organisation of Vine and Wine (O.I.V)http://news.reseau-concept.net/images/oiv_uk/Client/Stat_2002_def2_EN.pdf

[23] FAO 2004 http://faostat.fao.org/faostat/servlet/XteServlet3?Areas=%3E801&Items=564&Elements=61&Years=2004&Format=Table&Xaxis=Years&Yaxis=Countries&Aggregate=&Calculate=&Domain=SUA&ItemTypes=Trade.CropsLivestockProducts&language=EN

[24] *The Drink Pocket Book 2006*, 2005 World Advertising Research Center Ltd, 2005 AC Nielsen

1.2. A MORE DETAILED LOOK

1.2.a Beer

Where does our beer come from?

The vast majority of the beer we drink is brewed in the UK. Of the 60.3 million hectolitres of beer consumed in the UK in 2003, 58 million of them were UK-brewed. Allowing for a little exporting (3.5 million hl) and importing (6.5million hl), self sufficiency therefore stands at about 90%.

This represents a decline in self sufficiency since 1960 when imports accounted for only 5% of consumption. Indeed at the peak of beer drinking in 1979, imports were lower still at 1979. Since this period, imports measured by volume have more than doubled[25] while exports have increased fivefold.[26] This growth in exports will have had an effect on the type of beer brewed (which is tailored to non UK tastes) and on the transport needed for the beer to reach its final market. Both these factors will have had an effect on greenhouse gas emissions, as section three will show. The UK is the third largest European producer of beer, after Germany and Russia, although its important is much less in global terms. Worldwide the top three beer producing countries are, by a long way, China, the US and Germany.[27]

It should be noted that to these import figures just presented, 'personal imports' of the day-trip-to-France variety add to the total amount of alcohol imported. In 2003, the BBPA estimate that personal imports accounted for 2.9% of total alcohol consumed[28] meaning, as already highlighted that the official figures (9.1 per head or and 11.2 litres per adult head) need to be raised slightly. Personal imports of beer are now rapidly falling and in 2005 accounted for only 1% of total consumption.

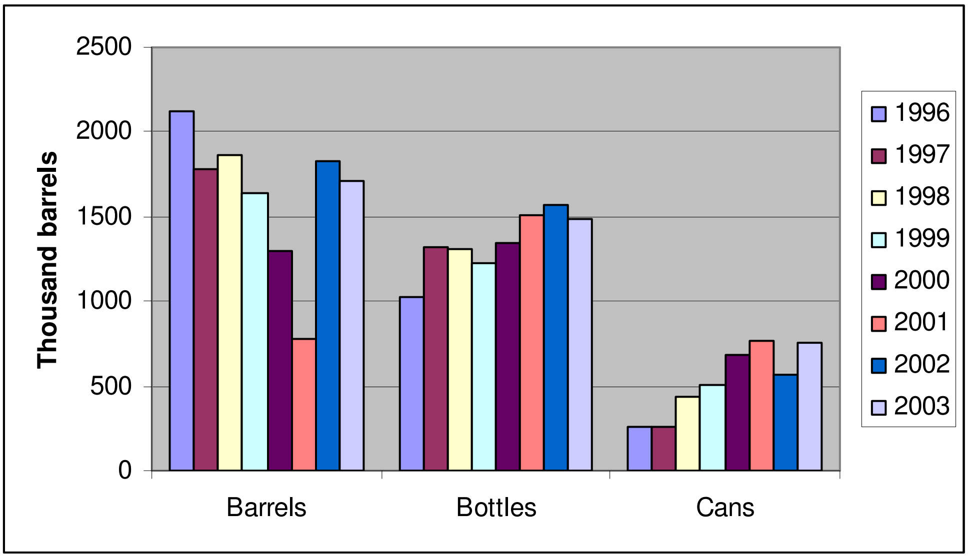
By volume, the vast majority of the beer we import comes from Ireland (mainly stout-type beers such as Guinness), followed by Germany. However when analysed by container type, Germany takes the lead in bottled beer imports, closely followed by France. The Dutch account for the highest individual proportion of our imported canned beer.[29]

Imports of keg beers have declined by about 20% between 1996-2003.[30] By contrast, the import of bottled beers has grown by 45% over that period and canned beer imports have nearly tripled in quantity.[31] Bottled and canned beer imports now make up 56% of total imports[32] and account for 14% of all bottled and canned beer. As Section three discusses, this growth in the popularity of bottled and canned *imported* beers mirrors the overall growth in popularity of bottled and canned beer both domestically produced and imported. Bottled beer as a whole grew by 65% between 1996 and 2003 and canned beer by 22%.[33]. The implications for GHGs are explored further in Part two, Section one.

---

[25] *Statistical Handbook 2004* British Beer and Pub Association, London, 2004, Table A4
[26] *Statistical Handbook 2004* British Beer and Pub Association, London, 2004 -Table A3a
[27] *The Barth Report* 2004/5, Nuremburg, Germany, 2005 http://www.johbarth.com/report05/Barth_2005_English.pdf
[28] *Statistical Handbook 2004*, British Beer and Pub Association, London, 2004
[29] *Statistical Handbook 2004*, British Beer and Pub Association, London, 2004Table A5
[30] *Statistical Handbook 2004*, British Beer and Pub Association, London, 2004Table A5
[31] *Statistical Handbook 2004*, British Beer and Pub Association, London, 2004Table A5
[32] *Statistical Handbook 2004*, British Beer and Pub Association, London, 2004 Tables
[33] *Statistical Handbook 2004*, British Beer and Pub Association, London, 2004 Table A11

Figure 4: Trends in beer imports split by container type



Note: one barrel is equivalent to 1.64 hectolitre or 164 litres

Beer versus ale

Traditional British beer is ale – brewed for a relatively short period of time at a cool to ambient temperature and served at room temperature. Today however, only 30% of the beer we now drink is brewed and served in this way. 'Cask' ales – where the fermentation process continues in the cask - account for 7% of the market and other ales and stouts another 23%. Continental style lagers make up the remaining 70% of the beer we drink.

These figures reflect a huge change in our tastes. In 1960, 99% of the beer sold was ale or stout.[34] By 1975, the split was roughly 75:25 ale/stout: lager. Section three explores the implications of this move towards lager drinking for energy use and greenhouse gas emissions.

Where do we drink?

There has also been a dramatic change in where we choose to drink. In 1971 (when records of this kind started) more than 90% of our beer drinking took place in pubs or other licensed premises. By 2003 this figure had dwindled to just over 60% - the rest of the time we choose, it seems, to drink at home.

It is important to note however that although we are buying more drink for consumption at home, the picture for out-of-home consumption in pubs, restaurants and hotels is a little more mixed. Overall spending (in real terms) on beer has grown slightly in the forty years since 1964. It has however declined by over a quarter since the peak of out-of-home drinking in the mid seventies.[35] For alcohol as a whole, out of home consumption is now 75% greater than it was in 1974, an increase which largely reflects the growing popularity of wine. This said, overall out of home drinking (of all alcoholic drinks) is still not as high as it was at the end of the 1980s. The picture for the future looks fairly static.[36] [37]

[34] The figures were not differentiated at this point in the statistical collections
[35] *Statistical Handbook 2004*, British Beer and Pub Association, London, 2004 Table E5
[36] Mintel, Pub Visiting - UK - August 2004
[37] Mintel, High Street Pubs and Bars - UK - April 2004

Table 1: 'On' versus 'Off' beer consumption

Beer consumption split between on and off channels	1971 (records start)	1985	2003
On sales by volume %	90.4	84.4	61.4
Off sales by volume %	9.6	15.6	38.6

Source: BBPA Statistical Handbook 2004, Table A13

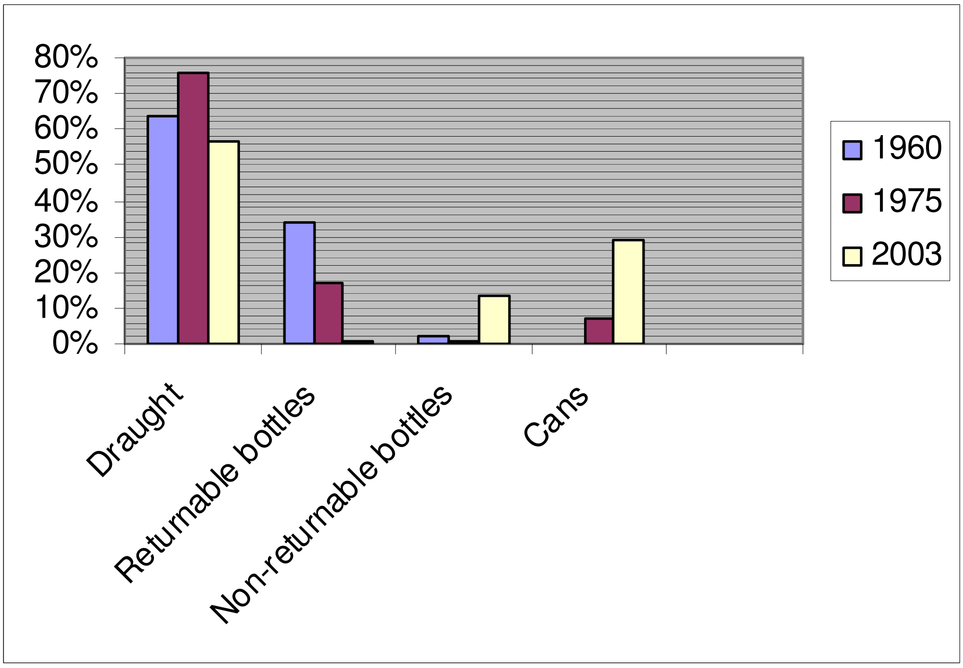
Packaging

Importantly, the change in where we are drinking has had an effect on how the beer is now packaged.

Traditionally, beer was served on-draught from large barrels and this is still the way in which most beer is now sold in pubs. Only 6% by volume is sold in packaged form[38] although for bars, clubs and restaurants, the picture will be very different.

As for home consumption, clearly barrels are not practical, and so people buy bottles or cans instead. Figure 5 below shows the shift away from draught and towards canned and bottled beer. As can be seen, draught beer still dominates but the split between draft and non-draught is now only 57% to 43%. While these figures show the split in terms of sales, they nevertheless also give an indication of the split by volume.

Figure 5: Trends in consumption of beer by packaging type



Source: *Statistical Handbook 2004*, British Beer and Pub Association, London, 2004

The difference in packaging choice has gone hand in hand with the shift, already noted, in the type of beer we like to drink. Although Figure 5 shows that most of what we drink is still pulled from the pump, for lager this is actually not the case at all. Slightly more than half the lager we drink is from a bottle or can (2002 data). By

[38] Andy Tighe, British Beer and Pub Association, personal communication, December 2006

contrast nearly three quarters of ale and stout is draught, a figure that has remained fairly constant over the last ten years.[39]

As lager drinking grows at ale's expense, it is likely that we will continue to see a growth in preference for bottles and cans.

1.2.b Spirits

How much do we drink?

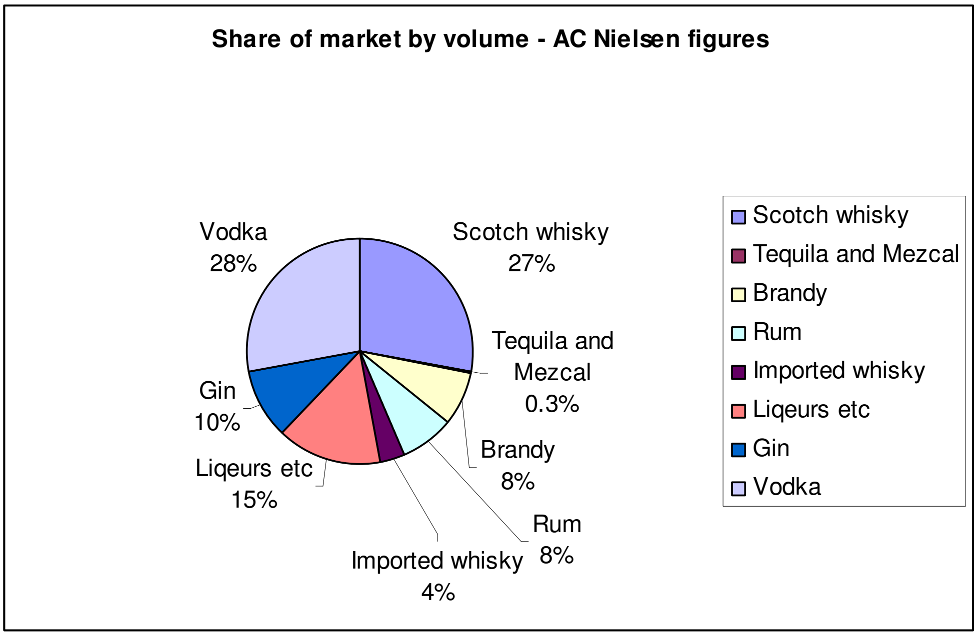
Because of the long maturation period of many spirits, whisky and brandy in particular, it is very difficult to link production, sales and consumption figures.[40] According to data published by the Wine and Sprit Trade Association (WSTA), in the twelve month period up to August 2005 110.8 million lpa of spirits were taken out of bond and released for UK purchase and consumption.[41] This figure does not include cross-channel shopping – that is, spirits bought in Europe and brought back for consumption in the UK.

The Scotch Whisky Association argue that it is a major assumption to equate purchase with actual consumption; however in the absence of any other information, it is necessary to use what is available. Assuming an average strength of 40% ABV 110.8 million litres of pure alcohol work out at around 2.3 litres per person aged 16 and over a year, or 3.3 average 70cl bottles a head.

Estimates of the split by spirit type vary (different estimates are presented in Figures 6 and 7) but roughly speaking vodka, gin and whisky (drinks that are produced in the UK as well as imported) account for about two thirds of the spirits we drink. These three provide the focus for the discussion below.

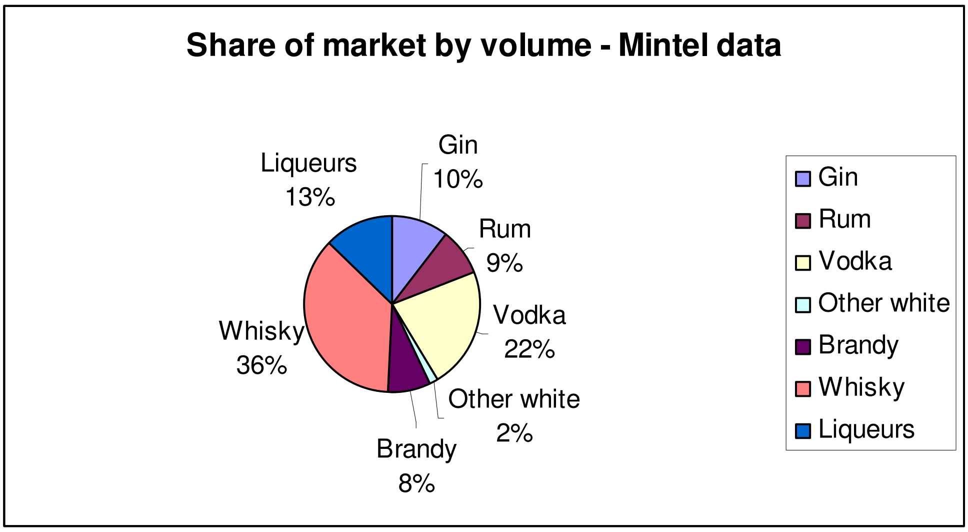
[39] British Beer and Pub Association http://www.beerandpub.com/content.asp?id_Content=419
[40] Scotch Whisky Association, personal communication, June 2006
[41] Wine and Spirit Trade Association, WSTA Spirit Data sheet, December 2005 http://site.wsta.co.uk/english2/statistics.html

Figure 6: Spirits – share of market volume (AC Nielsen data)



Note: 2004 data

Figure 7: Spirits – share of market volume (Mintel data)



Note: 2003 data

Where do we drink them?

According to the Gin and Vodka Association, off-trade sales of gin and vodka account for 75% of sales.[42] Mintel estimates that for white spirits (such as white rum, gin and vodka)[43] the off-trade accounts for 68.5% of consumption, for dark spirits (such as brandy) the off trade figure is lower at 61.1%[44] and for whisky, 78% by

[42] Gin and Vodka Association, GVA Fact Sheet 4: The UK Spirits Market
[43] *White Spirits – UK*, Mintel, March 2005
[44] *Dark Spirits – UK*, Mintel, April 2005

volume is drunk at home.[45] Notwithstanding the variations by product type, clearly the pattern of consumption for spirits is very different from that for beer.

Where are they produced?

The volume of spirits produced in distilleries that are included in the sector's Climate Change Agreement amounts to roughly 424 million litres of pure alcohol per annum. While not all distilleries are included in the CCA it does cover the majority and is here used as a 'good enough' working figure.[46] Note however that one major grain distillery and forty two malt distilleries (some of which are very small indeed) are not included in the CCA and hence the total volume of spirits produced (and emissions resulting from that production) will be greater than is presented here.

By contrast we consume (bearing in mind the caveats highlighted above) is only 110.8 million litres.[47] In other words we produce around four times more than we consume, we export most of what we produce but then we also import roughly half of what we end up consuming.

The 355 million litres of Scotch whisky we produce[48] (note this is the figure for whisky as-drunk and not in lpa) accounts for 87% of the UK's total production of spirits. The remaining 53 million litres provides a base for the manufacture of gin, vodka and a few other minor players.

It has proved impossible to find consistent data for the quantity of gin and vodka that is produced in this country, the quantity that is consumed, the quantity that is imported and the quantity that is exported. The Gin and Vodka Association's own figures for UK consumption are based on sources that vary. As regards production, the Gin and Vodka Association gives the figure in 2001 to be 72 million litres of pure alcohol (lpa).

The table below uses a combination of data to calculate our self sufficiency in gin and vodka. The figure is low, at under 10%.

Table 2: Self sufficiency in gin and vodka

Category	Number	Unit	Notes
Total gin and vodka consumed in UK	356,000,000	LPA	Source: share of gin and vodka consumption (GVA pie chart) total spirits consumption of total consumption (WSTA data)
Total gin and vodka produced in UK	72,000,000	LPA	Source: GVA
Total vodka produced	25,725,600	LPA	Source: AC Nielsen
Total gin produced	46,274,400	LPA	Derived from total production minus vodka production
Total vodka home produced for UK consumption	20,580,480	LPA	On the basis that 20% is exported (source: GVA)
Total gin home produced for UK consumption	13,882,320	LPA	On the basis that 70% is exported (source: GVA)

[45] *Whiskies – UK*, Mintel, August 2004
[46] Spirits Energy Efficiency Company, personal communication, May 2006
[47] Wine and Spirit Trade Association, 2005 statistics http://site.wsta.co.uk/english2/statistics.html
[48] WSTA Spirit Data Sheet - December 2005, Wine and Spirit Trade Association, December 2005 http://site.wsta.co.uk/english2/statistics.html

Total home produced gin and vodka for home consumption	34,462,800	LPA	Sum of above
Total home produced gin and vodka as % total UK gin and vodka consumption	**9.7**	**%**	

Since almost all the remaining spirits we drink (see pie chart above) are imported it appears that the UK's self sufficiency in spirits is only around 34%. In other words, around 66% of the spirits we drink will be imported, and hence the transport implications could be significant.

The picture is complicated still further by the fact that the gin and vodka that is distilled in the UK may use as its base grain neutral spirit (see Box 3 for an explanation) which may have been produced overseas. In other words for any given bottle of gin or vodka the following might apply:

a. Imported gin and vodka: produced outside the UK from grain neutral spirit also produced from outside the UK
b. Imported gin and vodka: distilled outside the UK but produced from grain neutral spirit made in the UK
c. Home produced gin and vodka: produced in the UK from grain neutral spirit produced in the UK
d. Home produced gin and vodka: produced in the UK but from imported grain neutral spirit.

There will then be 'hidden' transport associated even with home produced gin and vodka. For example, according to Diageo, in 2005 roughly 50% of GNS was of UK origin and 50% imported.

There also appears to be some re-importing of UK produced finished spirits. For example in 2005, 5.2 million litres of Scotch whisky (LPA) were imported into the UK. This is equivalent to 17% our domestic Scotch whisky consumption, assuming here that Scotch whisky consumption accounts for 30% of spirits consumption (an average of the figures presented in Figures 6 and 7 above). The reasons for this re-importing are not entirely clear. The Scotch Whisky Association offer two possible explanations: one is that the whisky might been sent abroad for bottling before being returned for sale in the UK. Another might be that volumes of Scotch Whisky have not been sold in the destination market and have therefore been returned.[49]

Exports are extremely important for the UK spirits market. Around 90% of all Scotch whisky produced is exported.[50] The same applies for over 70% of UK produced gin and 20% of UK produced vodka which reaches markets in over 200 countries.[51]

Packaging

Most spirits are packaged in 70cl bottles although 1 litre bottles are common for the exports market. A small quantity of miniatures are also produced. The 'premium and deluxe' spirits, as they are referred to in the trade, may also come with additional packaging such as presentation boxes.

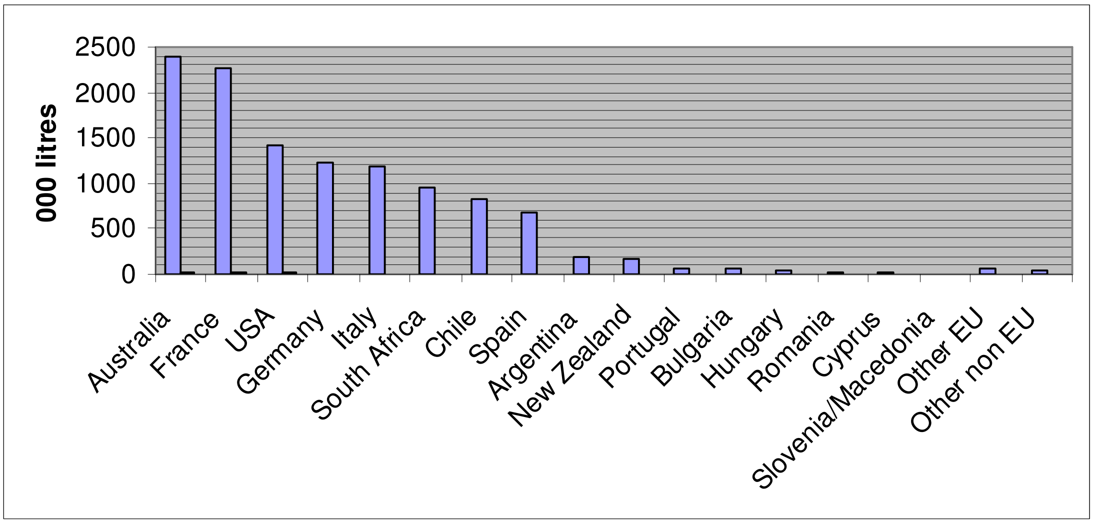
[49] Scotch Whisky Association, personal communication, May 2006
[50] '*Scotch at a Glance*' Scotch Whisky Association, 2004
[51] Gin and Vodka Association, GVA Fact Sheet 4: The UK Spirits Market

1.2.c. Wine

Where does it come from?

We drink over 1300 million litres of wine each year in the UK[52] and are one of the world's top two importers of wine. Australia is our main source of supply, closely followed by France and then by a little way, the US (mainly California).
Figure 8 shows the sources of wine imports into the UK.

Figure 8: Wine imports to the UK by country of origin



Source: The Drink Pocket Book 2006, 2005 World Advertising Research Center Ltd, 2005 AC Nielsen

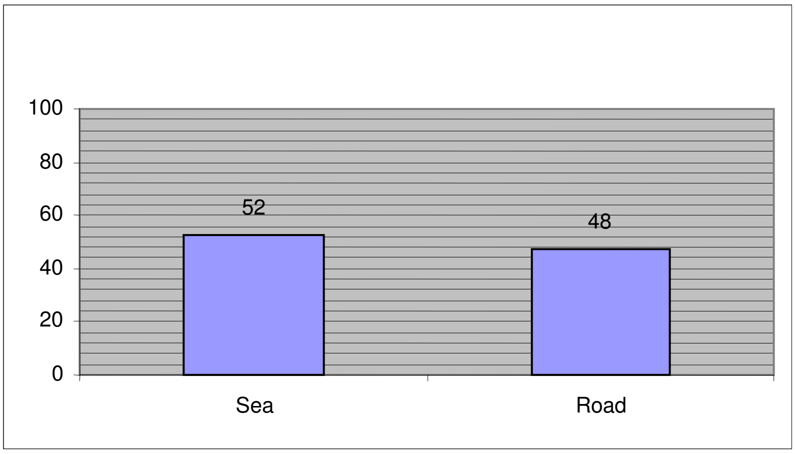
Mode of travel

North European wines tend to come in by road (or rail) whereas Southern European and New World wines will be brought in by sea.[53] The figure below, based on conversations with the importing industry, shows that the split between sea and road is roughly even.

---

[52] Wine and Spirit Trade Association, WSTA data sheet December 2005 http://site.wsta.co.uk/english2/statistics.html
[53] Seawing International, personal communication, February 2006

Figure 9: Wine imports by likely mode of travel



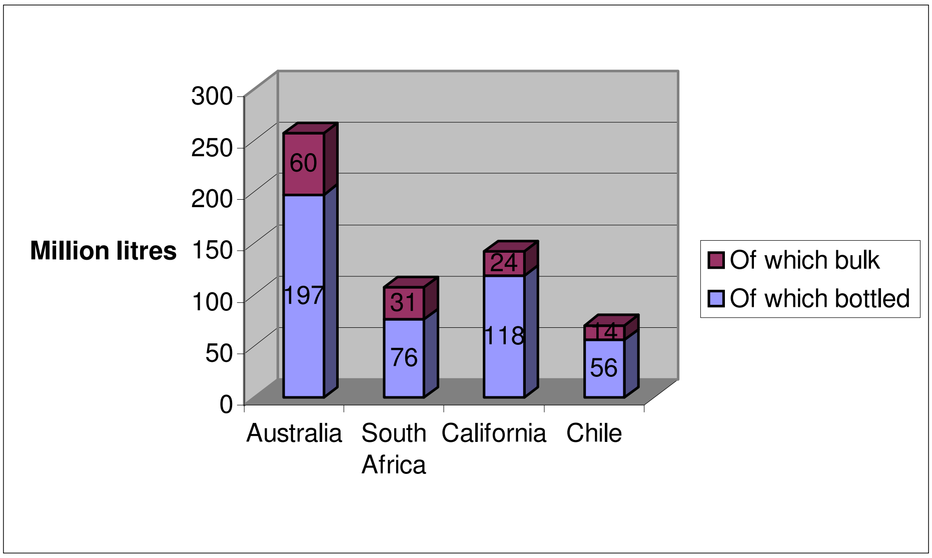
Wine packaging

Almost all wine is bought in 75cl bottles. A very small quantity is sold in smaller bottles, or in cans or in boxes, while in pubs the use of polycasks is common. For simplicity, the discussion that follows focuses entirely on bottles.

Most of the wine we drink is bottled in its country of origin before being shipped to the UK. However a significant minority of the cheaper wines (under £4.50 a bottle) can be and are transported in bulk containers and then bottled in the UK.

The chart below shows the total volume of imports into the UK from the major New World producers, together with the volume imported in bulk.

Figure 10: Imports of wine from the New World by container type



While the split between ready-bottled and bulk imports for European country imports is not known, according to WRAP (the Waste Resources Action Programme)[54] far fewer EU wines are transported in bulk because they tend to be at the higher price

[54] Nicola Jenkin, WRAP, personal communication, March 2006

end of the market. Bottles here are needed to maintain the quality of such wines. Moreover wine making can be very much seen as a traditional activity and as such enmeshed in cultural assumptions and attitudes. In this context the bulk freighting of wine can be looked upon with some disfavour.

Occasionally, logistical oddities occur. For example one very major wine brand is shipped in bulk containers from California to the company's main bottling plant in Northern Italy. It is then bottled and transported by road to its final market, including retail outlets in the UK.

PART TWO: ALCOHOL CONSUMPTION AND GREENHOUSE GAS IMPACTS

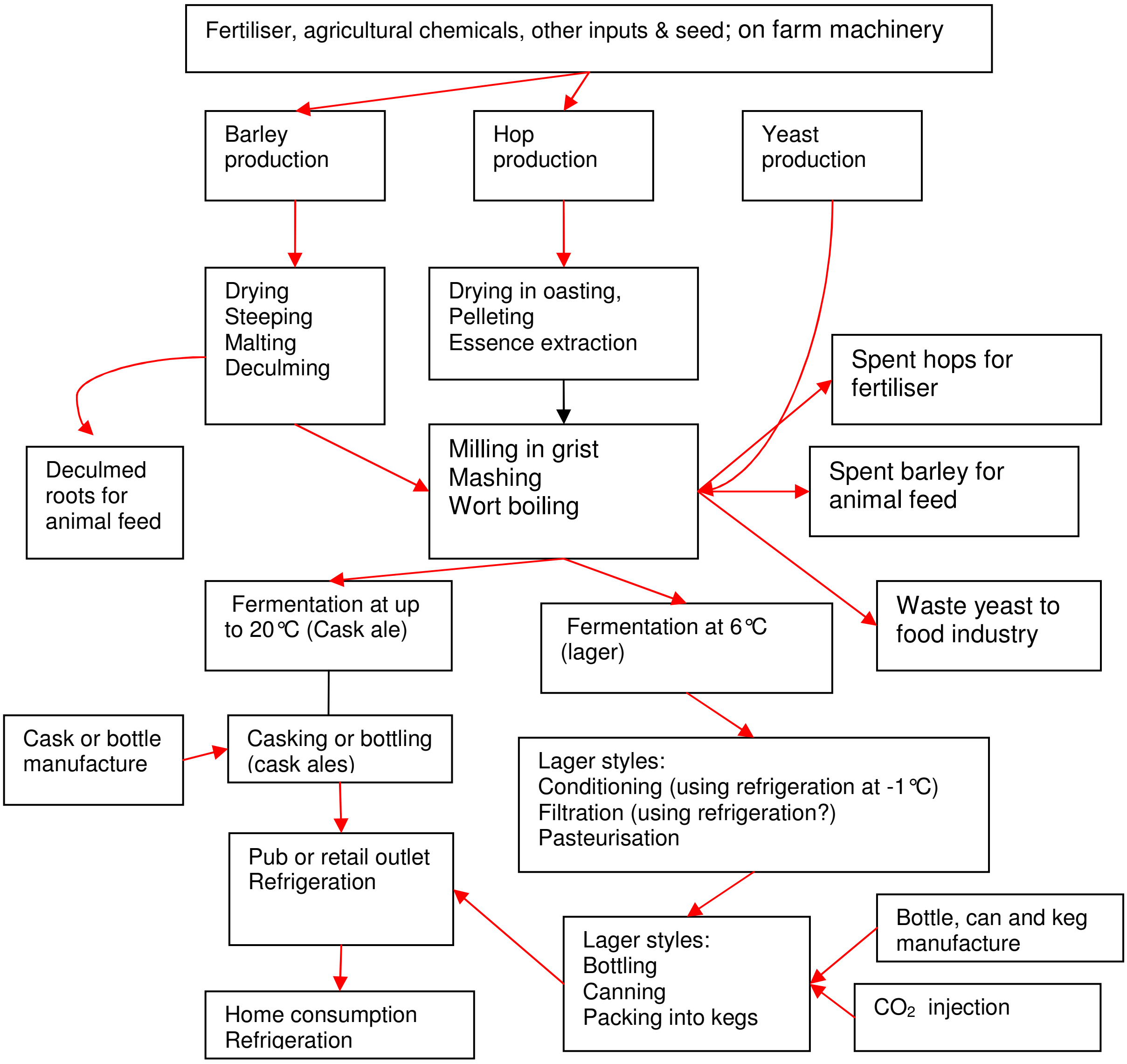
2.1. BEER

The purpose of this section is to examine whether at this stage we can quantify in 'good enough' terms the emissions arising from the beer production process. The agricultural production, malting, brewing and packaging stages are considered here. Transport and consumption related emissions for all alcoholic drinks are examined together in Section two, Part four.

2.1.a. Overview: beer and its life cycle

The production of beer is a many staged process. Energy will be used, and greenhouse gases emitted, at every stage. The main greenhouse gas emitted is carbon dioxide and it arises both from the use of fossil fuels and as a product of the fermentation process itself. Since the latter is very minor and considered to be more than compensated for by the carbon uptake of the barley during its cultivation it will not be considered here. The flow diagram below represents, in simplified form, the main processes involved:

Figure 11: Main processes involved in beer and lager production



2.1.b. The agricultural stage

The main ingredients needed to make beer are barley, hops and yeast. Other ingredients may be and often are added such as other starch-providing grains, fining ingredients and occasionally sugar and flavourings. The following paragraphs look only at barley and hops since these are the most significant. Yeast, and its possible contribution to beer related emissions is not examined, largely owing to lack of information. The same applies for the other more minor ingredients whose impacts are in any case unlikely to be particularly significant.

Much of the discussion on agriculture that follows is relevant to the discussion of whisky in the spirits section, below.

Barley

In 2004, 5.8 million tonnes of barley were produced in the UK. Allowing for a small volume of exports and an even smaller volume of imports,[55] 5.4 million tonnes of

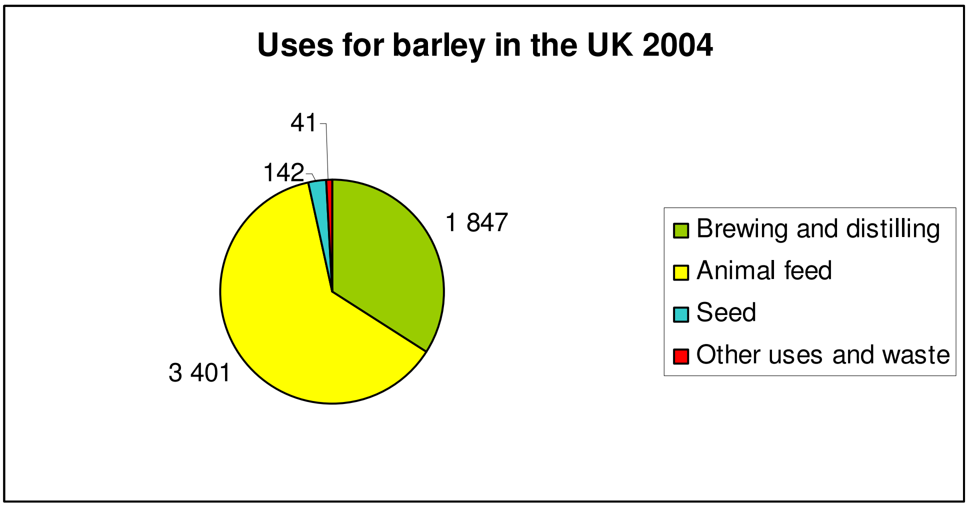
[55] 695 thousand tonnes were exported and additional 76 thousand tonnes were imported.

barley were available for use in the UK; in other words the UK is more than self sufficient in this grain.

About a third is used for brewing and distilling but the majority is grown to feed animals. How much is grown for feed will vary from year to year depending on the price of wheat; when wheat prices are high, barley for animal feed tends to be substituted instead.[56]

The chart below shows the proportion of barley used for different purposes.

Figure 12: Main uses for barley in the UK, 2004



Source: *Agriculture in the UK*, Defra 2004

Carbon dioxide emissions from barley production will arise from the use of energy to drive on-farm machinery and for the production and transport of fertilisers, seeds and other inputs. Nitrous oxide is also emitted both during the fertiliser manufacturing process and through natural soil processes.

As regards energy use, agriculture is not, as a whole, a major user of energy. According to calculations derived from two different sources[57] [58] emissions arising from energy use in UK agriculture works out at about 0.523 million tonnes of carbon or 0.29% of the UK's greenhouse gas total. Around a third of this arises from protected horticulture.[59]

So, of the remaining 0.35 million tonnes, how much might one attribute to barley produced for malting?

---

[56] *Agriculture in the UK*, Defra 2004, http://statistics.defra.gov.uk/esg/publications/auk/2004/chapter6.pdf

[57] Chris Plackett, Farm Energy Centre, personal communication, February 2006

[58] Aggregate Energy Balance 2004, DUKES 1.1-1.3 http://www.dti.gov.uk/energy/inform/energy_stats/total_energy/index.shtml

[59] Chris Plackett, Farm Energy Centre, personal communication 2006, cited in Garnett T. *Fruit and vegetables & UK greenhouse gas emissions: exploring the relationship*, Working paper, Food Climate Research Network, March 2006

Barley cultivation takes up 22% of the total area of land put down to crops in the UK,[60] and of this one might allocate a third to malting barley, or 7.3%. However as a proportion of total agricultural land (including grazing land) its share is smaller, at 5%.

Since no detailed breakdown of energy use by different agricultural land uses is available, it is assumed here that crop-related activities account for 80% of total energy use. As already highlighted, malting barley takes up 7.3% of total crop-related land use and hence it accounts for 7.3% of the energy use attributable to crop cultivation.

It is estimated then that agricultural crop related energy use produces tonnes carbon (80% of total agricultural energy use excluding protected cropping). This means that malting barley-related energy use emits 25404 tonnes carbon, contributing to a very small 0.014% of the total national emissions of greenhouse gases. The actual share to allocate to beer will be smaller still since malt is also used to make whisky and, additionally, is exported. Table 3 summarises the calculations made for malting barley's CO_2 emissions from energy use.

Table 3: Energy related emissions resulting from cultivation of malting barley

Category	Value	Unit	Source
Agricultural crop related carbon	278,400	tonnes carbon	Farm Energy Centre
Malting barley as % total agricultural land area	7.3	%	Defra Agriculture in the UK 2004
Malting barley carbon emissions	25,404	Tonnes carbon	
Malting barley's contribution to UK's GHG emissions	0.014	%	

Direct energy use is not the whole story, however. There is also the contribution made by fertiliser production to consider. According to one calculation, energy use from nitrogen fertiliser manufacture together with the N_20 emitted during its production accounts for about 1.11[61] [62] of the UK's total greenhouse gas emissions.

In 2002/3 the total tonnage of fertiliser applied to UK land was 1.131 million tonnes.[63] It is possible to calculate very roughly barley's share of total fertiliser use. The land area put to barley is about 1.01 million hectares. [64] If one assumes that average barley application rates are about 130 kg per hectare (see discussion below), then total fertiliser use for barley amounts to 131,300 tonnes or 11.6% of total N fertiliser

---

[60] *Agriculture in the United Kingdom 2004*, Defra 2005, http://statistics.defra.gov.uk/esg/publications/auk/2004/chart3-2.xls m

[61] Calculation based on estimates of kg CO_2e emitted per kg of N fertiliser production and transport in Mortimer N. D., Cormack P., Elsayed M.A. and Home R.E., 2003. Evaluation of the comparative energy, global warming and socio-economic costs and benefits of biodiesel, Final Report for the Department for Environment, Food and Rural Affairs, www.defra.gov.uk/farm/acu/research/reports/nf0422.pdf

[62] Tara Garnett , calculations based on data provided by the Agricultural Industries Confederation, 2006

[63] *Fertiliser consumption in the UK*, 1969/70 to 2002/03 *http://www.environment-agency.gov.uk/commondata/103608/i1_fert_l4_dt_441145.txt*

[64] *Defra,* Agriculture in the UK, 2005 Table 3.2 (2003 figures) http://statistics.defra.gov.uk/esg/publications/auk/2004/3-2.xls

use. Of this about a third is attributable to the cultivation of malting barley. In terms of total carbon equivalent emissions this amounts to approximately 0.046% of the UK's GHG emissions.

Table 4: N fertiliser-related GHG emissions arising from malting barley cultivation

Category	Unit	Value	Source
Total N fertiliser related emissions as % total UK GHG emissions	1.1	% total UK GHG emissions	Elsayed; Tara Garnett
Total barley related N use as % total N use	11.6	% total N use	Agriculture in the UK
Total malting barley related N as % total N use	3.87	% total N use	
Total malting barley related N fertiliser as % total UK GHG emissions	0.042	% total UK GHG emissions	

Once again, an allocation will need to be made between barley used for brewing, distilling and for export.

Nitrous oxide emissions are also emitted from agricultural soils and these will contribute to the UK's greenhouse gas emissions. Key factors affecting N_20 emissions from soils include WFPS (water filled pore space), temperature, mineral N concentration, crop type and rainfall.[65]

A rough calculation is made in Table 5 below for malting barley soil N_20 emissions, expressed in terms of its total contribution to the UK's GHG emissions.

[65] Dobbie K E and Smith K A. (2003). Nitrous oxide emission factors for agricultural soils in Great Britain: the impact of water filled pore space and other controlling variables. *Global Change Biology 9, 204-218*

Table 5: N soil-related GHG emissions arising from malting barley

Malting barley related soil N_2O emissions			
Category	**Number**	**Unit**	**Source**
Total area put to barley	1,010,000	hectares	Defra
Average N_2O-N emissions per hectare	1.25	kg/ha/yr	Smith KA Smith JU & Smith P 2005. *Scottish agriculture and global climate change: nitrous oxide emissions from fertiliser use*. Scottish Executive Environment Group Report 2004/09. ABRG:UEH/007/03. ISBN 0-7559-3900-X. Available: http://www.scotland.gov.uk/Resource/Doc/30701/0007033.pdf
Average N_2O emissions per hectare	3.9	kg/ha/yr	N20-N to N_20 requires multiplying by 3.14
Total N_20 emissions for barley	3,968	tonnes / ha/ year	
Total N_20 emissions for barley in CO_2e	1,230,036	Tonnes CO_2e	
Total N_2O soil emissions for barley in Carbon equivalents	335,464	Tonnes Ce	
Barley N_20 soil emissions as % contribution to total UK GHGs	0.19	%	
Malting barley N_20 soil emissions as % total UK GHGs	**0.06**	**%**	

Note: N_20 has a global warming potential of 310.

Finally Table 6 combines the three tables above to give total emissions for malting barley. This 0.12% needs to be divided further into emissions attributable to beer and to whisky. 43% and 33% of total malt produced are used to make beer and spirits respectively. In addition 19% of malt is exported. Since around half the barley exported makes its way back into the UK in the form of finished beer, half the exports figure is here re-allocated to beer. Half of that figure (half of 10%) is then deducted to take into account the small quantity of beer that we export. It should be remembered that our focus here is consumption rather than production related emissions, hence the slightly convoluted allocation procedure.

The figures resulting from these calculations put beer's total share of malting barley emissions at 48% and whisky's at 33% respectively (emissions related to exports make the figure up to 100% but are not included in this consumption related analysis). On the basis of this allocation, agricultural stage GHG emissions for beer work out at about 0.055% of the UK total. The figure shown for whisky related malting barley is just a starting point. Quantifying emissions for spirits adds several more layers of complexity, partly because starch sources other than barley are used (anything from rye to potatoes) and partly because much importing and exporting takes place which needs to be taken into account. Spirit related emissions are discussed in 2.2 below.

Table 6: Total GHG emissions arising from agricultural production of malting barley

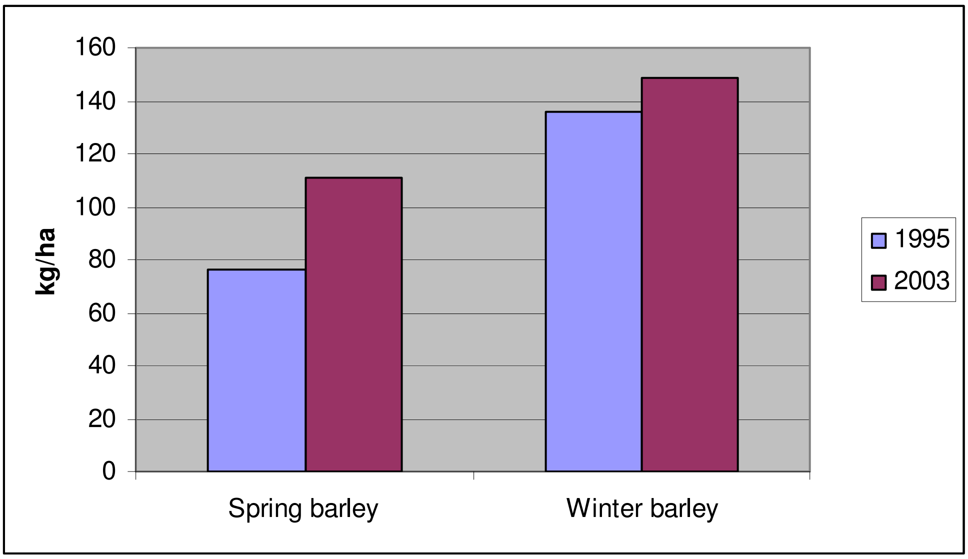
Category	Unit %
Malting barley CO_2 emissions as % UK GHG total	0.014
Malting barley N fertiliser emissions as % UK total GHG emissions	0.042
Malting barley N_20 soil related GHG emissions as% UK GHG total	0.06
Malting barley's contribution to UK GHG	**0.12**
Beer related malting barley as contribution to UK GHGs	**0.055**
Whisky related malting barley as contribution to UK GHGs	**0.038**

These figures (and this allocation procedure) will not be entirely accurate but is consistent with the approach taken in this paper which is to assume that overseas production processes will be similar in their specific energy efficiency and CO_2 outputs to those in the UK. While this is almost certainly not the case, in the absence of more accurate data it is the best that can be achieved.

Whatever the method of allocation at this stage, clearly the numbers being considered are very small and as such the agricultural stage of alcohol production at least, can be considered to make a very minor contribution to the UK's total emissions. Of those emissions which do arise, those relating to the manufacture and application of nitrogen based fertilisers and subsequent denitrification processes in the soil are the significant.

As such it may be worth noting that fertiliser application levels have been rising, as Figure 13 shows.

Figure 13: Nitrogen fertiliser applications for barley



Spring barley application levels have grown by 46% while for winter barley the growth is 8%. We have not been able to find data which differentiate between application levels for animal feed and for malting barley[66] but it tends to be the case that most malting barley is of the spring variety.[67] While fertiliser application levels are lower for spring than for winter barley, as the chart shows, there has been a far higher rate of growth in fertiliser application levels for the spring crop.

It is also possible that for spring barley, N application levels will increase further. The Home Grown Cereals Authority has published recent work[68] showing that optimum N application levels (in terms of yield, grain quality and cost effectiveness) for spring barley are around 150kg/ha, representing a 35% increase on current application levels and putting spring barley fertiliser requirements on a par with winter barley.

What has led to this higher N fertiliser use? There are a number of factors at play. Traditionally brewers wanted a barley which was low in protein (and hence nitrogen) but high in starch. The starch could then be converted first into sugar and then into alcohol. Barley with a high starch content also - and this is perhaps the more significant factor – produces a beer which is clearer since it is the protein content in the beer which makes the liquid cloudy. For 'real' or cask ales that are not chilled and filtered, minimising cloudiness was an important consideration.

Thus, traditionally, barley crops were not heavily fertilised since the more N fertilisers used, the higher the protein content in the grain. The downside, however, was a slightly lower yield. Now, with the growth in lagers which are conditioned, chilled, filtered and pasteurised before being stored in the keg, the protein content is not so critical – it can simply be filtered out. Hence there has been a shift towards using barley that has been more heavily fertilised than before; the resultant higher yield brings barley costs down and this saving compensates for the slightly lower starch content. The breeding of barley with higher genetic potential has also contributed to the greater requirements for N fertiliser applications, that they might fulfil this potential.

There is an additional explanation for the growth in higher-N barley. Many lagers are not, today, made from pure barley. Often additional grains, particularly maize, are used.[69] These alternative grains are cheaper than barley and, being high in starch, help along the fermentation process. As a result the barley itself does not need to have a high starch content - the high protein in the more heavily fertilised barley will be evened out by the high starch content of the other grains. The combination of barley which has been produced more cost effectively (since yields are greater) and lower cost additional grains is of course commercially attractive.[70] The energy and nitrogen fertiliser use associated with the production of these additional starches is not examined here.

Fuelling this increase in high-N barley production has been the growth both in exports of beer to the continent and further afield, and in the production of malt for

[66] It may be difficult to produce meaningful data since some malting barley which fails to make the grade is subsequently fed to livestock and so there is overlap between the two end-uses for the crop.
[67] Bill Handley, Home Grown Cereals Authority, personal communication, October 2005
[68] Overthrow, R. *Nitrogen management in spring malting barley for optimum yield and quality*, Project Report No. 367, Home Grown Cereals Authority, London, 2005
[69] A very small proportion of beers such as 'weiss' or wheat beers are also made of wheat but these tend to be minor players, particularly in the UK
[70] Peter Hanson, consultant to the Home Grown Cereals Authority, personal communication 2005

export (see below for a discussion of malting). Continental consumers tend to drink lager and so continental maltsters require malt produced from higher N-content barley.[71]

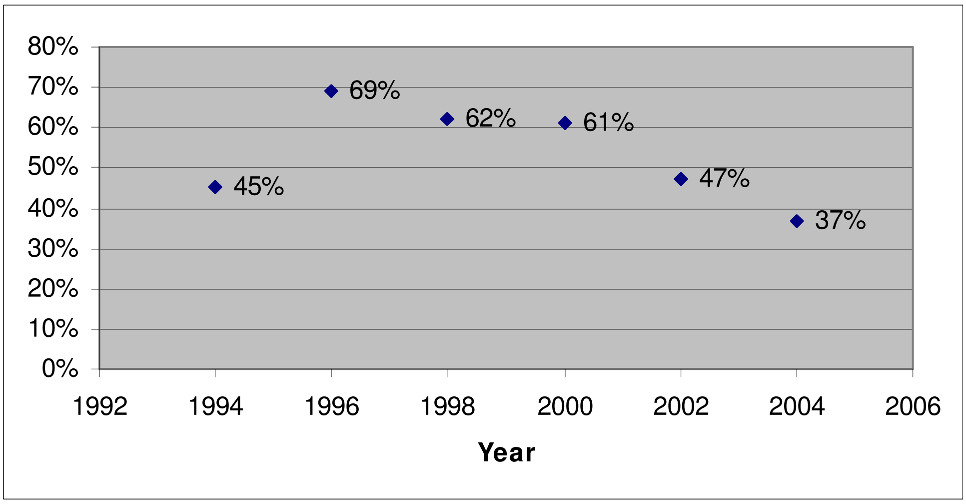
This said, the significance of these trends is small and even if fertiliser application levels were to increase more substantially still, the contribution of malting barley cultivation to total GHG emissions will remain very low indeed. There may of course be other environmental concerns arising from increased fertiliser applications but these fall outside the scope of this research.

Hops

Hops are the second major input into the beer production process. In 2004, we produced around 2.3 thousand tonnes of hops and consumed around 2.7 thousand tonnes. However these figures mask a flurry of import-export activity. For 2004, of the 2.3 thousand tonnes we produced, more than half (1.3 thousand tonnes) were exported, meaning that a further 1.7 thousand tonnes were imported to meet our brewing needs. In other words for 2004, our self sufficiency was only 37%.[72]

The proportion of hops we import tends to fluctuate according to weather and world hop prices. The chart below shows self sufficiency in hop production for a selection of years.

Figure 14: Self sufficiency in hop production / year



Source: Defra, *Basic Horticultural Statistics 2005*

Hops will also be imported into the UK for processing (into pellets and exports – see below) before being re-exported. The UK is a fairly significant world centre for hop processing.

The reason for both importing and exporting hops is because different varieties of hops impart different flavours and properties to beer. For a start, for beer to taste like beer, bitterness is needed and this is imparted by the alpha acids in hops, which break down during the wort boiling (see below) stage to produce the distinctively

[71] Peter Hanson, consultant to the Home Grown Cereals Authority, personal communication 2005
[72] Based on Defra statistics with thanks to Peter Darby, East Malling Research, personal communication, October 2005 for clarification

bitter isoalpha-acids. All hops contain alpha acids but some have a higher alpha acid content than others. Although high alpha hops are grown in the UK, on the whole, commodity hops purchased for their alpha qualities tend to be bought on the world market. The two largest alpha hop producers are Germany [73]and the US[74] who between them in 2004 produced 70.9% of total world alpha output. The UK happens to be one of the main importers of US hops.

In addition to bitterness, hops also impart additional aromas to the beer. Aroma hops – hops grown for this function rather than for their bitterness - are introduced into the beer towards the end of or after the boiling process, or even once the beers have been casked (see Brewing, below). Different varieties of hops yield very different flavours. Most of the aroma hops used in the UK will be indigenously sourced.[75] However where overseas brewers are brewing under license in the UK, the chances are that they will be using a very specific hop variety which could well be imported. With the growth in popularity of foreign lagers there has been a shift away from using UK hops. A few varieties of hops can be used both for their alpha and their aroma properties although they will still be introduced several times into the brew.

What does this mean in terms of greenhouse gas emissions? Hops are not produced in such significant quantities as to make transport (and the shift from home production to imports) a very major consideration: around 2700 thousand tonnes of hops were used in the UK[76] which in bulk terms is tiny compared with the 1.85 *million* tonnes of barley used for malting. Hops are also likely to travel by ship and as such emissions per tonne/km will be low. This said some hops are imported from as far afield as New Zealand.[77]

Fertiliser application rates in the UK for hops stand at around 150kg N /ha. [78] Application rates for hops grown overseas vary but also hover around this figure – the US rate is higher[79] at about 150-195 N kg/ha while in Germany the rates fluctuate between 122 - 171 N kg/ha.[80]

There will also be energy impacts at other stages in the hop life cycle. Recent years have seen a move away from using cone hops (the hops in their natural state) to hops in pelleted form and hop extracts. Both processes will require energy. The hop aroma extraction process, for example, involves the use of liquid carbon dioxide and extraction under intense and hence energy-demanding refrigeration. Unfortunately no data from Botanix, the UK's main (and indeed only) hop extractor was available.

On the plus side, environmentally speaking, pelleted hops and hop essences are more efficient to transport and so some of the processing emissions may be offset by lower transport energy costs.

---

[73] who receive extra support from their government
http://www.johbarth.com/report05/Barth_2005_English.pdf
[74] Peter Darby, East Malling Research, personal communication, October 2005 and The US and World Situation: Hops, USDA, Foreign Agricultural Service Horticultural & Tropical Products Division, April 2004
http://www.fas.usda.gov/htp/Hort_Circular/2004/Charts%20Circular/chart%20circular%20files/2004%20Hops.pdfv
[75] Peter Darby, East Malling Research, personal communication, October 2005
[76] Home production plus imports minus exports
[77] Peter Darby, East Malling Research, personal communication, October 2005
[78] Tony Redsell, National Hop Growers of England, personal communication 27/09/05
[79] http://www.uidaho.edu/wq/wqbr/wqbr17.html
[80] given in Table 5.1 of the Hop Report from Bayerische LFL
http://www.lfl.bayern.de/ipz/hopfen/05569/reporthops04.pdf

One needs also to consider the energy involved to dry the hops in oast houses. No data on this process seem to be available but given the quantities involved emissions will be very small compared with those for malting (see below) where some of the processes are comparable.

One emerging issue with a bearing on greenhouse gas emissions is refrigeration. At present hops are imported into the UK at ambient temperature. Some companies in the US insist that their hops arrive in refrigerated containers and are kept in refrigerated stores prior to export. This obviously means that US hop imports carry with them a greater greenhouse gas burden than other imports or UK grown hops. If UK-based brewing companies start to require refrigeration for non US hops as well, this may well increase overall energy use.[81]

2.1.c. Malting

The malting process

Once the barley has been harvested it is delivered to one of the 14 malting companies in the UK.[82] Transport mileage at this stage has not been quantified but is unlikely to be very high. A map provided by the Maltsters' Association of Great Britain shows that most malt houses are located near to the main sites of production.[83] Distances are roughly 20-50 miles.

After the barley has been grown it is usually stored until it needs to be turned into malt. Box 1 briefly describes the malting process.

The production of malt requires an intensive use of energy and as such the malting sector has, under the auspices of the Maltsters' Association of Great Britain, negotiated a Climate Change Agreement, in return for which the sector receives an 80% rebate on the cost of the Climate Change Levy. The sector target is to achieve a primary specific energy consumption of 1,197.84 kWh per tonne of malt by 2010. This represents a 9.5% reduction from the 1999 performance.[84]

In the 2004 assessment of its progress (known as the second Target Period) the sector was on course to meet these goals, achieving an 8.9% reduction in its specific energy consumption, far better than the 3.2% target required under the terms of the CCA at this stage. While this represents a significant *relative* improvement in energy, since there was also an increase in overall malt production, in absolute terms, emissions rose by 500 tonnes of carbon.

Box 1

Malting

The first task of the maltster is to reduce the moisture content of the barley, so as to inhibit germination and enable the grain to be stored for up to a year. In England, the barley tends to reach the malting house with a moisture content of about 15% although this can be higher in Scotland where it is wetter and where moisture levels

[81] Peter Darby, East Malling Research, personal communication, October 2005
[82] MAGB website www.ukmalt.com 2004 data
[83] MAGB website http://www.ukmalt.com/ map showing Malting Sites in Great Britain
[84] *Climate Change Agreements – Results of the second target period assessment*, Version 1.0 Future Energy Solutions AEA Technology July 2005

can be as high as 22%.[85] The moisture content needed for storage is about 12% and the wetter the grain the more energy will be needed to dry it.

When the barley is required for malting, the barley is reawakened by steeping in water. This process takes a few days; the grain is immersed for a period of time until it attains a moisture content of 46% and begins to germinate. The water is then drained off, the grain left to rest and then the process repeated again two or three times. Air (sometimes humidified) is blown through to dry the grains and warm them slightly.

Once the grains have germinated sufficiently, they are heated in a kiln to stop further germination. This is the most energy intensive stage in the process.[86] This converts the carbohydrates in the grain to sugars. Note that the darker malts used for stouts will have been heated for slightly longer and this will entail slightly more energy but the difference is fairly minor. After the malt has been made the grains are deculmed, meaning that the small roots which have formed as a result of the germination process are removed and sent off for animal feed.

Total energy use for the production of 1.64 million tonnes of malt in 2004 was around 1.957 million kWh. Using the breakdown of the energy mix supplied by the MAGB[87] this resulted in the generation of 0.141 million tonnes of carbon or 0.079% of the UK's total greenhouse gas emissions . Some of these emissions should be allocated to beer, some to spirits and some to exports. This study is concerned with consumption rather than production and, following the allocation procedure described in 2.1.b above, 48% of total emissions are allocated to beer (to take into account the re-import of malt in the UK in the form of beer and a small quantity of beer exports) and 33% to whisky. Strictly speaking, an emissions allocation should be made to the byproducts which go to make animal feed and deducted from alcohol's share of total emissions. However the amount to allocate will be extremely small and in any case the data are not available.

Clearly CO_2 emissions from malt (and beer) production will vary between countries but the purpose here is simply to gain a 'good enough' impression of the significance of the malting sector in terms of total CO_2 emissions. This is set out in Table 7.

Table 7: Beer malt related GHG emissions

MALTING	Number	Unit
Total malt production	141,307	tonnes carbon
Malting beer	67,827	tonnes carbon
As % total UK GHG emissions	0.038	%

Transport and energy use at the malting stage

As already suggested, the transport of barley to the malting site is unlikely to be significant in terms of greenhouse gas emissions.

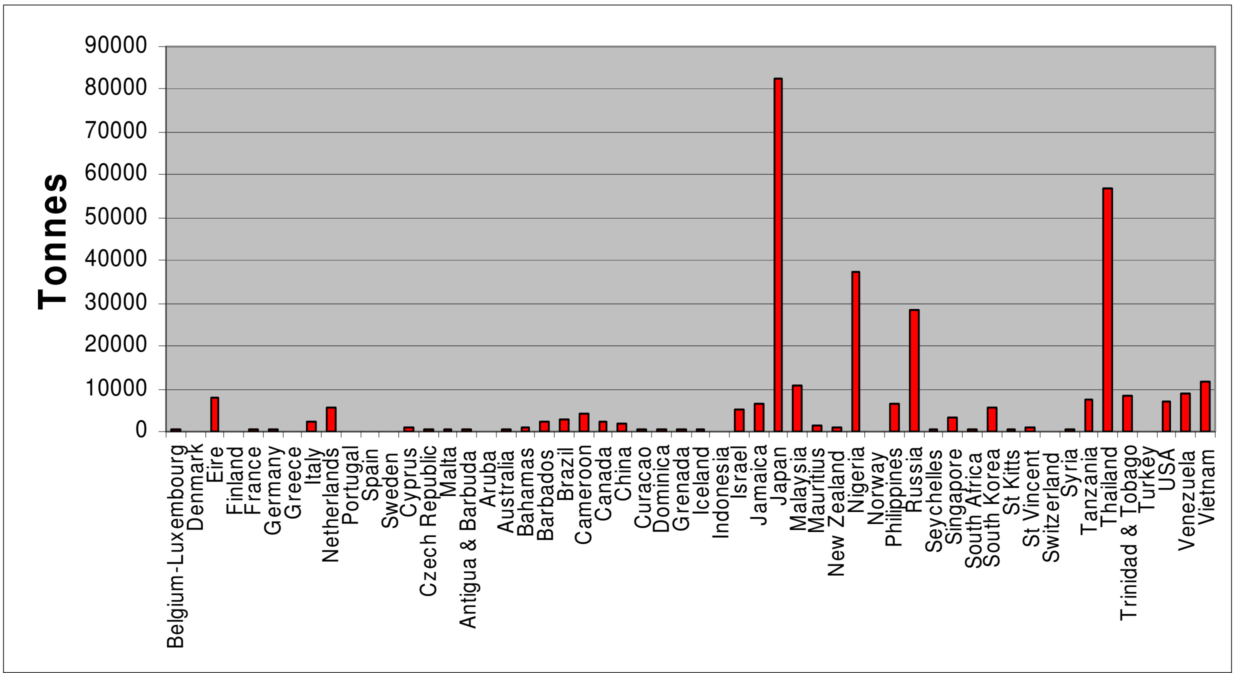
However at a global level the picture may be very different. The global malt market is growing at about 2-2.5% a year, with beer accounting for about 80% of world malt

[85] Ivor Murrell, Maltsters' Association of Great Britain, personal communication, 2004
[86] Ivor Murrell, Maltsters' Association of Great Britain, presentation for FCRN seminar, October 19th 2005
[87] Ivor Murrell, MAGB, personal communication, October 2005

use.[88] Since beer consumption in the UK is static, the growth for the malting sector arises from the increase in global demand for beer and hence the UK production of malt for the world market. The UK malting industry is in fact the third largest in the world and exports to over 80 countries.[89] In 2004, around 26% of the 1.6 million tonnes of malt produced in the UK were exported, or around 320,000 tonnes.

The vast majority (94%) of exported malt was to non-EU countries with, as the chart below shows, the main export destinations being Japan, Thailand, Nigeria, and Russia.[90] The main buyers of UK malt in Europe are the Republic of Ireland, the Netherlands and Italy. These European countries (Ireland in particular) also happen to be significant importers of finished beer into the UK. In effect malt, is exported from the UK before being re-imported in the form of beer and there will be (unquantified) transport implications arising as a result. While for the purposes of this consumption oriented study, export related emissions are not relevant they nevertheless add to the global emissions of CO_2.

Figure 15: Export destinations of UK malt



Data source: Home Grown Cereals Authority malt export data for 2004-5

We also import a small quantity of malt, around 16 thousand tonnes in 2004, almost all of it from Spain. Small quantities are also imported from Japan, Thailand – interestingly two of the UK's top export customers – as well as from the US. This is because UK brewers brew foreign brands (for example the Japanese Kirin) here in the UK and are required to use the particular kind of malt, hops and so forth.

[88] Renwick A and Coombe S, *The UK Cereals and Oilseeds Subsectors: Final report for the Home Grown Cereals Authority*, Rural Business Unit, University of Cambridge, April 2003
[89] MAGB website http://www.ukmalt.com/maltindustry/industry.html accessed 6 Oct 2005
[90] Home Grown Cereals Authority http://data.hgca.com/Data%20Archive/Trade/UK%20Exports%20-%20Malt.xls accessed 6 Oct 2005

Furthermore we import tiny volumes of barley – around 16 thousand tonnes in 2004, almost all of it from Spain. We also, somewhat bizarrely also import small quantities from Japan, Thailand – two of the UK's top export customers – as well as from the US.

2.1.d. Brewing

Making the beer
Once the malt has been produced it is transported to the brewery where it is made into beer. The box below summarises the processes involved.

Box 2

The beer making process

Grist production
At the brewhouse, the malt is crushed in roller mills to produce a coarse flour known as 'grist.' At this point other cereals, including flaked maize, unmalted barley and wheat may be introduced in order to produce particular characteristics of flavour or colour or for economic reasons.

Mashing and boiling
This grist is then 'mashed' in a large vessel or 'mash tun' with hot water (known in the industry as liquor). The sugars in the malt dissolve in the liquor and eventually a sweet brown liquid is drawn off, called wort. The spent grains are sold for animal feed (see below).

The wort is then boiled with hops, or hop extract, in large vessels, known as coppers. This process releases the bitterness from the resins at the base of the hop petal. The spent hops are then separated off and removed for sale as a fertiliser.

Cooling and fermentation
The hop-flavoured wort is cooled in a heat exchanger. In large UK brew houses which have seen significant investment in new technology, the residual heat tends to be reused for other processes.

Yeast is then added to the wort in the fermenter and acts on the sugars to produce a combination of alcohol and carbon dioxide. The resultant carbon dioxide is not a significant source of greenhouse gas emissions and in fact sometimes this CO_2 is recovered and then reinjected into the beer during the canning process. The mixture is then left to ferment.

For ale, the fermentation process is usually complete within a few days and can take place at temperatures as high as 20° C. For lager, by contrast,[91] fermentations require up to several weeks at temperatures as low as 6°C.

The fermentation is complete when the desired alcohol content has been reached and the right flavour has developed. The yeast itself multiplies during the process. Some of it is skimmed off after fermentation for use in future brews.[92] However, since yeast multiplies rapidly to levels way beyond brewery requirements the surplus

[91] The word lager comes from the German word lager - to store at a cold temperature.
[92] National Hop Association of England, http://www.hops.co.uk/sectiontwo/Brewing.htm accessed 26/09/05

is sold to the food industry for manufacture into health foods, Marmite, animal feed and other products.

Conditioning & Packing
Once the wort has been fermented, what happens next depends on the final product – draught or keg beer, canned or bottled beer, ale or lager - being made.

For cask conditioned beers ('real' ales), the beer goes directly into the cask, barrel or bottle. More hops may be added to the cask (dry hopping) for extra aroma. Finings are added which bind the materials responsible for haze and sink to the bottom, clarifying the beer. The yeast in the beer is still active, and the beer will undergo a second fermentation in the cask, normally in the cellar of a pub. Cask conditioned beer is a delicate product and, just like the beer undergoing fermentation in the brewery, it is vulnerable to attack from all kinds of contamination by wild yeasts and other micro-biological organisms.

Other beers and lagers are conditioned in the brewery at around -1°C for around three days). Some are fined with isinglass. All will be filtered to remove proteins and particulates and since some proteins precipitate at low temperature, the beer is chilled prior to filtration. Filtration is normally preceded by a centrifugation step to remove the bulk of solid material. Most keg, bottled and canned beers will have been pasteurised which increases the beer's stability and extends its shelf life but this also has implications for energy use. An alternative is sterile filtering, whereby the beer is filtered so finely that it is rendered free of micro-organisms, so allowing the pasteurisation stage to be omitted.[93]

Finally cask, bottled and canned beers and lagers are put into their containers. Additional CO_2 will also be injected (see above), to produce the extra fizziness that consumers have come to expect.

Energy impacts
As can be inferred from the box above, brewing is an energy demanding process due to the intensive processes (such as mashing, boiling and cooking, fermentation and filtration) involved. The sector has negotiated a Climate Change Agreement, its target being to reduce specific energy use by 14% by 2010 from the 1999 baseline.[94]

By the second target period in 2004, considerable progress had already been made towards achieving that goal, with specific energy use declining by 9.8%, ahead of target. Absolute energy use and CO_2 emissions had also declined. This reflects improvements that have in any case been occurring over recent years. According to the BBPA, both carbon emissions and specific energy use per tonne of output are now more than 40% lower than they were in 1990.[95] Much of the improvement has arisen because of a change in the fuel mix – nearly 80% of the fuel used is gas and the remainder is from electricity with only a small contribution from oil. Also very important is the introduction of new energy efficient technologies and the recycling of waste heat within the brewery. This has partly been offset by the increased electricity use which has been caused by the growing demand for lager type beers.

[93] Sorrell S (2000) *Reducing barriers to energy efficiency in private and public organisations: Barriers to energy efficiency in the UK brewing sector*, Science and Policy Research Unit, University of Sussex
[94] *Climate Change Agreements – Results of the second target period assessment*, Version 1.0 Future Energy Solutions AEA Technology July 2005
[95] BBPA website

According to the BBPA, in 2004 total emissions from brewing were 0.6 million tCO_2.[96] The table below shows emissions per litre of brewed beer expressed both in terms of CO_2 and carbon. Since emissions arising from the production of imported beer are not quantified as part of the Climate Change Agreement, emissions equivalent to 5% of total UK brewing emissions are added on here to take into account these additional imports minus exports.

Table 8: Total beer brewing related emissions

Item	Number	Unit
Total brewing emissions	600,000	tonnes CO_2
Total brewing emissions	163,636	tonnes carbon
Plus imports minus exports	8,182	tonnes carbon
Total brewing emissions	171,818	tonnes carbon
As % total UK GHG emissions	**0.096**	**%**

Viewed in terms of emissions per litre the national averages yield the following results:

Table 9: Brewing CO_2 emissions per litre of beer

Item	Number	Unit
Total brewing emissions	171,818	tonnes carbon
Carbon from brewing/litre beer	0.028	kg carbon/litre
CO_2 from brewing/litre beer	**0.1**	**kg CO_2/litre**

Of course CO_2 emissions per litre brewed will vary between breweries. Scottish and Newcastle reports figures identical to the average above of 0.1kgCO_2/litre[97] For InBev too (makers of Bass, Stella Artois, Becks and other well-known brands), figures are similar at 0.11kg CO_2e/litre.[98] For SAB Miller, emissions per litre are higher at around 0.15kg CO_2e/litre.[99] And for the brand Heineken, emissions are 0.117kgCO_2/litre.[100] All are however within the same order of magnitude.

The breweries mentioned above are all major companies which explains the similarity in their emissions. However emissions vary more significantly according to the size of the company. On the whole, the dominant larger enterprises are far more energy efficient than the smaller breweries. The British Beer and Pub Association factors in these variations when it estimates the energy use and emissions for its CCA reporting. It 'allows' very small breweries up to three times more energy per hectolitre of beer brewed.[101]

[96] Andy Tighe, British Beer and Pub Association, presentation given at FCRN alcohol seminar in London on 19 October 2005
[97] Scottish & Newcastle, http://www.scottish-newcastle.com/sn/cr/environment/carbemissions/
[98] InBev Citizenship report http://www.inbev.com/citizenship/4__2__5__greenhouse_gase.cfm
[99] SAB Miller, *Our Responsibilities* http://www.sabmiller.com/SABMiller/Our+responsibility/Reducing+our+environmental+footprint/Reducing+our+carbon+footprint/
[100] *Towards Sustainability: Sustainability report, update 2004*, Heineken International http://www.heinekeninternational.com/content/live/files/downloads/CorporateResponsibility/Sustainability%20report%20update%202004.pdf
[101] Andy Tighe, BBPA, personal communication, October 2005

This is not to say that smaller breweries cannot be – and are not – efficient. Data from the BBPA shown in Sorrell (2000)[102] illustrates this point. On average in 1998 small breweries used twice as much energy to produce a litre of beer than large breweries. However this general observation masks much variation: Sorrell's table, copied below, illustrates the wide range in specific energy consumption within each brewery size range. Thus, the least efficient small breweries use six times as much energy per litre of beer as the most efficient. On the other hand, the most efficient smaller breweries can be around twice as efficient as the least efficient largest ones.

Table 10: Specific energy and water efficiency of UK breweries in 1998 by size range

Capacity (th hl/year)	SEC (MJ/l)	SEC range (MJ/l)	SWC (hl/hl)	SWC range (hl/hl)
<100	3.26	1.20-7.17	7.78	3.06-19.43
100-499	2.63	1.09-4.51	8.12	3.19-14.17
>500	1.63	0.96-2.32	5.90	3.51-9.94
Mean	1.70		6.04	

Source: BBPA reported in Sorrell (2000)

Where do the hotspots in the brewery lie? One of the few detailed surveys of the sector, by Sorrell (2004)[103] states that 'no firm data is available on the breakdown of energy use by end use' within the brewing sector. He suggests that the figures will vary between breweries and within the same brewery depending on the packaging mix. He does however, go on to give some estimates for a brewery producing keg ale. Steam use is dominated by mashing and wort boiling, while electricity use is dominated by refrigeration. If the brewery makes use of returnable bottles, the steam use for bottle cleaning before filling tends to exceed all the other thermal energy requirements uses combined.

Table 11: Energy utilisation by different brewery processes

Type	Area	%
Thermal energy	Brewhouse	20-50
	Packaging	25 -30
	Space heating	<10
	Utilities	15 -20
Electrical energy	Refrigeration	30 -40
	Packaging	15 -35
	Compressed air	10
	Brewhouse	5 -10
	Boiler house	5
	Lighting	6
	Other	10-30

Source: Sorrell (2000).

[102] Sorrell S (2000) *Reducing barriers to energy efficiency in private and public organisations: Barriers to energy efficiency in the UK brewing sector*, Science and Policy Research Unit, University of Sussex
[103] Sorrell, S., E. O'Malley, J. Schleich and S. Scott (2004), *The Economics of Energy Efficiency: Barriers to Cost Effective Investment*, Edward Elgar, Cheltenham

The temperature at which fermentation takes place will also have an effect on emissions of CO_2 and the growth in demand for cold-fermented lager beers has already been noted. The resulting increase in refrigeration demand has in fact led to a doubling in the brewing sector's electricity use between 1976-1996.[104]

Of course in addition to CO_2 emissions, there are a number of other environmental concerns associated with brewing. These include water use and waste effluents. These are beyond the remit of this overview but it is important to note that there may be trade-offs on occasion between measures to improve energy efficiency and to reduce other environmental impacts. For example water and effluent treatment plants will use energy although they are of course essential if other forms of pollution that breweries generate are to be minimised.

2.1.e. Bottling and packaging

Clearly, while the malting and brewing stages are energy intensive, in terms of their absolute impact on the UK's emissions of greenhouse gas emissions, the individual contributions are small.

But what about packaging? How significant is this in relation to total beer life cycle emissions and what might its contribution to overall UK emissions be?

As noted above there has been a growing shift towards packing and selling beer in bottles and cans. Bottles and cans together contain about 43% of the volume of beer consumed in the UK. In the following paragraphs the energy use resulting from the use of both these forms of packaging is explored.

Cans

For cans it is necessary to take into the account energy used in (and CO_2 resulting from) the production of both steel and aluminium cans. In 2004, according to the Metal Packaging Manufacturers' Association (MPMA) some 7782 million beverage cans were sold in the UK, and although there was some importing and exporting involved this figure equates approximately to UK production and use. Of this figure, 4146 million cans or around 53% were used for alcoholic beverages; of these, the majority will have been for beer and to a lesser extent, cider.

Most (65%) alcohol cans are made of aluminium with the remainder (35%) of steel. The average aluminium can weighs around 15 grams while steel cans are generally heavier at 30 grams. Note that the tops of steel cans are almost always made of aluminium. However for the purposes of this rather rough and ready study, the steel cans are assumed to be 100% steel.

In order to calculate emissions resulting from the production of alcohol beverage cans, several separate elements need to be considered. For a start, the production of the aluminium and steel plates are calculated separately from the actual production of the cans themselves. Information for aluminium production was obtained from Alfed and for steel from the International Iron and Steel Institute via Corus Steel. For the actual manufacture of the cans, data were supplied by the Metal Packaging Manufacturers' Association.

[104] British Beer and Pub Association, *Twenty Years of Environmental Improvement* http://www.beerandpub.com/content.asp?id_Content=130 accessed 4 April 2006

There is also the recycling factor to take into account. The recycling rate for aluminium cans is commonly estimated to be around 42% [105] [106] For steel cans the recycling rate is similar at about 44%[107] It is important to note that the recycling rate is *not* the same as the recycled content of a given can. For steel, for example, while 44% of cans go onto be recycled, the average can contains 25% recycled content.[108] However since these 42% and 44% of aluminium and steel (the recycling rate) find their way eventually back into one product or another, the recycling rate is used here in the calculation. Detailed calculations can be found in Appendix 1. Note that the recycling process has already been factored in to the emissions data provided by the International Iron and Steel Institute and these data also include emissions associated with the transport of raw materials. For aluminium, transport is not included and a separate calculation is made to quantify energy used for recycled aluminium.

Table 12 below summarises emissions from steel manufacture, aluminium manufacture and can manufacture respectively. Recycling rates and subsequent reduced energy use are included in the calculations.

Table 12: Beer can related greenhouse gas emissions

Stage	Carbon emissions (tonnes)	CO_2 emissions (tonnes)
Aluminium sheet manufacture	56,139	205,842
Tin plate steel manufacture	20,504	75,182
Can manufacture	16,892	116,860
Total	**93,535**	**342,960**
Contribution to UK total GHG emissions	**0.052%**	**0.052%**

These three figures taken together – emissions during the production of the aluminium metal, the steel metal and the drinks cans themselves - put metal alcohol drinks cans' contribution to the UK's greenhouse gas emissions at about 0.052% of the UK's total greenhouse gas emissions.

Strictly speaking UK canned beer exports should be subtracted from the figure and UK canned beer imports included but since canned imports and exports are more or less equal they are assumed to balance out here. Of course the efficiency of can production overseas may be different from what it is here in which case the figure

105 http://www.recycle-more.co.uk/nav/page712.aspx
106 http://www.wasteonline.org.uk/resources/InformationSheets/Packaging.htm
107 http://www.wasteonline.org.uk/resources/InformationSheets/metals.htm
108 http://www.corusgroup.com/en/responsibility/cspr/news/press_releases/UK_steel_packaging_recycling_rate_surges

might be a little different. A fuller study would need to take these imports and exports into account.

Glass

13.4% of all beer we drink is from the bottle. The size and hence the weight of beer bottles vary widely in the UK. A quick glance along the drinks aisles will show that whereas most wines and spirits are bottled in standard 750ml and 700ml bottles respectively, for beer the container sizes vary widely and can range from 250ml up to 750 ml. The 250ml bottles tend to be the norm for multi-packs and as this is the standard European size we may see these grow in market share in future years.[109]

It is hard to know, given the range available, what this means in terms of total beer related glass tonnage. According to estimates provided by the British Beer and Pub Association[110] the total tonnage of glass beer bottles was about 600,000 tonnes – 150,000 from the on-trade and 450,000 from the off-trade.

Another estimate is obtained from a WRAP report. This report analyses waste stream data and finds that total tonnage arising from beer bottles and other alcoholic beverages (excluding wines) such as flavoured alcoholic beverages (FABs) amounts to about 711,052 tonnes.

How compatible are these two figures once the non-beer element of the 711,052 is taken away?

From BBPA data it is possible very roughly to separate out beer bottles from other alcoholic beverages as follows:

Table 13: Beer glass tonnage in UK waste stream

Item	Number	Unit	Notes
Total beer share of alcohol market	46.3	%	Source BBPA 2004 Table D3
Bottled beer share of total alcohol market	6.44	%	BBPA 2004 Table A11
FAB share of total alcohol market	2.7	%	Source BBPA 2004 Table D3
Bottled beer plus FAB share	9.14	%	
Total glass from beer and other alcoholic beverages (ex wine and spirits) in waste stream	711,052	Tonnes	*Colourite Project: Maximising Cullet Additions in the Glass Container Industry: Code: GLA0039*, report written by Glass Technology Services Ltd for WRAP, 28th February 2006
FAB share of above	29.54	%	2.7% of 9.14
FAB tonnage in waste stream	210,048	Tonnes	
Beer share of glass waste stream	70.46	%	
Beer tonnage in glass waste stream	**501,004**	**Tonnes**	

It should be stressed that both the BBPA and the WRAP figures are estimates. As can be seen, the waste stream figures for beer derived from the WRAP report are lower than the BBPA estimates. This may be because we have assumed that the economic share of FABS is equivalent to their share by volume in the waste stream. Since FABS are considerably more expensive per litre sold than beer, the 29% share

[109] Richard Heathcote, Bulmer Cider, personal communication, July 2006
[110] BBPA figures based on its Annual Beer Market Survey 2003, Andy Tighe, personal communication, March 2006

figure, could by volume well be an overestimate. 20% might be more in keeping with their relative expense in which case the total volume of beer related glass in the waste stream works out at about 570000 tonnes – far nearer to the BBPA estimate.

For the purposes of this discussion, the total WRAP figures of 711052 tonnes are used for estimating total alcohol glass figures since this is relevant to a discussion of the alcohol sector's total (not just beer) impact. For calculating the contribution that glass beer bottles make to total *beer* related greenhouse gas emissions, the BBPA figure of 600,000 tonnes is used.

For glass bottles, data on carbon emissions were taken from the Carbon Trust and supplemented with information provided by Glass Technology Services Ltd (see Appendix 2). Using these data, the manufacture of container glass is estimated to emit around 0.183 tonnes carbon per tonne of glass produced. Hence total beer related glass carbon emissions are 109800 tonnes carbon (402600 tonnes CO_2) , or about 0.06% of the UK total.

How does this figure compare with other studies? A very comprehensive LCA of 330 ml glass beer bottles conducted for the Danish Environmental Protection Agency calculated carbon emissions per tonne of glass to be about 0.221 tonnes carbon. This figure includes glues, labels, caps, all glass production-associated transport and secondary packaging. The calculations are net of process emissions that could be allocated to other co-products.[111] Bearing in mind the differences between Denmark and the UK's energy mix, the figures appear fairly similar. The various LCAs of wine (which are discussed in more detail below) are likewise in rough agreement with the figures presented here.

Adding can and bottle related packaging emissions for beer the total comes to 0.11% of the UK's total GHGs.

Table 14: Total beer glass and can related GHG emissions

Beer cans	0.052
Beer bottles	0.06
Total	**0.11**

It is important to note that for the 43% volume of beer that is sold in packaged form, the contribution made by bottles or cans is likely to be significant relative to the agricultural, brewing or malting stages. As the popularity of cans and bottles grows so the impact of cans and bottles is likely to grow both in absolute terms and in its relative contribution to total beer life cycle emissions.

A discussion of how the package type influences both total life stage emissions and the relative importance of the individual life stages can be found in Section 2, Part 6.

2.2. SPIRITS

This section explores emissions associated with the spirits we drink, looking, as with beer, at the agricultural, alcohol production and packaging stages. The discussion begins with whisky and moves on to consider the other most popular spirits we drink.

---

[111] *Life cycle assessment of packaging systems for beer and soft drinks: disposable glass bottles*, Technical Report 2, no.401, Danish Environmental Protection Agency, 1998

2.2.a. Agriculture

Whisky

CO_2 emissions associated with the cultivation of malting barley were examined in 2.1.b. It was calculated that agriculture stage emissions for whisky account for 0.036% of the UK's total GHG emissions.

However this is by no means the whole story, for several reasons. Most whisky is not made just from malted barley; the majority is produced from a blend of barley and other grains.

The two tables below, following the method used in 2.1.b, calculate the contribution made by *non-barley* grains such as wheat for whisky production to the UK's total greenhouse gas emissions (barley related emissions have already been quantified in Section 2.1.b). It is assumed here that 1 tonne of grain produces 400 litres of pure gin and vodka.[112] While for whisky one tonne of mixed grain yields 376 litres grain whisky (measured in lpa) and one tonne of barley yields 411 lpa of malt whisky,[113] for simplicity the 1:400 ratio is used as greater accuracy will make little difference to the final figure.

First fertiliser manufacture related emissions are calculated:

Table 15: Whisky non-barley grain related fertiliser production emissions

Item	Number	Unit	Source and comments
Total quantity of whisky produced	354,808,663	lpa	SWA; whisky produced within CCA. Note that total whisky production by SWA members (including those not in the CCA) came to 358million lpa in 2004)
Total tonnage of grain required	920,784	tonnes	SWA
Total barley used for distilling	620,000	tonnes	MAGB data for malt for distilling gives 591 tonnes which is approx 620000 tonnes barley
total grains (ex barley) for distilling	300,784		total tonnage minus barley
total hectarage for non-barley grains	37,598	ha	8 tonnes/ha assuming wheat yields- Source Agriculture in the UK
fertiliser application rates	188	kg/ha	Source: British Survey of Fertiliser Practice (for non milling wheat)
Total spirits non-barley grains N fertiliser	7,068	tonnes	
Total UK fertiliser application	1,131,000	tonnes	
Spirits wheat as % total fertiliser	0.62	%	
Total N fertiliser emissions as % UK	1.10	%	Tara Garnett

[112] This is in agreement with the GVA's estimate of total grain production and total alcohol consumption and is also based on internet searches. The tonnage required will vary according to the alcoholic drink. For fruit-based spirits such as brandy, proportions will be very different.

[113] Scotch Whisky Association, personal communication, June 2006

GHG			
Total whisky non-barley grain related emissions as % total UK GHG emissions	0.01	%	

Then soil N_20 emissions are calculated and multiplied by multiplied by the global warming potential (of 310) to give emissions in terms of CO_2 equivalents.

Table 16 Whisky non-barley grain related soil N_20 emissions

Item	Number	Unit	Source and comments
Average N_2O-N emissions per hectare	1.25	kg/ha/yr	Smith KA Smith JU & Smith P 2005. *Scottish agriculture and global climate change: nitrous oxide emissions from fertiliser use*. Scottish Executive Environment Group Report 2004/09. ABRG:UEH/007/03. ISBN 0-7559-3900-X. Available: http://www.scotland.gov.uk/Resource/Doc/30701/0007033.pdf
Average N_20 emissions per hectare	3.93	kg/ha/yr	
total N2O for spirits wheat	147,706	kg/year	
total N2O in tonnes co2e	45,789	tonnes CO_2e	assuming N_2O GWP of 310
Total N2O in tonnes Ce	12,488	Tonnes Ce	
Total UK GHG emissions	179,000,000		
Spirits non barley as % total GHG emissions	0.01	%	

Finally, the total malting barley emissions (from section 2.1.c) are added to the calculation, yielding a figure of 0.059% of the UK's total GHG emissions.

This figure is for whisky production. 90% of the whisky we produce is exported and since this paper is concerned with *consumption* rather than *production*, then most whisky related emissions should rightly be excluded from consideration here. Hence Scotch whisky related agriculture stage emissions generate only a tenth of the figure above, or 0.00467% of the UK's GHGs.

Table 17: Total whisky related agriculture-stage contribution to UK GHG emissions

Item	Number	Unit
Whisky related malting barley as contribution to UK GHGs	0.038	%
Total whisky grain related emissions as % total UK GHG emissions	0.01	%
Total whisky grain related soil N_20 emissions	0.011	%
Total whisky agriculture emissions as % UK GHG total	**0.058**	**%**
Total UK consumption related whisky agriculture as % UK GHG total	**0.0058**	**%**

On the other hand we import about 66% of all the spirits we consume and so emissions generated through the cultivation of the raw ingredients for these other drinks also need to be considered. At the end of this subsection an attempt is made to quantify total agricultural emissions related to spirit consumption, excluding exports but importing imports. However figures will be based on UK emissions since overseas data are not available. Evidently agricultural practices and climatic conditions will vary from country to country so this approximation will not be fully accurate.

In the meantime the next sub section estimates gin and vodka related agriculture stage emissions are calculated as follows.

Gin and vodka

According to the Gin and Vodka Association, 188,000 tonnes of UK wheat and barley were used in the production of gin and vodka.[114]

In order to calculate GHG emissions arising from the cultivation of these grains the same procedure is used to that given above. A proportion of UK agricultural energy use is allocated based on hectarage. Fertiliser production GHG emissions and soil denitrification N_20 emissions are also calculated based on the average fertiliser requirements per hectare as provided by Defra.[115]. On farm agricultural energy use is not included as these are assumed (based on the experience of the calculations made in 2.1.b above) to be so small as to be negligible.

Table 18: Gin and vodka-related fertiliser production emissions

Gin and vodka fertiliser production emissions			
Category	**Value**	**Unit**	**Source**
Total wheat & barley for gin & vodka distilling	188,000	tonnes	GVA and Defra
Total hectares	23,500	ha	Defra - based on yield of 8 tonnes/ha
Fertiliser application rates	150	kg/ha	British Survey of Fertiliser Practice 2002 (approx)
Total gin & vodka related N fertiliser	3,525	tonnes	
Total UK fertiliser application	1,131,000	tonnes	
Spirits wheat as % total fertiliser	0.31	%	
Total N fertiliser emissions as % UK GHG	1.10	%	Elsayed et al.,; Tara Garnett
Total spirits wheat N fertiliser	0.0034	%	

[114] Information supplied by Vivienne Cuckow, the Gin and Vodka Association
[115] *British Survey of Fertiliser Practice 2002*, Defra, 2003

emissions as % UK GHG			

Table 19: Gin and vodka related soil N_2O emissions

Category	Value	Unit	Source
Average N_2O-N emissions per hectare	1.25	kg/ha/yr	Smith KA Smith JU & Smith P 2005. Scottish agriculture and global climate change: nitrous oxide emissions from fertiliser use. Scottish Executive Environment Group Report 2004/09. ABRG:UEH/007/03. ISBN 0-7559-3900-X. Available: http://www.scotland.gov.uk/Resource/Doc/30701/0007033.pdf
Average N_20 emissions per hectare	3.93	kg/ha/yr	
total N2O for spirits wheat	92,355	kg/ year	
total N2O in tonnes co2e	28,630	tonnes	assuming N2O GWP of 310
total N2O in tonnes Ce	7,808	tonnes	
Total UK GHG emissions	179,000,000	tonnes CO_2e	
Spirits non barley as % total GHG emissions	0.0044	%	

The summed total is very small:

Table 20: Total gin and vodka agriculture stage emissions as contribution to UK total

Combined total emissions from gin and vodka as % total UK GHG emissions	**0.0077**

Combining whisky, gin and vodka agricultural production related emissions, the total comes to 0.0657% of the UK's greenhouse gas emissions. This is emitted during the production of 424 million litres of pure alcohol but UK spirits consumption stands only 111 million litres, or 27% of the total. As such the consumption related contribution, from the agricultural stage of whisky production is **0.0177%**

Table 21

Agricultural production	Contribution to UK GHGs %
Total gin & vodka emissions	0.0077
Total whisky emissions	0.058
Total emissions	0.0657
Total UK spirits *consumption* emissions as % total UK GHGs	0.0177

2.2.b. Malting

As with beer then, the agricultural stage makes a virtually insignificant contribution to the UK's greenhouse gas emissions.

This section examines whether the malting stage for whisky production is more substantial. 2.1.c has discussed the malting process and calculated overall emissions from malt production. There will be differences in the energy intensity of producing malt for brewing and malt for distilling but these are assumed to be relatively minor and are not considered here.

On the basis that 33% of all malt produced is used for distilling spirits, it is calculated that spirits-related malting emissions amount to 46631 tonnes of carbon (or 171,000 tonnes CO_2). This accounts for 0.026% of the UK's greenhouse gas emissions.

However, 90% of our whisky is exported so the consumption related figure is an order of magnitude lower at 0.0026%. This, while low, is still more than the emissions resulting from the agricultural production of all grains for spirit consumption (including those other than whisky) in the UK. in other words, the malting stage is considerably more GHG intensive than the agricultural stage.

2.2.c. Distilling

Data for distilling process emissions are collected as part of the spirits industry's Climate Change Agreement (CCA), managed by the Spirits Energy Efficiency Company (SEEC).[116] The agreement covers approximately 67 facilities which represent most of the distilleries in the UK. Fifty eight of the sites included in the CCA are malt whisky distilleries which collectively account for about 80% of our malt whisky production. The remaining 20% of malt whisky is produced by the 42 malt whisky distilleries which are not included in the CCA.

In addition, 7 grain distilleries, all located in Scotland are also included in the CCA. These large grain distilleries produce all the new-make grain whisky spirit (the 'backbone' of blended whiskies) made in the UK. They also produce grain neutral spirit (GNS) which may be further processed into other spirit drinks such as gin and vodka. Some grain distilleries also go a step further and produce the finished spirits themselves.

The distilleries included in the SEEC's CCA vary considerably in size; grain distilleries are large and some produce in one day the same volume of alcohol as some of the smaller malt distilleries produce in a year. Six of the grain distilleries are included in the EU Emissions Trading Scheme. The CCA also covers two white spirits distilleries where GNS is bought in for processing into other spirit drinks and a dark grains plant which processes distillery by-products into animal feed.
.
The Spirits Energy Efficiency Company calculates that total CO_2 emissions from the sector during the second milestone period (October 2003 to September 2004) of the Climate Change Levy amounted to 587246 tonnes CO_2 or 160158 tonnes of carbon.

However it is important to note several points. First, not all distilleries are included in the SEEC's Climate Change Agreement, as highlighted above. Some alcohol related emissions are therefore not captured in the CCA figures.

Second, and perhaps as a counterbalance to the first point, some of the distilleries not only produce spirits but, making use of the spent grains from the distilling process, also manufacture animal feed. Under the CCA, energy use at all the facilities covered are quantified but only the spirits outputs are used to calculate the sector's milestone performance. In other words it may appear that the industry consumes more energy to produce spirit than it actually does since some of those emissions are attributable to animal feed production.

[116] The Spirits Energy Efficiency Company is a partnership between the Scotch Whisky Association and the Gin and Vodka Association

To add to the complexity, the CCA only quantifies emissions resulting from the actual distilling process. The blending and bottling (the process of bottling as distinct from bottle production which is discussed below) of most Scotch whisky takes place at separate blending and bottling complexes which are not eligible for inclusion in a Climate Change Agreement. As a result their ensuing emissions are not quantified.

Due to the time lag between production and marketing (Scotch whisky must be matured for a legal minimum of three years although in practice whiskies ten or more years old are not uncommon), it is not possible to make a direct link between distilling emissions produced now and what we drink today. Most of what appears on the shelf today was distilled at some point in the 1990s or earlier and a bottle of blended Scotch whisky will contain many different whiskies from different distilleries each of which may have been distilled in different years blended whiskies. Production efficiencies then will have been different from what they are today.

Finally and as already emphasised, we do not consume all the alcohol we produce nor do we produce all the spirits we consume.

This makes it hard to quantify accurately emissions resulting from the distilling process (and harder still to calculate transport emissions). A very simplistic approach is adopted here as follows.

The Spirits Energy Efficiency Company data shows that the production of 424 million litres of alcohol (LPA) generates 587246 tonnes CO_2 or 160158 tonnes of carbon. It is estimated that we consume around 111 million litres of spirits (LPA), equivalent to 27% of total UK production. It is therefore assumed that our UK consumption of alcoholic spirits accounts for 27% of the emissions produced by the UK spirits sector, amounting to 43242.7 tonnes of carbon. By this reckoning, distilling emissions arising from our own consumption of spirits contribute 0.024% to the UK's total greenhouse gas emissions. Some of these emissions will, as noted, arise from the production of animal feed and therefore should not be attributed to alcohol. However, since 20% of malt whisky distilleries and one large grain distillery is not included, the figure is in any case likely to be an underestimate.

Evidently the accuracy of this figure rests upon the assumption that energy use and CO_2 emissions at overseas distilleries will be the same as they are here. This is very unlikely to be the case. Even the UK figure, which is the sum of all emissions, above, masks major variations in energy use by alcohol type. There is, for instance, a significant difference in the energy efficiency of whisky as compared with gin and vodka; grain neutral spirit, the basis for gin and vodka takes somewhere in the region of 2-3 times more energy to produce per litre as new-make grain whisky spirit. The GNS then needs to be distilled again to produce gin or vodka. Since we import more vodka and gin than we do whisky it is likely that these imports will be higher in embodied energy per litre than the figures presented here. We also import spirits which are not grain based, such as rum and brandy, and it is not known how their energy intensity compares with those of grain based spirits.

Box 3

How spirits are made

All spirits are made by distilling a basic alcohol-containing liquid. This liquid or 'wash' is obtained by fermenting a starch-containing substance such as grains, potatoes, apples or grapes. The following paragraphs summarise the process of making some of the most common spirits: whisky, gin, vodka and brandy.

Whisky
The early stages of whisky making are essentially the same as those for beer. Malted barley is first ground into a coarse flour – grist. This is then mixed with hot water in a large circular vessel known as a mash tun. Mashing produces wort, a sugary liquid, which is then transferred to fermentation vessels where yeast is added. Yeast converts sugar in the wort into alcohol. Fermentation produces a low-strength alcohol known as wash.

Most malt whisky is distilled twice in copper Pot Stills. The first still produces 'low wines' with an alcohol content of about 20% ABV. These are then transferred to the second still which produces potable spirit. However only the middle cut of the spirit produced during the second distillation is taken. The foreshots and feints are less pure and so are redistilled with subsequent batches. Distilling residues are converted into animal feeds.

The production of grain whisky follows a similar process. The main difference is that the mash consists of a mixture of malted barley and other unmalted cereals which are cooked under pressure and the resulting wort has a lower alcoholic strength than that of malt distilling. Distillation is carried out in large Patent or Coffey Stills and unlike the distilling of malt whisky, grain whisky distilling is a continuous process.

Following distillation, all new-make Scotch whisky spirit is matured in oak casks in Scotland for a minimum period of three years. Much Scotch whisky matures for upwards of 8 years.

Finally the whisky is either blended with other whiskies from the same or different distilleries, or bottled directly from the cask. Unlike wine, the ageing process is halted once the whisky has been bottled.

Gin
Gin can be made from any neutral spirit alcohol - the base can be grain (normally barley and maize) or molasses and has no flavour at all. As with the production of beer, the base starch is mixed with water, heated, cooled, and allowed to ferment. The wash so produced is then distilled to an alcohol content of 95% ABV.

This is then diluted to a strength of about 45% ABV and left to steep with flavouring botanicals (famously juniper but others may include citrus peel, various spices and angelica). The liquid is then heated in a still and, as with whisky, only the middle portion is used. The foreshots and feints are returned for distillation with the next batch.

Finally the spirit is diluted to reach the required minimum alcohol content (37.5%ABV) and then bottled.

Cheaper gins can be made by simply adding essential oils to the diluted neutral spirit alcohol. This 'cold compounded' gin cannot be called 'distilled' or 'London' gin.

Vodka
The starting point for vodka is, as with gin, a neutral spirit. In the EU the spirit is usually produced from grain (wheat, barley, maize, rye) or molasses. In Eastern Europe it may also be made from potatoes, or rice.

As with gin, the wash is usually distilled twice although many vodkas are triple distilled, some even more. The distillate is diluted to an ABV of about 55% before it is filtered, usually through charcoal. Sometimes coagulants are used to bind impurities so that they can be filtered out more readily. Finally, more water is added to give the vodka the legal EU minimum ABV of at least 37.5%. At this stage some producers include additives while others may introduce flavouring such as natural essences or fruits or herbs which are steeped in the vodka for several days. No maturation period is required.

Brandy
Brandy is made from wine which is distilled by a process similar to that described above. The spirit is distilled twice before being transferred to wooden barrels to mature. The maturation period depends on the quality of the brandy sought – for example a minimum of two years is required to qualify for the V.S label (very superior) and 4 years for the VSOP (very superior old pale) label.

2.2.d. Bottle production

According to the WRAP study already discussed,[117] the total quantity of spirit related glass in the UK waste stream amounts to 207,815 tonnes. Using emission figures given above in 2.1.e, it is estimated that spirit related bottle production accounts for **0.02%** of the UK's total GHG emissions.

It is possible to gain a rough sense of the reliability of the WRAP tonnage by the following method. If one assumes that spirits are sold, on average at a strength of 40% ABV, and that they are mostly packaged in 70cl containers, and if one uses the average whisky bottle weights estimated by James Ross Consulting Ltd [118] then the total tonnage of spirit glass in the UK waste stream is roughly 188000 tonnes. This is slightly lower than the figure given above but not too far off.

Table 22: Total tonnage of spirit related glass

Item	Amount	Unit	Source
Total UK consumption	110,800,000	LPA	WSTA
Assuming 40% ABV	277,000,000	Litres	
Assuming 70cl bottles	3,957,142,861	Bottles	
Average weight of spirit bottle:			
⇒5% at 380g	7,519	Grams	WRAP
⇒95% at 480g	180,446	Tonnes	WRAP[119]
Total spirit glass tonnes	187,964	Tonnes	

2.3. WINE

At the outset of this section it should be stressed that the information presented here is very partial. Unlike beer which is almost all indigenously produced, almost no wine at all is produced in this country. Instead we import from a wide range of countries which will all vary in their production systems and hence their impacts.

Despite very extensive internet searches, very few studies focusing on energy use and CO_2 emissions resulting from viti-viniculture were found. The discussion below

[117] *Colourite Project: Maximising Cullet Additions in the Glass Container Industry: Code: GLA0039*, report written by Glass Technology Services Ltd for WRAP, 28th February 2006
[118] James Ross Consulting Ltd were commissioned to do the WRAP research
[119] *Colourite Project: Maximising Cullet Additions in the Glass Container Industry: Code: GLA0039*, report written by Glass Technology Services Ltd for WRAP, 28th February 2006

is based on all that we could uncover: two formal life cycle analyses (LCAs - one not yet published) and two state commissioned reports on energy efficiency. In addition, helpful information was provided by Diageo (which owns a number of well known brands including Blossom Hill Wines and Piat D'Or) and from one or two other sources. The LCAs considered emissions from viticulture through to distribution; one of the energy efficiency reports looked just at the wine making stage and the other one looked at direct (but not indirect) energy use for both wine making and viticulture. Efforts were made to disaggregate data and so to enable like with like comparisons to be made but this was not always possible.

What does strikingly emerge however is that CO_2 emissions from the wine making process vary hugely. Some of the variations are attributable to differences in methodology but most probably reflect the fact that wine is made in geographical regions as far apart as the Americas, Europe, Africa and the New World. All these different regions have different soils and climates, operate at different scales of production, have different levels of efficiency and use different mixes of energy. Whether they are producing for the cheaper or more expensive end of the market will also make a difference.

2.3.a Viticulture

While it has proved difficult to find much information on viticulture-related energy use and greenhouse gas emissions, it is likely to be the case that the relative contribution made by this stage in the wine life cycle is likely to be low. It has already been concluded above that agriculture stage emissions for both beer and spirits are low and do not dominate overall life cycle emissions.

Is this likely to be more or less true for vine growing? On the one hand average fertiliser application rates for vines are very much lower than they are for barley cultivation. From a brief internet survey of recommended application levels the rates vary from 40-50 lb nitrogen/acre (this is about 45-50 kg/hectare)[120] [121] to 0-30 kg/ha,[122] to 66kg N per ha [123] to 24kg N/ha. Notwithstanding this variation (and the fact that some growers will apply above the recommended levels) application rates are evidently lower than they are for barley and wheat where levels range from about 110 to 193 kg per hectare.[124]

What is more, fertiliser application rates are lower despite the fact that grape yields can be (although are not always) higher than yields from cereals. Table 23 shows average wine grape yields for a range of countries. Note that this table only provides snapshot of yields in 2003 and there can be wide variations from year to year.

Table 23: Average wine grape yields by country

[120] http://viticulture.hort.iastate.edu/info/pdf/domotonutr.pdf
[121] *Balancing the nitrogen budget*, Bill Peacock, University of California, Davis, http://cetulare.ucdavis.edu/pubgrape/ng296.htm
[122] Soyer J.-Pierre, Forget Dominique et Guilbault Pascal *Pratique de la Fumure de la Vigne en production* N° spécial "Gestion et entretien des sols", supplément au N° 995, janvier 2004, de la revue bordelaise *L"Union Girondine des vins de Bordeaux* (pp. 30-35).
[123] *Fertiliser Recommendations for Horticultural Crops* http://www.hortnet.co.nz/publications/guides/fertmanual/grapes.htm
[124] *British Survey of Fertiliser Practice 2002*, Defra 2003 http://www.defra.gov.uk/environ/pollute/bsfp/2002/bsfp2002.pdf

Country	1000 ha	1000kg	yield tonnes/ha
Argentina	198	2,208,100	11.0
Chile	110	954,600	8.7
US	257	3,132,500	12.2
Germany	102	1,170,000	11.5
Spain	1181	6,496,700	5.5
France	877	6,245,200	7.1
Italy	795	6,156,400	7.1
Australia*	157	1,329,600	8.5
New Zealand	19	76,400	4.0
South Africa	110.00	1,158,000	10.5

Source: Situation Report for the World Vitivinicultural Sector in 2003: Supplement to Bulletin de l'O.I.V., Organisation Internationale de la Vigne et du Vin (O.I.V.)
Note: yields will vary from year to year
*Data for Australia does not distinguish between table grape and wine grape production

With wine grape cultivation the industry seeks to strike a commercial balance between optimising volumes (achievable through fertiliser applications and, if needed, irrigation) and optimising quality. Put a little simplistically, poor soils tend to produce lower yields of better quality wine, although there will be plenty of exceptions. For some famous wines, yields can be as low as 1.5 tonnes per hectare.

Another point which is perhaps relevant to direct energy use in the vineyard is that grapes are perennials – vines should last for 40-50 years and some may be much older than this. Barley on the other hand needs to be planted anew each growing season. This may have implications for on-farm energy use. This said, during the course of the growing season grapes will need to be pruned and (depending on the production location and system) irrigated, both activities which entail the use of energy.

A casual observation might therefore lead one to conclude that grape production is less energy intensive than beer production. How accurate might this be?

One estimate for Australian vineyards puts emissions at 0.153 tonnes CO_2 per tonne of grapes or 0.042 tonnes carbon.[125] This figure is based only on emissions arising from energy use in the field and not from fertiliser manufacture. The study does not consider greenhouse gases other than CO_2.

For comparison, one Spanish study puts viticulture stage emissions at 0.205 tonnes CO_2 per 750 litres wine[126] (which equates approximately to a tonne of grapes) or 0.056 tonnes carbon. A second Spanish study gives an even higher figure of 0.491tonne CO_2/tonne grapes.[127] These Spanish studies are formal life cycle analyses and their calculations include energy use and GHG emissions associated

[125] *Australian Wine Industry State of the Environment 2003*, South Australian Wine Industry Association Incorporated 2004, Adelaide, Australia
[126] Aranda, S. Scarpellini, I. Zabalza *"Economic and Environmental Analysis of the Wine Bottle Production in Spain by means of Life Cycle Assessment"* International Journal of Agricultural Resources, Governance and Ecology. Special Issue on Life Cycle Assessment in the Terciary Sector. Year 2005. –**R** ISSN (Print) 1462-4605; ISSN (on line) 1741-5004
[127] Fullana, P.; Gazulla, C. Clavijo, M.J; Puerta, M.; Tubilleja, M., 2005. *Análisis del ciclo de vida del vino de crianza D.O.C. Rioja*. Dirección General de Calidad Ambiental, Consejería de Turismo, Medio Ambiente y Política Territorial del Gobierno de La Rioja.

with the production and transport of inputs such as fertilisers and pesticides. In addition they include soil N_20 emissions which, according to the author of one of the studies, accounts for half the global warming potential (GWP) in the vineyard studied. It is important to note that the fertiliser application rates quoted in the Spanish studies look very high indeed at around 85 kg per hectare - far higher than recommended practice. Half of this N was in the form of inorganic fertiliser and the remaining half was manure[128]. Lower N fertiliser inputs will equate both to avoided energy CO_2 (from the manufacture of the fertilisers) and avoided N_20 (from fertiliser manufacture and more significantly from soil denitrification processes).

Table 24 summarises the data that has been found for emissions at the agricultural stage.

Table 24: GHG emission ranges for the viticultural (grape growing) stage

Range of emissions given for viticultural stage				
Country	**CO_2e g/75cl**	**C/g/litre**	**Source**	**Comment**
Spain	205.00	74.55	Aranda et alia	Generic data used (SimaPro) CO_2 from inputs (eg. energy and fertilisers) calculated
Spain	492.00	178.91	Fullana et alia	Soil N_2O emissions found to be highly significant
Australia	153.00	55.64	State of the Environment 2003	On site energy use only considered and only CO_2
Average	283.33	103.03		

Using the first Spanish figure and multiplying it by the 1302 million litres of wine that we drink it appears that the agricultural stage of wine consumption contributes 0.054% to the UK's total greenhouse gas emissions. The second figure finds the contribution to be 0.13%. Since the Australian study does not include N fertiliser application and non emissions other than CO_2 it is considered here to be too low.

This finding is interesting because, perhaps counter-intuitively, it seems that emissions from the agricultural stage for wine are very much higher than they are for spirits or beer.

2.3.b. Wine making

Box 4 gives a brief and simplified description of the wine making process

Box 4

Wine making

Once the grapes reach the winery the stems are mechanically removed and the grapes crushed to release the must, or juice.

If white wine is being made the juice is run off immediately, leaving the skins and stalks behind. The juice that comes out from the pressure of the grapes alone is called "free-run" juice, and is generally considered superior to the juice that is pressed out. The liquid, or must is then fermented in refrigerated conditions following the introduction of a yeast culture.

For red wine the process is similar except that after the grapes are crushed the skins are left in the must to colour the liquid and for the tannins in the skin to flavour it.

[128] the figures given are for N content and not for the total weight of the fertilisers

During the fermentation process the specific gravity of the fermenting must is periodically measured to determine when fermentation is complete. Once this stage has been reached (the process can take between one to four weeks), the wine is racked: in other words the wine is drawn off from the settled yeast cells. The wine can be racked several times. Most wine makers also add sulphur dioxide to prevent both oxidation and any further oxidation.

In order to removed the solids that are still suspended in the liquid, the wine is fined using bentonite (a kind of clay), egg whites or isinglass. It is also filtered. Finally the wine is transferred to storage tanks (or for some wines, oak barrels, to allow the oak to impart additional flavours to the wine). Many wines undergo a second type of fermentation, called malolactic fermentation. Here the wine maker adds a bacterium to the wine that breaks down malic acid into the milder lactic acid. The aging process can be anywhere from three months to three years. The wine is then stored further – possibly for years - before it is bottled, and possibly aged further.

From the scant literature available on greenhouse gas emissions from wine production it appears that emissions per volume of wine produced vary, as for the agricultural stage, very widely indeed.

The table below highlights the range of figures that have been found. As the comments column shows, there are differences in the methods used, in what is included and what is excluded. What is plain however is that a simple answer to the question 'how much CO_2 is embodied in a bottle of wine?' is hard to give.

Table 25: GHG emissions ranges for wine making stage

Range of emissions given for wine making stage				
Country	CO_2e g/75cl	C/g/litre	Source	Comment
Spain	189.00	68.73	Aranda et alia	Generic data used (SimaPro)
Spain	21.00	7.64	Fullana et alia	Generic data used (GaBi)
Australia	235.00	85.45	State of the Environment 2003	On site energy use only considered and only CO_2
Diageo	24.00	8.73	Diageo	Average of all operations - emissions will vary from country to country
California	45.00	16.36	BEST Winery report and other sources	Non electricity energy use based on assumptions
Mean average	**102.80**	**37.38**		

It is also important to note that given the fragmented nature of the wine industry the variation may be even greater than noted here. Hence using an average of these data may give a distorted impression of reality. The studies themselves are examined more closely in 2.3.d below.

To get a picture of the range of emissions obtainable from the different studies for *both* the viticultural and vinicultural stages, table 26 was compiled. An additional column provides an average for each of the stages and for the summed stages.

What is interesting is that the totals that emerge are remarkably similar – and very close to the mean[129] despite the individually large variations in emissions at different life stages. From this small sample of studies, it is estimated here that emissions resulting from wine production (viticulture and viniculture only) contribute about 0.1% of the UK's total greenhouse gas emissions.

Table 26: GHG emission ranges for the viti-vinicultural stages combined

Item	**Mean average**	**Australian**	**Spanish (Aranda et al)**	**Spanish (Fullana et al)**	**Units**
Viticulture	103.03	55.636	74.55	178.91	g/Ce/litre
Viniculture	37.38	85.454	68.73	7.64	g/Ce/litre
Sum of stages	140.41	141.09	143.28	186.55	g/Ce/litre
Total	0.00014	0.00014	0.00014	0.00019	tonnes Ce/litre
Total wine consumed	1.3E+09	1.3E+09	1.3E+090	1.3E+09	litres
Total wine GHG	182533	183418.2	186264	242509.09	tonnes Carbon equiv.
As contribution to UK GHG total	0.102	0.103	0.104	0.14	%

Note: Bottle production is excluded from these calculations it is considered separately below

[129] although one might dispute how relevant the mean is, given the variation

2.3.c. Bottle production

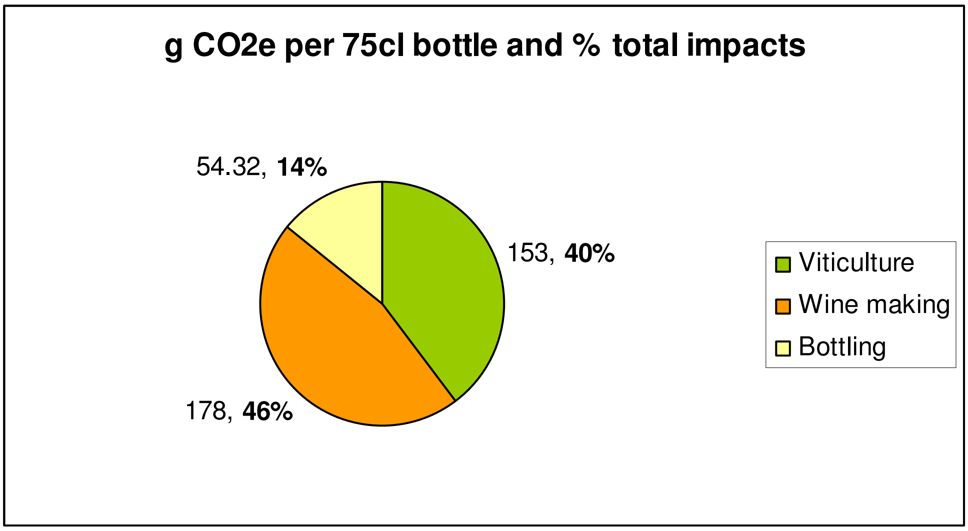
According to the WRAP report,[130] the total quantity of wine related glass in the UK waste stream amounts to 731133 tonnes. Using emission figures given above in 2.1.e it is estimated that wine related bottle production accounts for **0.07%** of the UK's total GHG emissions.

According to a study commissioned by WRAP European wine bottles tend, on average, to be lighter than New World wines.[131] However more new world wines are bulk imported than European wines.

2.3.d. Wine: identifying the life cycle hotspots

It is difficult to generalise as to which stage in the wine life cycle is the most energy intensive since different studies reach different conclusions. For example the figure below, taken from the Australian report cited above shows that the emissions are fairly evenly divided between the processes of growing and producing the wine. Note that while bottling is included, the actual production and transport of the bottles are not. Note too that the pie chart figures show grams of CO_2 produced per 75 cl wine bottle and not per litre.

Figure 16: CO_2 emissions per bottle of wine by life cycle stage (Australian study)



Source: *Australian Wine Industry State of the Environment 2003*, South Australian Wine Industry Association Incorporated 2004, Adelaide, Australia

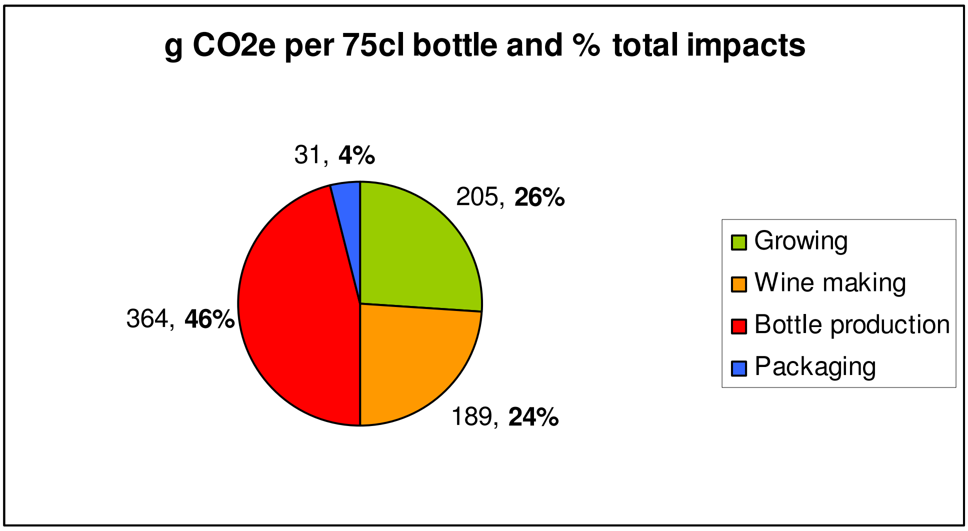
The Spanish Aranda study,[132] which used generic SimaPro software data, also concludes that the emissions from wine making and viticulture are similar although in this instance it calculates that the winery stage (including the production of the wine and its bottling but not the bottle production stage itself) produces 220 grams CO_2

---

[130] Glass Technology Services Ltd. *Maximising Cullet Additions in the Glass Container Industry*, Project code: GLA0039, Waste Resources Action Programme, February 2006
[131] Kevin Williams, James Ross Consulting Ltd, pers.comm April 2006: estimate based on data gathered for WRAP Wine project
[132] A. Aranda, S. Scarpellini, I. Zabalza *"Economic and Environmental Analysis of the Wine Bottle Production in Spain by means of Life Cycle Assessment"* International Journal of Agricultural Resources, Governance and Ecology. Special Issue on Life Cycle Assessment in the Terciary Sector. Year 2005. –**R** ISSN (Print) 1462-4605; ISSN (on line) 1741-5004

per 75cl bottle or 300 grams per litre. As Figure 17 shows, however, the actual production of the bottles is by far the most significant stage; additional packaging also adds to the impacts.

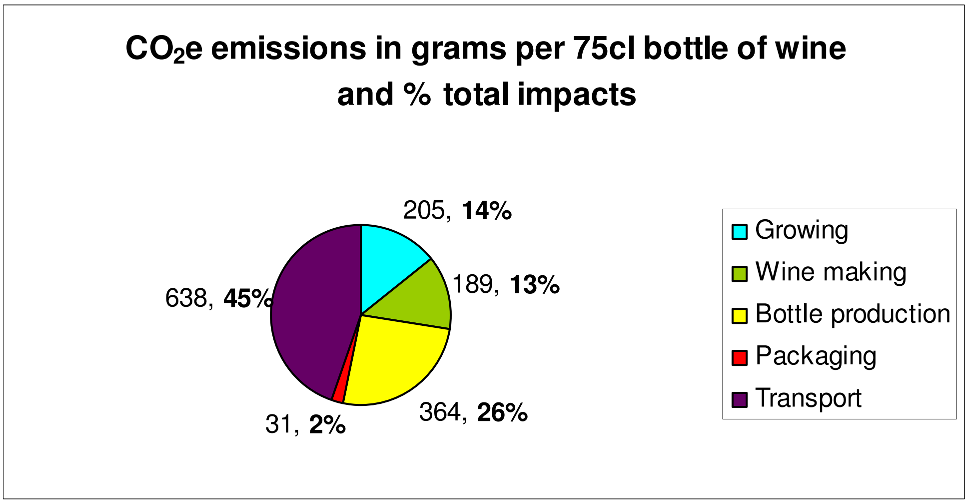
Figure 17: CO_2 emissions per bottle of wine by life cycle stage –- Spanish study by Aranda (excludes transport)



Source: Alfonso Aranda Usón, University of Zaragoza, Spain, inventory data used for publication of A. Aranda, S. Scarpellini, I. Zabalza *"Economic and Environmental Analysis of the Wine Bottle Production in Spain by means of Life Cycle Assessment"* International Journal of Agricultural Resources, Governance and Ecology. Special Issue on Life Cycle Assessment in the Terciary Sector. Year 2005. –**R** ISSN (Print) 1462-4605; ISSN (on line) 1741-5004

The pie chart above excludes transport emissions. However, the study authors assume that 32% of the wine is exported, some of it by ship to the Americas and to Australia, New Zealand and South Africa and the rest is consumed domestically. Once transport is included, emissions from this stage dominate over all others

Figure 18: CO_2 emissions per bottle of wine by life cycle stage –Spanish study by Aranda (includes international transport)

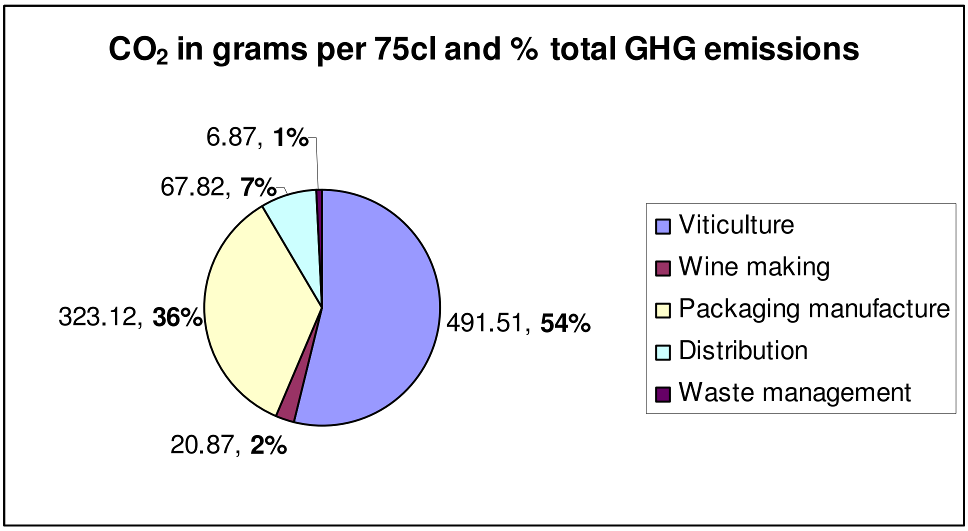


Source: Alfonso Aranda Usón, University of Zaragoza, Spain, inventory data used for publication of A. Aranda, S. Scarpellini, I. Zabalza *"Economic and Environmental Analysis of* *the Wine Bottle Production in Spain by means of Life Cycle Assessment"* International Journal of Agricultural Resources, Governance and Ecology. Special Issue on Life Cycle Assessment in the Terciary Sector. Year 2005. –**R** ISSN (Print) 1462-4605; ISSN (on line) 1741-5004

Note: both transport and waste are included in this chart

The second Spanish study presents a different picture. For a start, it finds overall emissions to be lower than calculated in the first study, as Figure 19 shows.

Figure 19: CO_2 emissions per bottle of wine by life cycle stage - Spanish study by Fullana (includes domestic transport)



Source: Fullana, P.; Gazulla, C. Clavijo, M.J; Puerta, M.; Tubilleja, M., 2005. *Análisis del ciclo de vida del vino de crianza D.O.C. Rioja*. Dirección General de Calidad Ambiental, Consejería de Turismo, Medio Ambiente y Política Territorial del Gobierno de La Rioja.

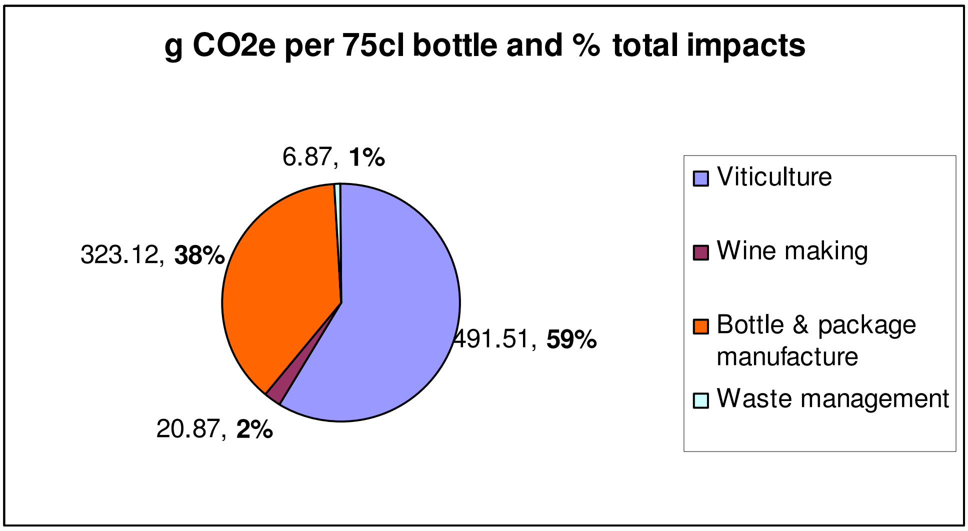
Note: transport and waste included in this chart

These figures assume a domestic distribution structure. However the Fullana study also looks at what would happen if all the wine produced were exported to the UK and calculates that CO_2 emissions per 75cl bottle would be 9% greater than the figures presented for domestic distribution only. This means that the contribution made by transport rises from 7% of the lower, domestic-only figure to 15% of the new and higher overall figure. Total emissions would be now be 992 g/CO_2/75cl wine (361g C/litre) as compared with the 1427 estimated in the Aranda study.

Note that waste is included in the Fullana study and omitted in the Aranda one but this stage does not add much to the overall numbers.

The different transport assumptions evidently account for some of the differences in the emissions figures given in the two studies. Once transport is excluded the figures look more similar: overall life cycle emissions per 75cl bottle of wine add up to 789g CO_2e /bottle in the Aranda study and to 835g CO_2e/bottle in the second Fullana one However a closer look suggests that while the *overall* total may now be similar, the two studies still differ in considerably in their estimates of emissions for the individual life stages – compare Figure 17 above with Figure 20 below.

Figure 20: CO_2 emissions per bottle of wine by life cycle stage –Spanish study by Fullana (excludes transport)



Source: Fullana, P.; Gazulla, C. Clavijo, M.J; Puerta, M.; Tubilleja, M., 2005. Análisis del ciclo de vida del vino de crianza D.O.C. Rioja. Dirección General de Calidad Ambiental, Consejería de Turismo, Medio Ambiente y Política Territorial del Gobierno de La Rioja.

According to the Fullana study the actual viticultural process generates around two and a half times more emissions than in the Aranda study. According to Gazulla, a contributing author in the Fullana study, this can be explained by the fact that nitrous oxide emissions were significant and accounted for nearly 50% of cultivation related GWP.[133] The study took especial care to take N_20 into account and developed a specific model to calculate N_20 emissions to air and to groundwater. However the authors of the first study (Aranda et alia) also confirmed that they considered N_20. The difference in the figures might be explained by the fact that in the Fullana study fertiliser application rates (which included both inorganic and organic fertiliser) were about double what was used in the Aranda study.

An even more striking finding is that in the Fullana study total emissions from the wine making stage were extremely low – compare 21 grams CO_2e/75cl bottle with the 189g CO_2e/75cl calculated in the Aranda study. In other words wine making emissions in the Fullana study are around 9 times lower than in the Aranda study. The authors of the Fullana study also found their conclusions surprising[134] and some form of reassessment of the data may be forthcoming.

Figures for packaging manufacture are similar.

The differences between the two studies may reflect either real differences in the farming and production systems or else differences in the methodology and generic

[133] Christina Gazulla, ESCI, Universitat Pompeu Fabra, Barcelona, personal communication, March 2006
[134] Christina Gazulla, ESCI, Universitat Pompeu Fabra, Barcelona, personal communication, March 2006

data sources used – or indeed both. It is difficult to judge which of the calculations is likely to be the more accurate.

Finally, it would be helpful to know whether, on average, wines from the New World tend to carry with them a higher or lower GHG burden but from the very limited data that exist it is not possible to make any judgements.   It is also very probable that simple generalisations of this nature will not prove possible given the diversity of countries that fall within the 'New' and 'Old' world categories and the likelihood of considerable variation even within countries.   Australian electricity production, for example, depends heavily on coal, and as a result the CO_2 arising from viticultural processes fuelled by electricity will probably be higher, on average than elsewhere. However this is not necessarily the case for other New World countries.

A 'common sense' judgement might lead one to suppose that given the longer transport distances travelled by New World wines, their impacts could be higher. However life cycle analysis shows time and again that there can be little or no connection between common sense and reality. There are many different life stages to consider and for transport alone, the mode of travel will have a strong influence on overall emissions.

2.4. TRANSPORT AND LOGISTICS

Alcohol and its packaging are heavy and bulky, and often travel long distances. This has implications for transport and its impacts.

To gain a full understanding of total transport related emissions from alcohol it would be necessary to quantity journeys at each stage in the life cycle, from the transport of raw and ancillary ingredients right through to the final disposal of the empty drink containers

This has not proved possible. Not one of the alcohol related trade associations records transport movements. Such data as are available – mainly from studies published by the Department for Transport and DEFRA - tend to be very general and incomplete. The paragraphs that follow merely suggest what the importance of transport relative to other stages might be.

2.4.a. Transport within the UK - freight

Average distances

WRAP has looked at average distances travelled within the UK for beer, wine and Scotch Whisky. All whisky distilleries (and almost all spirits distilleries) are located in Scotland and hence the distances travelled can be fairly substantial. WRAP estimates that the average distance travelled for a bottle of whisky, from the point of bottle manufacture to its arrival in an individual's home is around 546 miles (874km).

For wine (once it has reached UK shores) the WRAP report assumes a journey length of about 435 miles (696km). For bottled and canned beer transport distances within the UK were estimated to be lower at around 356 miles (570km). The study does not look at draught beers and lagers.

Trends in transport emissions

One factor which is likely to have had an impact on beer transport related emissions is concentration in the sector. In 1900 there were 6447 breweries in the UK. Today there are around 584,[135] an order of magnitude lower, but nevertheless an increase on the low point of 191 in 1980.

These 584 breweries will vary drastically in size from the very smallest micro-breweries to major international players. Of these breweries, a relatively small number take a very large market share. Indeed the top four breweries in the UK (Carlsberg, Coors, InBev and Scottish & Newcastle) together hold about 80-84% of the market.[136] There are a further 60-odd medium sized breweries and the remainder are microbreweries which collectively account for just 1-2% of the entire market.

This market concentration will have had an effect not just on beer related transport and also on energy use in the brewing stage but whether the effect has been positive, environmentally speaking, or negative, is not clear.

Concentration will have meant longer journeys from malt houses to breweries. It will also have meant longer journeys to pubs and other sales outlets, all of which will have led to an increase in 'beer miles.' On the other hand, fewer longer journeys with larger loads, rather than many short journeys with small roads may not lead to more CO_2 emissions overall.

Furthermore, recent years have seen beer volumes through pubs falling considerably, and an increase in sales through the 'off-trade' – including supermarkets. One commentator notes[137] that this may have led to fewer journeys with large volumes of beer being delivered directly to supermarkets depots with corresponding increases in efficiency. The growth of pub chains, also means that breweries now tend to deliver to one main depot and then the many different brands are together loaded onto a lorry and delivered to a particular pub outlet – in the past, several brewers will individually have made deliveries to the same outlet.

Moreover it is not the case that an increase in the number and influence of small breweries (were this achievable) would lead to a reduction in transport related emissions. Local breweries do not just distribute locally. 'Craft' ales brewed in Suffolk have access to a national distribution structure and while it is likely that most of their beers are distributed fairly locally, some do indeed make their way into the households of people all over the UK.

All this is speculative since there has to date been no analysis of the different options for alcohol distribution. However it is possible that while today's relatively efficient centralised distribution system is more efficient than the smaller scale, more localised distribution system of the past, a regionalised distribution system would nevertheless be more efficient than the system we have today. With regional systems, transport efficiencies of scale can be achieved without the long distances entailed in a nationalised structure.

Calculating alcohol related freight emissions

A very patchy attempt is made here to put some sort of a figure on emissions from alcohol-related transport. Different data sources and different boundaries (what is included and what is not) have been used and the different results compared.

[135] Iain Loe, Camra, personal communication, October 2005
[136] Iain Loe, Camra personal communication, October 2005
[137] Andy Tighe, British Beer and Pub Association, personal communication, June 2006

According to Department for Transport statistics, the movement of agricultural products and food and drink together within the UK accounted for 30% of freight tonne kilometres. Freight movements themselves accounted for 16% of total emissions from transport, which in turn accounts for roughly 24% of all UK GHG emissions (27% of CO_2 emissions).[138]

This is a fairly top down way of calculating emissions and much (possibly significant) detail will be missed. By this reckoning however, domestic food freight transport as a whole (including agricultural goods) accounts for 1.152% of total emissions.

Another way of calculating domestic alcohol related freight transport is to use figures calculated in the Defra food miles report.[139] This study estimates that total transport emissions associated with UK food transport amount to 19 million tonnes of carbon dioxide or 5.18 million tonnes of carbon (2002 figures), a figure which includes overseas transport and car travel to and from shops. This equates to 2.9% of the UK's greenhouse gas emissions.

Breaking this down a little further, it calculates that 39% of these total food transport emissions are caused by the movement of heavy goods vehicles (HGVs) and light goods vehicles (LGVs) within the UK. This equates to 7.41 million tonnes of CO_2. Also according to the Defra report, the transport of beverages (excluding tea and coffee) accounts for 16% of this 7.41 million tonnes, or 1.19 million tonnes CO_2. (0.32 million tonnes carbon). On the basis of calculations shown in Appendix 3 which quantify individually the overall volumes of alcohol and soft drinks, and the overall weight of packaging associated with these two kinds of beverages, transport emissions for soft and alcoholic drinks ban be allocated on a 50:50 basis. This works out at 0.59 million tonnes CO_2 (0.16 million tonnes carbon) or **0.09**% of the 179 million tonnes of greenhouse gases (in carbon equivalents) emitted by the UK in 2003.[140] according to Defra's Family Food survey,[141]

Figures provided by the DfT[142] put total beverage related freight emissions at 126229 tonnes carbon. Allocating as above 50% of emissions to alcoholic drinks, the figure comes to 0.126 million tonnes of carbon, not too dissimilar to that estimated in the Food Miles report.

Cereals movements account for a further 5% of UK HGV emissions and some allocation to alcohol related cereals might be made but since the figures relative to total cereal use for fodder and other food production will be small these emissions are not considered here.

2.4.b. Transport within the UK: personal transport

Changes in place of consumption

---

138 *Transport Statistics Great Britain*, Department for Transport, table 3.8

139 *The Validity of Food Miles as an Indicator of Sustainable Development*, report prepared by AEA Technology for Defra, July 2005

140 The transport figures in the food miles report use 2002 data and throughout this paper, for consistency, 2003 GHG emissions have been used).

141 UK Purchased quantities of household food & drink 1974 to 2004-05 *Family Food*, Defra 2005, http://statistics.defra.gov.uk/esg/publications/efs/datasets/efscons.xls

142 Tom Spencer, Department for Transport, personal communication May 2006

A change in *where* we choose to drink, as discussed in section two, above, will also have had transport implications. Alcohol will be travelling not only to pubs, hotels and restaurants but also to distribution centres for their onward journeys to supermarkets and other retail outlets. How this has affected the overall amount of alcohol-related freight transport is unclear, as discussed above. The shift towards buying alcohol from supermarkets will also have had an impact on personal car journeys although a decision as to how much travel should be allocated to beer in relation to other supermarket goods will be a complex one.

Does this switch to buying alcohol from 'off premises' such as supermarkets mean that we are driving (or walking) less to the pub? On the contrary; from the data[143] (and with the exception of beer, where spending has been falling since the late 1980s) spending on alcohol in hotels, pubs and restaurants is steadily, if modestly, growing.

However it is still the case that the majority of wine and spirits we consume will be enjoyed at home, rather than in licensed premises. Most of the wine we drink is bought from licensed off-premises (including supermarkets) for consumption in the home. Only 16.5% is bought from restaurants, pubs, clubs and hotels.[144]

To the distribution-stage emissions calculated above then should be added transport to and from pubs for drinking plus a proportion of food shopping-related transport emissions. Any figures here will be speculative. Figures for travel to pubs are not available, although it is worth noting that travel for entertainment accounts for 5% of total personal mileage.[145] The definition of entertainment excludes visits to friends, travel for holidays, for sport and for 'other personal business' and so it might be reasonable to suppose that trips to the pub or to a restaurant probably accounts for at least half of his 5%.[146] If personal travel accounts for 10-11% of the UK's greenhouse gas emissions,[147] and travel to and from pubs accounts for 2.5% of personal travel then it is calculated that travel for leisure eating and drinking purposes accounts for around 0.275% of total UK emissions. If one allocates perhaps 25% of this 0.275% to alcohol as distinct from food (25% of 2.5% of 10-11%) then the figure for total alcohol related personal travel comes to 0.069% of the UK GHG total. Of course some journeys will be made on foot or by public transport but since the average trip length for leisure is 7.9 miles, the probability that a car journey will be involved (especially since three quarters of households have a car) will be high.

As regards shopping trips, again according to the Defra Food Miles report, food related car travel accounted for 13% of total food transport CO_2 emissions, or 13% of 19 million tonnes - 2.47 million tonnes. (0.67 million tonnes carbon).

---

[143] *BBPA Statistical Handbook 2004*, British Beer and Pub Association 2004, Table E5
[144] *Wine UK*, Mintel, January 2005
[145] *Focus on Personal Travel 2005*, Department for Transport 2005, table 3.1 http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/downloadable/dft_transstats_037493.pdf
[146] *Focus on Personal Travel 2005*, Department for Transport 2005, table 3.1 http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/downloadable/dft_transstats_037493.pdf
[147] Depending on how emissions are measured – see Transport Statistics Great Britain 2005, Department for Transport Table 3.8 http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/page/dft_transstats_041491.pdf

One might very approximately allocate a proportion of these emissions to alcohol on the basis of our spending on alcohol as a percentage of total food spend. Alcoholic drinks (for home consumption) account for 12% of per capita spending on food.[148] If 12% of total food shopping is related to alcohol this amount to 0.08 million tonnes of carbon or greenhouse gas emissions. It has been argued however that over 60% of the cost of alcohol at the point of purchase relates to duty and VAT, and so a simple se of spending as a basis for proportioning out tonnes of carbon dioxide emissions is be distortive and unfairly 'penalises' alcohol.[149] This is a fair point and so the 0.08 million tonnes are here halved (0.04 million tonnes), to allow for this distortive effect

2.4.c. Alcohol transport: adding it all up

Adding all forms of transport together – freight transport, journeys to pubs etc and alcohol related shopping trips - this means that UK domestic alcohol related transport comes to 0.564% of the UK's greenhouse gas emissions.

Table 27: Total domestic alcohol transport emissions

Alcohol movements	Million Tonnes C	% UK GHG emissions
Domestic freight transport	0.16	0.090
Travel to pubs etc	0.12	0.069
Travel for shopping	0.04	0.022
Total	**0.32**	**0.181**

There is also overseas travel to consider. The Food Miles report does not show the relative contribution of different imports to CO_2 emissions. What it does show, however, is that the split in emissions between within-UK and overseas transport is roughly equal. As already shown, alcohol is a sector where a substantial proportion of what we drink is imported . On the basis that 10% of our beer is imported, 100% of wine and 66% of our spirits then, by volume we import 25% of what we consume. Since many of the imports will travel long distances, it is in our judgement reasonable to assume that emissions for the overseas transport stage will be at least equal to in-UK emissions.

Table 28: Total domestic and international alcohol transport emissions

Item	Million Tonnes Carbon	% UK GHG emissions
Domestic freight transport	0.16	0.090
Travel to pubs etc	0.12	0.069
Travel for shopping	0.08	0.022
Overseas transport	0.32	0.181
Total	**0.64**	**0.362**

How does this figure compare with those calculated in other studies? A recent series of studies commissioned by WRAP looks at transport associated with bottles of ale

[148] *Family Food 2003/4*, Defra, 2005
http://statistics.defra.gov.uk/esg/publications/efs/2004/chapter4.pdf
[149] Scotch Whisky Association, personal communication, June 2006

and lager, wine sold through UK supermarkets, and Scotch whisky. Overseas packaging related transport associated with wine and some beers were included. In total by their calculations transport associated with alcohol amounts to 0.23 million tonnes of carbon dioxide (0.063 million tonnes carbon), or 0.035% of UK's total greenhouse gas emissions.

This is an order of magnitude smaller than the estimate given above. However it is very important to note that the WRAP study considers only a small proportion of total alcohol related transport.

For a start transport associated with home consumption only was considered – distribution to pubs, restaurants and other 'on-premises' was not. Second, for beer, the transport of barrels (which will be highly significant for pubs) is not included. It has already been shown in 1.2.a above that most beer (57%) is still bought from pubs, and in draught form although this is likely to change in the coming years. Third, for wine, only travel associated with wine sold through supermarkets was considered. This accounts for 70% of off-sales, which in turn account for 80% of total wine sales (by volume).[150] In other words the study looks at 56% of all wine consumed in the UK, leaving 44% of wine sales excluded from the analysis.

Fourth, for spirits, transport associated with Scotch whisky only was examined. This drink accounts for 30% of all the spirits we consume. Of the remaining 70% many spirits will be imported, adding to the transport emissions. It has already been estimated that self sufficiency in spirits is about 66%.

Finally, the WRAP-commissioned study is concerned only with transport that relates to packaging. Thus while transport from the point of bottle manufacture through to travel to home is considered, emissions associated with upstream transport of raw alcohol ingredients such as malt or grapes, or GNS, are not quantified.

To see what the WRAP data could produce were some of these omissions compensated for by supplementing with additional data, a further calculation was made. The aim was to see whether one might arrive at a figure for domestic alcohol related transport, one that excluded the overseas import stage[151] but which was based on the total UK consumption of alcohol (and not just off-trade or supermarket related sales). From the WRAP data sheets, estimates for transport emissions per tonne of glass moved (in the UK) were obtained. This was simply the total transport related emissions (within the UK) divided by WRAP's total tonnage of glass for each alcohol type considered. These figures were multiplied by the total volume of alcohol related glass of each type in the UK waste stream (which was obtained from another WRAP study)[152]. Interestingly the end calculation was fairly similar to WRAP's original one (which included the overseas stage but a lower volume of glass) - 203019.63 tonnes of CO_2 or 0.03% of the UK's greenhouse gas emissions – and still a very low figure.

However it is important to note that there were several omissions in the study which, if included, are likely to raise the figure substantially. The first is that movements of keg beer were not included since specific data on this subject are not available. Second and perhaps more importantly, transport associated with the movements of

---

[150] *A Study into the Interaction of Imported Wine Bottles and the UK's Cullet Supply Project code: GLA0059*, written by Glass Technology Services for WRAP, 31 December 2005
[151] Except for beer where it was not possible to disaggregate the data
[152] Glass Technology Services Ltd. *Maximising Cullet Additions in the Glass Container Industry*, Project code: GLA0039, Waste Resources Action Programme, February 2006

raw ingredients (other than packaging) were not considered in the WRAP study. This means that the movement of barley and other grains, of malt, of grapes and so forth were excluded from the calculations. The import of grain neutral spirit, the base for gin and vodka which is often imported, was also not considered in WRAP study. Finally, for the freight distribution stages of the journey additional emissions for the return journey should also be factored in. Some backhauling may occur but its prevalence is unknown.

On the whole then, if is felt here that while the first calculation (based on the Defra food miles study and on DfT data) may be somewhat crude it give a better picture of the total contribution made by the alcohol sector to the UK's greenhouse gas emissions, and itself could be an underestimate, particularly at the overseas transport stage.

One useful insight, however, that was gained from the WRAP data is that for wine where almost all of it is imported, emissions generated at the import stage are roughly equivalent to those generated within the UK. This bears out the findings of the Defra Food Miles study[153] and lends weight to the assumptions of the first alcohol related transport calculations in this study.

As a final comment on transport issues, one might suggest that since alcohol related transport is estimated to contribute to nearly 0.4% of the UK's greenhouse gas emissions – a fair amount for one element of one part of the food and drink we consume - then from a policy perspective a greater focus on alcohol related transport might be called for. The Department for Transport is currently funding a benchmarking study for the alcohol sector -

2.4.d. Allocating transport emissions by alcohol type

In the absence of information it is difficult to decide how transport emissions should be allocated by alcohol type. While more beer by volume is imported than any other alcoholic drink (meaning that it may be responsible for the majority of emissions in the UK), very little of it is imported from overseas.

The following allocation method is used: for transport in the UK (calculated to be 0.2% of the UK's total GHGs) transport emissions were allocated on a volume basis. For instance, since beer accounts for around 80.5% by volume of all alcohol consumed, then 80.5% of domestic alcohol transport emissions are allocated to beer.

For overseas transport (estimated as equal to the domestic leg), allocations were likewise allocated in proportion to their volume. Roughly ten percent of beer of the total volume of beer consumed is imported, all the wine and two thirds of the spirits.

Table 29: Transport related emissions by alcohol type

Item	Beer	Wine	Spirits	Totals
Total consumption litres	6,030,100,000	1,300,000,000	277,000,000	7,607,100,000
Share total volume %	80.50	16	3.50	100
UK transport emissions % GHG contribution	0.15	0.03	0.01	0.18
UK transport emissions tonnes carbon	*0.26*	*0.05*	*0.01*	0.32

[153] *The Validity of Food Miles as an Indicator of Sustainable Development*, report prepared by AEA Technology for Defra, July 2005

Total imports litres	646,400,000	1,300,000,000	184,666,667	2,131,066,667
Share total import volume %	30.33	61	8.67	100
Overseas transport emissions % UK GHG contribution	0.05	0.11	0.02	0.18
Overseas transport emissions tonnes carbon	*0.11*	*0.20*	*0.03*	0.32
Total transport emissions as % GHG contribution	**0.20**	**0.14**	**0.02**	**0.36**
Total transport emissions tonnes carbon	***0.37***	***0.25***	***0.04***	**0.65**

As the table shows, in absolute terms beer is associated with more transport CO_2 than the other alcohol categories simply because we drink so much of it by volume.

2.5. CONSUMPTION RELATED ENERGY USE: THE DOMESTIC AND HOSPITALITY SECTORS

This section begins by looking at refrigeration in the home and in licensed premises. It then moves on to consider more generally energy use in licensed premises such as pubs, bars, clubs, restaurants and hotels. For brevity these various licensed premises are referred to collectively as the 'hospitality sector.'

2.5.a Refrigeration

Lagers, cider and white wine are usually drunk chilled and there has recently been a growth in the popularity of 'ultra-cold' beers and ciders which place additional demands on refrigeration.

Domestic refrigeration

Domestic refrigerators and fridge freezers (excluding chest and upright freezers) have been estimated to produce 1.34 MTC. Adding an extra 15% to allow for the leaking of refrigerants, this is approximately equivalent to 0.86% of the UK's greenhouse gas emissions.

Alcoholic drinks are not frozen and hence they are not 'responsible' for freezer related emissions. It is not possible to separate out freezer energy use from total fridge-freezer energy use. However stand-alone refrigerators contribute 0.32 MTC of the total 1.34MTC. Hence the 0.32MTC figure is simply doubled here, the assumption being that the fridge part of the fridge freezer will use a similar quantity of energy. As such it is estimated that refrigeration accounts for 0.64MTC or 0.43% of the UK's total greenhouse gas emissions.

As discussed above alcohol accounts for around 12% of household spending but we assume here that this figure should be halved to 6% to take into account the distortive effect of tax. We assume also that roughly half of the alcohol bought will be refrigerated (taking into account white wine, beer and some spirit purchases) and so 3% of total refrigeration emissions might be allocated to alcohol. This constitutes 0.01% of the UK's greenhouse gas emissions.

This approach raises a question which has been discussed in some detail in another FCRN paper.[154] Since we all have refrigerators irrespective of whether we consume alcohol or not, is it actually appropriate to allocate any refrigeration emissions at all to alcohol? To which the initial response might be that this is true of virtually any product requiring chilling. Some of us do not buy frozen peas. Others will not refrigerate their fruit. Others still keep their butter out of the fridge. And so reasons for not allocating emissions to all these products can be found. Nevertheless the fact remains (as already mentioned) that we all have fridges and we seem to have upgraded to larger ones as the years go by.[155] It is indeed arguable that the growth of refrigeration has gone hand in hand with the growth in demand for products (such as beer and wine) which can be consumed both at home and outside the home.[156] So in that sense alcohol is -albeit to a lesser extent than fresh and chilled processed foods - complicit in trend towards larger fridges.

It should be noted, however, that from a practical energy reduction point of view, examining alcohol's contribution to household refrigeration energy use and seeking to tackle that alone will yield no real gains. What is needed rather is to look at the sorts of food that do go into our fridges as a way of considering how our food choices and lifestyles have lead to a growing dependence on refrigeration. Now that home refrigeration is ubiquitous, certain foods have developed and certain practices around food arisen (including bringing beer home and drinking it cold rather than going to the pub) and have become the norm; as result new technology has emerged and continues to emerge[157] which helps 'service' the norm but which also anticipates and seeks to fulfil future demands, the which will also be dependent on refrigeration. In other words there is a symbiosis between the technology, our food and our expectations, and this symbiosis can lead to the development of new technologies and new cultural norms.[158]

Commercial cold storage

In-home refrigeration is just one part of the refrigeration supply chain. Breweries, pubs, restaurants, clubs, hotels off-licenses and other retail outlets will also store alcohol under refrigerated conditions. Since brewing stage refrigeration use is already included in the brewing stage CO_2 emissions (see 2.1.d) they are not considered here. Of course an analysis of the relative importance of refrigeration to the beer life cycle would need to extract refrigeration-related emissions from the total 600,000 tonnes brewery related CO_2 which the industry reports, and then add it to the total given in Table 30.

The Market Transformation Programme holds data on the number and type of cooling-related equipment in commercial premises in the UK, together with its energy use. Using the data available for pubs it is estimated that pub related cooling equipment contributes 0.2% to the UK's total. As for the domestic energy use above,

[154] Garnett T. *Fruit and vegetables & UK greenhouse gas emissions: exploring the relationship*. Draft paper produced as part of the work of the Food Climate Research Network. February 2006

[155] Boardman, B (2004) *Achieving energy efficiency through product policy: the UK experience*. Environmental Science and Policy 7(3), 165-176

[156] Garnett T. (2006). (draft, forthcoming). *Food refrigeration: what is the contribution to greenhouse gas emissions and how might they be reduced?* A working paper produced as part of the Food Climate Research Network

[157] Processed ready meals are a clear example here.

[158] See Garnett T. (draft, forthcoming). *Food refrigeration: what is the contribution to greenhouse gas emissions and how might they be reduced?* A working paper produced as part of the Food Climate Research Network

15% has been added to the carbon figures shown to allow for the other greenhouse gases. Table 30 below gives more details:

Table 30: Commercial refrigeration related emissions for alcohol

Equipment in pubs & off licenses	Number	Mean kWh year	Total kWh	Tonnes carbon	% Contribution to UK GHGs
Retail display cabinets (RDCs) integral	158,200	3,450	545,790,000		
Cold rooms	7,000	9,000	63,000,000		
Ice machines	70,000	8,760	613,200,000		
Service cabinets	105,000	5,475	574,875,000		
Cellar coolers	70,000	13,140	919,800,000		
Total			**2,716,665,000**	**317,850**	**0.2%**

Source: data provided by the Market Transformation Programme.

Hotels and restaurants will also make use of refrigeration equipment for cooling alcohol but since it is difficult to separate out food from drink they are not considered here. Refrigeration energy use for hotels and restaurants is, in any case, included in the data set out in Table 31, below.

2.5.b. Energy use in the hospitality industry

Contact was made with 'Hospitable Climates, an organisation set up to promote energy efficiency in the hospitality industry. They provided what they stressed was a very rough estimate of average pub energy use on a per m^2 basis. According to their data it appears that energy use in pubs contributes nearly 0.5% to the UK's total greenhouse gas emissions.

Of course pubs do not just sell alcohol. They also sell soft drinks and many offer food as well. According to the British Beer and Pub Association[159] 58% of pub turnover is alcohol related and as such it is assumed here that 58% of energy use should be attributed to alcohol, or 0.28% of total UK greenhouse gas emissions.[160]

On the other hand, in addition to pubs, many other licensed premises (clubs, bars, hotels, restaurants) sell alcohol. As a conservative estimate, these establishments are assumed to require the same amount of alcohol related energy as do the pubs. This brings the total alcohol related contribution of the hospitality sector to 0.56% of the UK's greenhouse gas emissions.

[159] Andy Tighe, British Beer and Pub Association, personal communication 2006
[160] the effect of VAT and alcohol duty is not considered here since profits are made from all foods and drinks sold

Table 31: Estimated hospitality sector energy use and GHG emissions

Pub energy use	kWh/m²	Per pub kWh/m² (average 240m²)[161]	All pubs kWh/m² (60000 total)[162]	Tonnes carbon	Contribution to UK GHGs %
Electricity use	355	85,200	5,112,000,000	598,104	
Fossil fuel use	354	84,960	5,097,600,000	264,056	
Total	**709**	**170,160**	**10,209,600,000**	**862160**	**0.48**
58% allocation to alcohol					**0.28**
Contribution from other licensed premises					**0.28**
Total hospitality sector contribution					**0.56**

In Table 32 below the small contribution made by domestic refrigeration energy use is added to hospitality-sector energy use. A CO_2 allocation is then made to each alcoholic beverage. The method chosen here is to allocate on the basis of the total volume consumed. This will not be fully accurate for many reasons. Most beer is drunk in pubs whereas most wines and spirits are drunk at home (where in a sense emissions are lower although the pub will hardly go away if one chooses to drink at home instead). Spirits tend not to be stored refrigerated, for wine some does and some does not, and likewise for beer. Many spirits will also be mixed with other chilled drinks (tonic, orange juice etc) meaning that the overall emissions associated with the drink in question will be higher. For simplicity the volume allocation approach has been used.

Table 32: Total consumption (hospitality sector and domestic) stage related GHG emissions

Item	%age
Total pub related emissions	0.28
Clubs, restaurants and hotels	0.28
Total domestic refrigeration emissions	0.01
Total as % of total GHGs	**0.57**
% from beer	0.46
% from wine	0.09
% from spirits	0.02

[161] 240m² assumption is from Hospitable Climates
[162] Total pub numbers on British Beer and Pub Association website http://www.beerandpub.com/content.asp?id_Content=345

2.6. ADDING IT ALL UP AND COMPARING THE FIGURES

2.6.a. Alcohol's contribution to the UK's greenhouse gas emissions

Once all the calculations made in the sections above are added together, the contribution made by the alcohol we drink is seen to account for 1.46% of the UK's total greenhouse gas emissions.

Nearly 0.6% of this can be attributed to the actual consumption stage, be it in pubs, restaurants, clubs or, to a lesser extent, at home.

Table 33: Alcohol's contribution to UK greenhouse gas emissions; total and by alcohol type

Life stage	Beer	Wine	Spirits	Total as % total UK GHGs
Agriculture	0.055		0.018	
Malting	0.038		0.003	
Alcohol production	0.096		0.024	
Total agriculture and alcohol production (sum of above)	0.189	0.1	0.044	0.33
Packaging production	0.11	0.07	0.02	0.20
Transport	0.2	0.14	0.02	0.36
Consumption	0.46	0.09	0.02	0.58
Total emissions by alcoholic drink as % contribution to UK GHGs	**0.96**	**0.40**	**0.10**	**1.46**
Share of total emissions by alcoholic drink to total alcohol GHG emissions	*65.46*	*27.42*	*7.12*	*100.00*

Note: separate estimates are not made for viticulture and viniculture since these individual stages vary considerably as discussed in 2.3.b above.

2.6.b. How accurate are these figures likely to be?

As emphasised throughout this paper, many of the figures are estimates based on very top-down figures. Often a guess has had to be made as to the proportion of each life stage (food transport, say) one might have to attribute to alcohol.

This said, nearly 1.5% (or 0.92% if the consumption stage is excluded) is likely to be a considerable underestimate for several reasons. For a start, the analysis presented here looks just at the three main categories of drinks. Cider is not included, nor are flavoured alcoholic beverages, fortified wines, liqueurs, mixers and other less important players. These added together would add to the total.

Second, for packaging production, forms of packaging other than cans and glass bottles are not included. The inclusion of barrels, kegs and secondary packaging could increase the emission figures by a fair margin since, while these are returnable containers, there will be replacements of old or damaged vessels. Moreover, transport associated with movements of the raw materials required to produce the packaging in the first place are not included and once again these could raise the packaging figures substantially.

Third, for beer and whisky, it is assumed that the energy efficiency (and carbon intensity) of production systems (eg. brewing or distilling) overseas will be the same as they are in the UK. This is unlikely to be the case. For some countries (such as those which use a high proportion of renewable or nuclear energy) the carbon intensity of electricity use may be low but in others, such as Australia, it may be high. Different countries will also be more or less efficient in their use of both fuel and electricity owing to differences in technology and practice.

For transport, exports and re-imports (which to a small extent does occur) are not quantified, nor is transport associated with the movement of raw materials such as barley and other grains, malt, grain neutral spirit or, as mentioned, raw materials for packaging (except for steel). The carbon attributed to the importing stage is just an estimate. The Defra Food Miles study warns that its calculations for the overseas transport stage are likely to be underestimates[163] and it thus seems reasonable to suppose that, since this paper has drawn on the food miles study, the transport figures given here are similarly low.

2.6.c. Emissions per unit of alcohol consumed and identifying the hotspots

While beer accounts for around 80.5% of alcohol consumption by volume,[164] it emits only 62% of alcohol emissions. Wine's volume share of alcohol consumption is 16% but its emissions contribute over 27% to the alcohol total. For spirits, the total volume of consumption is 3.5% while its share of emissions is 6.7%.

But since we drink, say, spirits in vastly smaller quantities than we do beer, it is perhaps not especially helpful to compare drinks on a volume basis. A comparison per unit of alcohol consumed is probably more sensible.

Table 34 compares emissions on a per unit basis, assuming the following average alcohol contents to be as follows: beer - 4.5% ABV; wine - 12% ABV; and spirits - 40% ABV.

Table 34: Emissions by alcohol type per unit

Item	Beer	Wine	Spirits
Total consumption litres	6,030,100,000	1,300,000,000	277,000,000
Total consumption in units	27,135,450,000	15,600,000,000	11,080,000,000
Contribution per unit	**3.52988E-11**	**2.57179E-11**	**9.40884E-12**
Contribution per unit excluding packaging refrigeration & transport	*6.96506E-12*	*6.41026E-12*	*3.99819E-12*
Contribution per unit excluding consumption	1.83892E-11	1.98718E-11	7.6083E-12

Viewing the data in this way beer emerges as the most CO_2 intensive form of alcohol, followed by wine and then spirits. The differences between beer and wine are very small indeed. Spirits rank as slightly less CO_2 intensive but once again it should be remembered that the figures are minor and are easily less significant than the error margins in the data. Once packaging, transport and consumption (perhaps the most

[163] *The Validity of Food Miles as an Indicator of Sustainable Development*, report prepared by AEA Technology for Defra, July 2005
[164] *Statistical Handbook 2004* Table D1, British Beer and Pub Association,.

variable of the life stages) are excluded the differences between the three alcohol types reduce further. On the basis of the data available and used in this report, it is in our view not possible to judge whether one type of alcoholic drink is less energy intensive than another.

2.6.d. Assessing emissions by packaging type and identifying the hotspots

Figures 21, 22 and23 show, for the three main alcohol types, the relative contribution made by each stage to its total life cycle emissions.

Figure 21: Relative contribution of life cycle stages to beer emissions

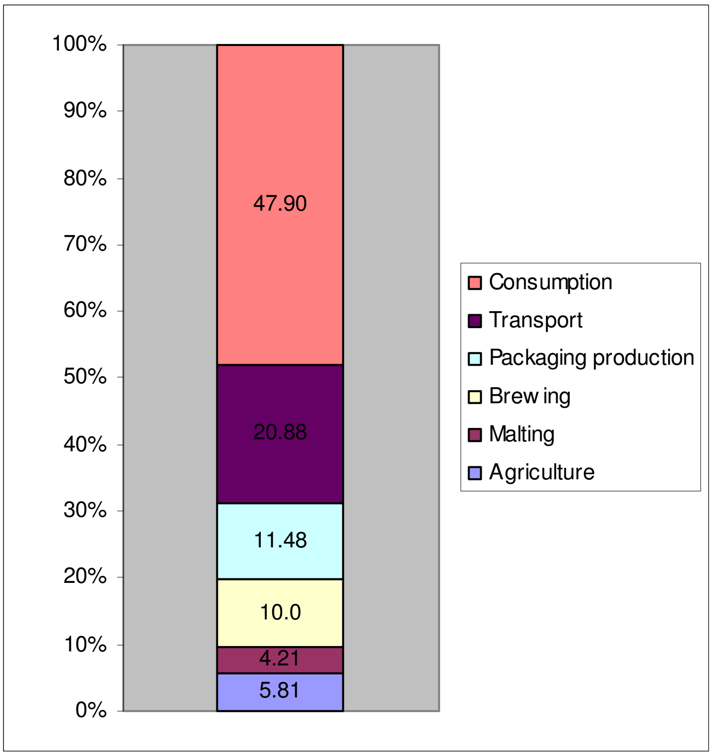


Figure 22: Relative contribution of life cycle stages to wine emissions

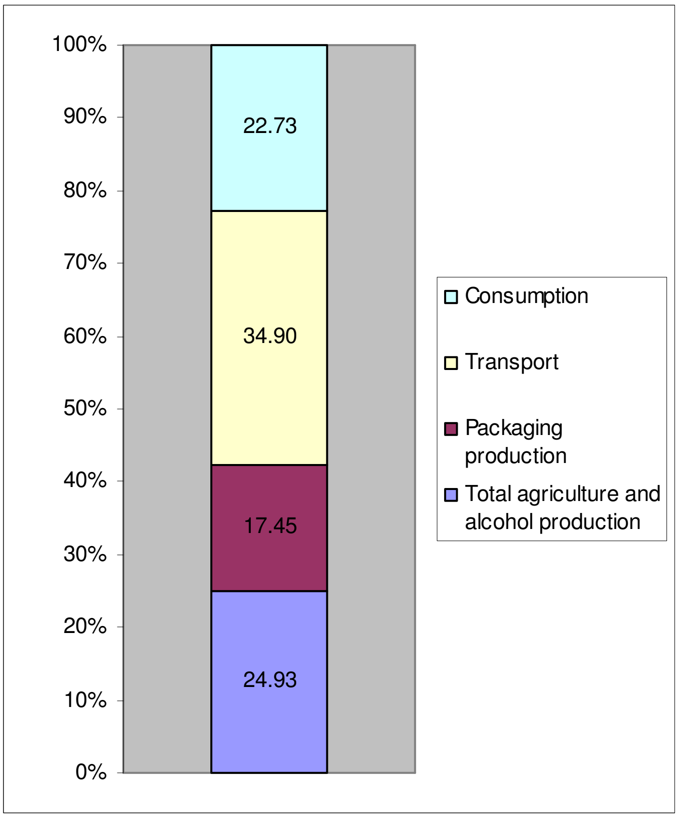
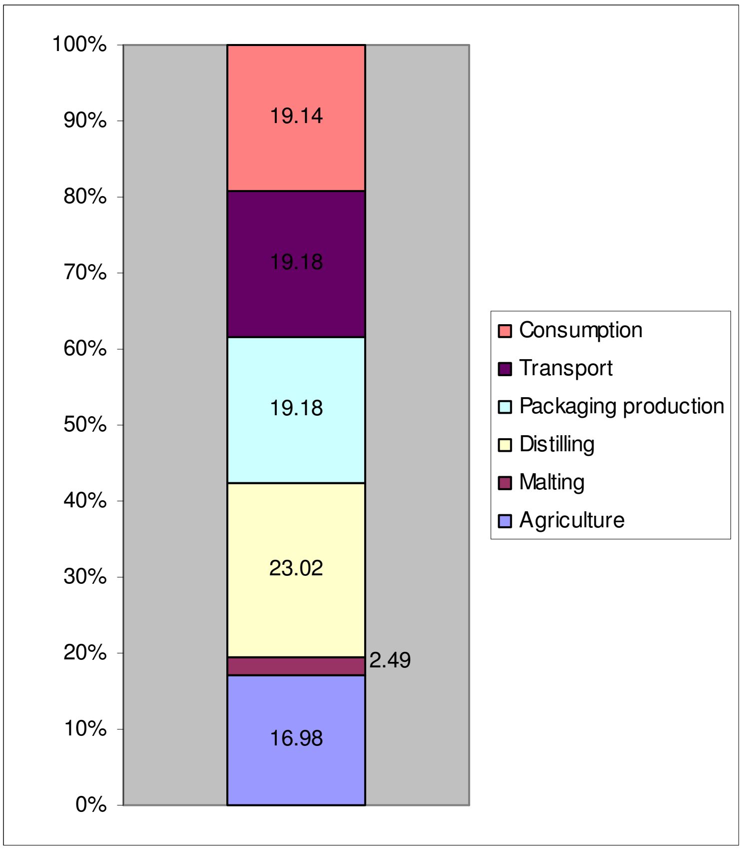


Figure 23: Relative contribution of life cycle stages to spirit emissions



As can be seen, for beer the consumption stage is clearly the most significant followed by transport and then by a fair way, by packaging. For wine, unsurprisingly, the transport stage has the highest relative impacts followed by the consumption and viti-vinicultural stages. For spirits, impacts are very evenly distributed although the distilling stage is the most significant and the malting stage is very minor, reflecting the fact that most spirits do not include malting in their production. For whisky production, malting is likely to be more significant.

Packaging is, interestingly, less significant than may sometimes be supposed. This is a general conclusion and needs modifying for beer packaged in bottles and cans. For bottled beer, as Figure 24 shows, packaging accounts for a third of total emissions - just slightly less than consumption related impacts. For canned beer, packaging emissions are still less significant than consumption and transport, although still almost twice the average for beer as a whole. Overall emissions for packaged beer are higher than for draught beer.

Figure 24: Relative contribution of life cycle stages to bottled beer emissions

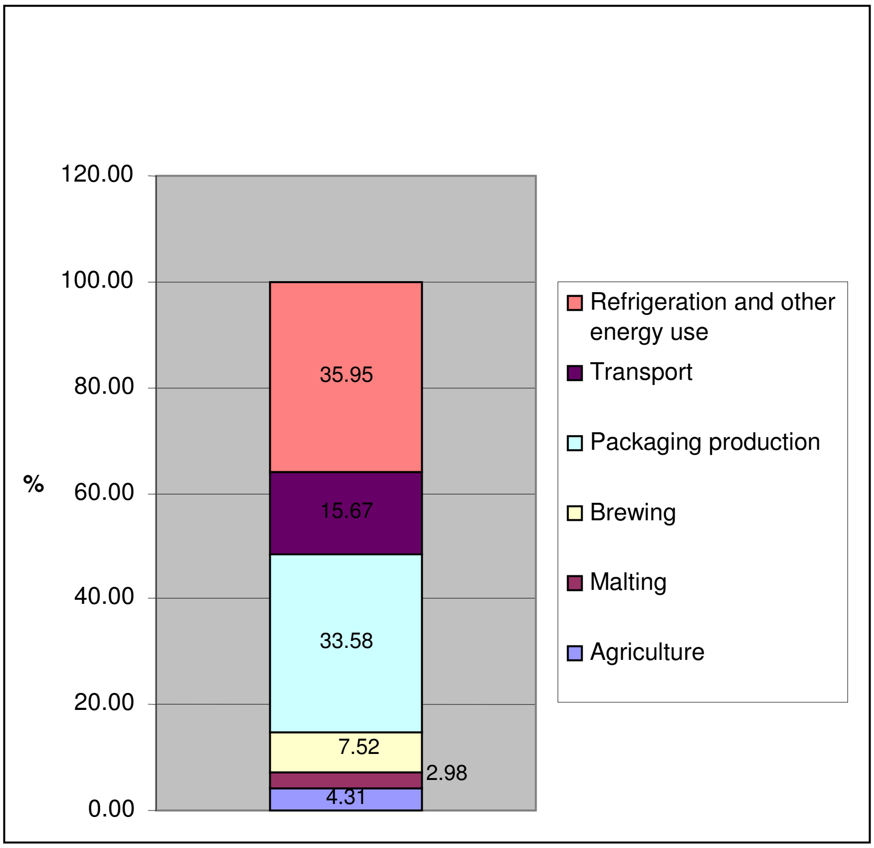
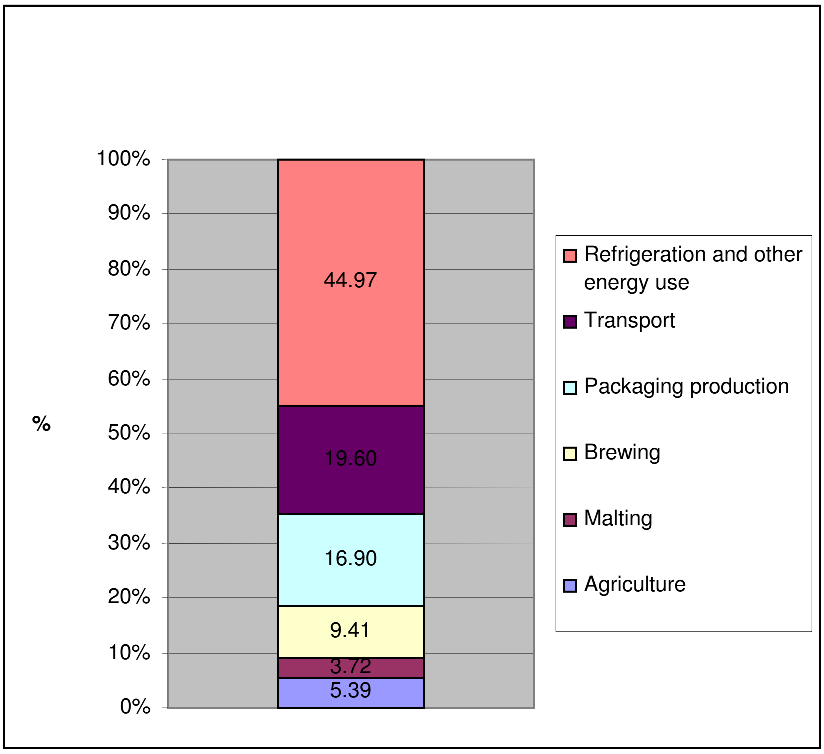


Figure 25: Relative contribution of life cycle stages to canned beer emissions



The difference in CO_2 emissions per unit between bottled and canned beer can probably be explained by the fact that metal cans in the UK usually have a fairly high recycling rate. The manufacture of cans out of recycled metals is very much less energy intensive than manufacture from virgin materials, the accepted figure being that the manufacture of aluminium sheet from recycled aluminium uses only 5% of the energy which would be required were it made from raw materials. [165] By contrast, while there may be many good environmental reasons for recycling glass, from a CO_2 perspective the inclusion of 10% of recycled glass into the furnace will reduce furnace energy consumption by only 2.5%.[166]

It is possible that the emission figures used here for glass are in fact a little low. For a start the figures take into account only energy use in furnaces. Energy used in the extraction of the raw materials is the movements of these materials. CO_2 emitted during the production and transport of corks, caps, labels and other parts are similarly ignored. One Spanish life cycle analysis of beer bottle production[167] does take these and other factors into account and as a result estimates emissions per tonne of glass to be 0.3421 tonnes carbon per tonne of glass. This is twice the figure used in this report. Since the Spanish energy mix is different from the UK's, and its production efficiency may also be different, it is not possible to conclude that total UK glass related emissions should be doubled but the point is perhaps worth noting.

---

[165] Aluminium Recycling: Fact sheet 11, Alfed, http://www.alfed.org.uk/templates/alfed/content.asp?PageId=108

[166] *Energy use in the Glass Container Industry*, Energy Consumption Guide ECG027, the Carbon Trust, UK, March 2005 http://www.thecarbontrust.co.uk/energy/pages/search_results.asp#

[167] Life Cycle Assessment of Different Reuse Percentages for Glass Beer Bottles Teresa M. Mata and Carlos A. V. Costa, *International Journal of Life Cycle Assessment*, 6 (5) 307 – 319 (2001)

If figures estimated by WRAP were used the contribution made by alcohol related glass would be around three and a half times greater or 0.68% of the UK's total emissions. In turn, the alcohol sector's total contribution to the UK's greenhouse gases would be 2%of the emissions total. For bottled beer, the contribution of the packaging stage to total bottled beer emissions would increase from 33% to 63%. For wine, packaging's share would increase from 17% to 59% and for spirits from 20% to 47%.

The WRAP figure is however likely to be excessively high since all the other studies found are more in keeping with (if not identical to) the calculations made in this paper here. Nevertheless it may be that the figures used in the paper here may be at the lower end of estimates.

It is also the case that the calculations made here for glass and cans assume a UK energy mix and UK energy efficiencies. While most cans are indeed produced here in the UK, for glass - and for green glass in particular – the picture is very different. Almost all the green glass in the UK waste stream is of overseas origin, reflecting the fact that most green glass is from wine bottles and most wine is bottled overseas. According to Andy Hartley of Glass Technology Services,[168] essentially most western industrial countries use the same technology and so have similar furnace. Some, however, use oil as a fuel source and so the CO_2 intensity will be higher. The proportion of cullet, or recycled content, which goes into the furnace will also vary from country to country and this too may have a bearing on CO_2. The glass recycling rate in the UK is 44% while the European average is around 67%.[169] Recycling rates for all the main European countries from which we import alcohol (France, Germany, Netherlands and others) are all higher than in the UK, with the exception of Spain where they slightly lower. [170][171]

Taking all these factors into account it may well be the case both that the relative importance of glass is a little greater than presented here and, following on from this, that overall emissions are higher than has been calculated.

Note that the relative importance of packaging may be higher for all alcohol types if barrels and kegs are taken into account. As regards beer, the production of beer kegs (which are now mainly made of steel) will require energy and ensuing emissions here have not been quantified above (owing to lack of data). While kegs can be reused many times, damaged or lost kegs will also need to be replaced. Moreover kegs need to be re-sterilised after each use and this can require significant amounts of energy. As noted above, Sorrell (2004)[172] comments that if a brewery makes use of returnable bottles, the steam use for bottle cleaning before filling tends to exceed all the other thermal energy requirements uses combined. For wine and spirits,

---

[168] Andy Hartley Senior Environmental Consultant at Glass Technology Services, personal communication, May 2006

[169] Andy Hartley Senior Environmental Consultant at Glass Technology Services, personal communication, May 2006

[170] *Glass Gazette,* Issue 31, Feve - The European Container Glass Federation October 2005, 2004 data.

[171] Note that this is the recycling rate for all glass and not just container glass. The proportions are for glass reuse but this does not necessarily mean that all reused glass is remelted to produce glass once more; some is recovered for other purposes

[172] Sorrell, S., E. O'Malley, J. Schleich and S. Scott (2004), *The Economics of Energy Efficiency: Barriers to Cost Effective Investment*, Edward Elgar, Cheltenham

barrel production will also increase the relative importance of packaging. Some will be very old casks that but others will be made of steel.

The type of packaging will also have a bearing on transport. Cans and to a lesser extent bottles may be less energy intensive to transport than barrels since the latter will not stack as well as pallets of cans and bottles. As such more lorries may likely to be needed for a given volume of beer. While detailed transport comparisons are not possible owing to lack of data, it could be that that this will slightly lessen the difference between packaging types.

PART THREE

3.1. OPTIONS FOR EMISSIONS REDUCTION: TECHNOLOGICAL IMPROVEMENTS

This section takes a look at what is being done to reduce emissions from the alcohol sector and what other options might be available. The focus is on alcohol that is produced within the UK – mainly beer and whisky - rather than that, like wine and other beverages, which is produced elsewhere. This is in contrast with the consumption oriented approach of the rest of the paper but reflects the fact that it is far easier to do something about energy use and emissions that are generated in the UK than it is to do anything about those emitted overseas even if the end product is destined for the UK population.

3.1.a. Agriculture

For beer and wine the agricultural stage emissions are not considered to be especially significant. As such the options for reduction are not discussed here except to note that there is a Defra funded project , Green Grain (LK0959)[173] which looks specifically at grain grown for distilling (and animal feed). The research, which began in 2004, is exploring the potential for developing wheat varieties with improved characteristics such as high starch grains with high ethanol yields, improved amino acid balance, reduced gliadin proteins and reduced requirements for fertiliser N. The research is due to be completed in 2009.

A fuller analysis of the cereals sector and its greenhouse gas emissions will form the subject of a separate FCRN paper.[174]

3.1.b. Malting, brewing and distilling

As noted, malting, brewing and distilling emissions are subject to Climate Change Agreements and some production sites are even included in the EU Emissions Trading Scheme. Spurred on by its CCA targets, and building on energy efficiency efforts that were already taking place, the alcohol industry itself is devoting considerable attention to reducing emissions (and hence costs) here. Organisations such as the Carbon Trust are also involved in providing advice on energy efficiency.

A full analysis of the options available and the technologies adopted would require extensive research, the which is beyond the scope and capacities of the FCRN. As a flavour of new developments underway, it is worth noting that Brewing Research International (the main research institution associated with the brewing industry) is currently working with companies on new technologies to increase energy efficiency in certain parts of the brewing process, such as the wort boiling stage. In addition the BBPA in partnership with the Food and Drink Federation, the Cold Storage and Distribution Federation and Dairy UK involved in a Defra and Carbon Trust-funded project aimed at reducing emissions from refrigeration.

---

[173] for more details see http://www2.defra.gov.uk/research/project_data/More.asp?I=LK0959&M=KWS&V=green+grain&SCOPE=0

[174] *Cereals and oilseeds: their contribution to the UK's greenhouse gas emissions*, Food Climate Research Network, forthcoming

Scottish and Newcastle will also soon be using spent grains from the brewing process as fuel on three of its beer and one of its cider sites. When fully implemented they are anticipated to reduce steam energy emissions by around 40% but the projects are likely be up and running over the next 1-3 years.

Individual distillers are also taking steps to improve the efficiency of their operations. For example the excess heat generated by Bowmore distillery in Islay is used to heat the community's swimming pool. The old Pulteney distillery in Wick is fuelled by a combined heat and power plant running on biomass; the spare heat is used to warm nearly 600 homes in the vicinity.[175]

3.1.c. Packaging

Adding up packaging emissions for the alcohol sector as a whole, the contribution made by alcohol bottles to the UK's total life cycle emissions stand at about 0.17% of the UK's total emissions.[176] For cans the figure is lower at 0.05%, reflecting the fact that only beer (and cider) is packaged in this form. For comparison the contribution of glass and metal packaging in the food sector as a whole to the UK's greenhouse gas emissions is as follows: for glass 0.25%, or 453000 tonnes of carbon[177] and for cans the contribution is 0.1% or 93535 tonnes of carbon.[178] As highlighted above, others give different figures for the carbon intensity of glass manufacture and if WRAP figures used, the carbon emissions would be higher.

As regards packaging and its environmental impact, WRAP is currently focusing considerable efforts on the alcohol sector and is considering various possible approaches. The first is the possibility of light weighting bottles. The second is the scope for increasing bulk imports of wine. And the third, linked strategy concerns the reuse of green cullet in the UK waste stream. In addition initiatives aimed at increasing glass recycling are also underway. It is interesting to note how much activity there is on packaging despite the relatively modest contribution it makes to total life cycle emissions. Perhaps this is because packaging is a highly visible issue whereas transport and energy use in the hospitality sector, while more important, are less tangible.

Glass recycling

Recycling glass has many well known environmental advantages. From the energy and CO_2 perspectives making glass from cullet is a little less energy intensive than making it from raw materials. As mentioned, for every 10% of recycled glass used in the furnace feedstock, 2.5% less energy is required.[179] At present the average recycled content in glass is only around 33%. Note that that this is not the same as the overall glass recycling rate which stands at 44% since some recovered glass is

[175] *Scotch whisky…the original sustainable industry*, Scotch Whisky Association, undated, http://www.scotch-whisky.org.uk/swa/files/EnvironmentBrochure.pdf

[176] This figure is a sum of emissions from beer, wine and whisky calculated in sections 2.1.e, 2.2.d and 2.3.c.

[177] Total glass taken from Glass Technology Services Ltd. *Maximising Cullet Additions in the Glass Container* Industry, Project code: GLA0039, Waste Resources Action Programme, February 2006 www.wrap.org.uk and a figure of 0.183 tonnes carbon/tonne glass based on figures explained in 2.1.e above.

[178] Calculations derived from data provided by the Metal Packaging Manufacturers' Association, Corus Steel and ALFED.

[179] *Energy use in the Glass Container Industry*, Energy Consumption Guide ECG027, the Carbon Trust, UK, March 2005 http://www.thecarbontrust.co.uk/energy/pages/search_results.asp#

used for other applications such as water filtration and fibreglass insulation.[180] By contrast in some European countries the recycled content of green glass can be as high as 90% and for clear around 50-60%.[181]

The recycling rate for the alcohol sector is particularly low. In 2004 only 16% of glass from licensed premises was collected for recycling.[182] The remainder is landfilled.[183] This is despite the fact that various schemes have in the past been initiated. *Bottleback* is one such example. Set up by the BBPA this scheme ran between 1998 and 2000 collecting 70 tonnes of glass a week (3640 tonnes a year) from licensed premises. However, the scheme no longer operates because according to the BBPA[184] of a fall in the value of waste glass, the relatively low cost of landfill and a low route density (a sufficient density needs to be achieved) all of which rendered the scheme commercially unviable.

More recently, WRAP has launched a number of projects aimed at tackling this problem. It has trialled glass collection schemes in Glasgow and Oxford and has also produced a Pub Glass Toolkit giving guidance on establishing collections from licensed premises.

Provisional data from a survey conducted by Databuild and commissioned by WRAP suggest that glass collections from licensed premised increased from around 90,000 tonnes per annum in 2004/5 to 160,000 tonnes in 2005/6.[185] The majority of this glass is collected as mixed colour. However, the higher percentage of clear cullet in commercial glass collections

This is particularly disappointing since glass waste from the hospitality sector contains a higher proportion of clear glass than the UK glass waste stream as a whole (52% clear glass as compared with the UK average of 35%),[186] meaning that from a recycling perspective it is an attractive source of cullet. While green glass makes up 40-50% of the glass waste stream,[187] [188] there is a readier UK market for the scarcer clear glass cullet than. As a result there is a lot of green glass available for recycling for which there is no end market and it ends up being landfilled. landfilled.

Glass lightweighting

One of WRAP's major glass projects is Container Lite. This in essence has two research strands. The first explores the feasibility of lightweighting bottles, that is for reducing their average weight to that achieved by the 'best in class.' The second option (for wine) is to consider the scope for increasing the import of wine in bulk

---

[180] Andy Hartley Senior Environmental Consultant at Glass Technology Services, personal communication, May 2006

[181] Andy Hartley Senior Environmental Consultant at Glass Technology Services, personal communication, May 2006

[182] Note that pubs produce high volumes not only of alcohol bottles but also soft drinks.

[183] *Recycled Glass Market Study & Standards Review – 2004 Update*, Waste Resources Action Programme, May 2004

[184] Andy Tighe, British Beer and Pub Association, personal communication, 2006

[185] Notes from the fifth meeting of the Glass Forum, WRAP, Banbury, 31 October 2006 http://www.wrap.org.uk/downloads/GlassForumMinutesOctober06.5806e7f5.pdf

[186] *An Analysis of the Viability of Reverse Haul within the UK Hospitality Sector*, report written by Oakdene Hollins for the British Beer and Pub Association, London, March 2005

[187] *Recycled Glass Market Study & Standards Review – 2004 Update*, Waste Resources Action Programme, May 2004

[188] Glass Technology Services Ltd. *Maximising Cullet Additions in the Glass Container* Industry, Project code: GLA0039, Waste Resources Action Programme, February 2006

containers, for bottling here in the UK. The latter would help reduce the excess green cullet that we have in the UK waste stream (an issue which is discussed further below).

A survey carried out by the Waste Resources Action Programme found that the average weight of wine bottles varies hugely. While the average bottle weighs just under 500 grams the range can be between 890 and 300 grams .[189]

Clearly the lighter the glass bottle, the less glass (and hence production energy) is needed per given volume of wine. In addition, less transport energy will be required.

WRAP calculates what the CO_2 savings might be if the lightest bottles were used and concludes that that if the average bottle weight changed from 500 grams to 300 grams (a 40% reduction) then packaging related CO_2 would likewise be cut by 40% as would transport and waste CO_2.[190] This is a theoretical improvement and in practice, given the range of countries from which we source our wine, achieving even a fraction of these reductions would be difficult. Were more wine to be imported in bulk and then packaged here in the UK however, the task would be more feasible.

This is where WRAP's Wine Initiative comes in. As highlighted above, a significant volume of wine is already bulk imported in large containers into the UK The advantage of bulk importing is not just that it enables the UK to have control of bottle weights but also – and even more importantly – it means that less energy is required to transport the wine to the UK's shores since only liquid, rather than both liquid and glass is being carried.

On average, one bulk container holds the same volume of liquid as three containers carrying bottles. Once the disposal components of bulk containers are taken into account, for a given volume of wine, transport emissions from bulk imports are about 40% of those which arrive already bottled.[191]

According to an estimate by James Ross Consulting (JRC), the consultancy charged with carrying out this research for WRAP,[192] around 30-40% of all off-sales could be converted to bulk imports, which means that total transport savings of around 18-24% could be attained. Note that these are for off-sales only – the project does not examine the scope for on-sales which account for a further 20% of all wine sales.[193] If the potential for bulk importing these were also included the figure could be higher still.

As for European wines, Italy, Germany and Spain already bulk import some wines into the UK. JRC estimate that around 10-15% of European wine could potentially be bulk imported. More than this would be difficult: most European wine regions have strong traditions, backed by local legislation and there would probably be

[189] James Ross Consulting Ltd, 2005: data prepared for the Waste Resources Action Programme Wine project.
[190] James Ross Consulting / Best Foot Forward 2005/6: data prepared for the Waste Resources Action Programme Wine project
[191] Kevin Williams, James Ross Consulting Ltd, pers.comm April 2006: estimate based on data gathered for WRAP Wine project
[192] Kevin Williams, James Ross Consulting Ltd, pers.comm April 2006: estimate based on data gathered for WRAP Wine project
[193] *A Study into the Interaction of Imported Wine Bottles and the UK's Cullet Supply Project code: GLA0059*, written by Glass Technology Services for WRAP, 31 December 2005

resistance to exporting more in bulk.[194] On the basis of this 10-15% figure, CO_2 savings of 6-9% are thought to be possible.

Estimating the total potential savings is difficult without knowing the split between European and new world transport emissions. If, for the sake of argument, we assume a split 66:34 for the new and old world respectively (this is probably reasonable since the volumes imported are similar), then one could envisage total transport savings of between 24-33%. If wine related overseas stage transport emissions are estimated (see table 29 above) to be 0.11% of the UK's total GHG emissions then this means that bulk importing could reduce the contribution to between 0.08-0.09%.

Once in the UK the wine could be bottled in lighter containers (made from recycled green glass), which would also have the effect of reducing glass manufacture related emissions. Interestingly such a measure might have the effect of increasing the UK's production-related greenhouse gas emissions (since bottle production would take place here rather than overseas) even though on an absolute global scale, CO_2 would be reduced.

According to WRAP's Container Lite report, while the capacity for bottling here in the UK does not currently exist, they believe there is potential exists for expansion.[195]

The WRAP project also looks at the scope for lightweighting whisky and beer bottles. For whisky, it is calculated that reductions of between 27% and 34% are achievable depending on whether UK manufactured whisky bottles only or all whisky bottles used for whisky consumption in the UK were lightweighted. Savings could also be achieved with beer bottles although WRAP does not quantify what these might be.

The WRAP project does not explore the scope for importing spirits (or wine) in bulk. According to Diageo, some spirits are already transported in bulk, sometimes over-strength for over-blending. For example their Scotch whisky is exported in bulk to Korea and then bottled locally. [196]

Other ways of dealing with green cullet

As mentioned above, one of the benefits of bulk wine importing into the UK is that this could help redress the colour imbalance in the UK glass waste stream. Most of this green glass results from our consumption of wine – almost nothing else is packaged in green glass. Since we do not make wine and since no other manufacturers want to use the green glass, we are faced with a problem. As highlighted above, bulk importing wine and bottling it here in the UK would be a very effective way of dealing with the problem since the green cullet could be used to make the wine bottles.

At present, for the very small quantities of green glass that we do make, the cullet incorporation rate is very high at 90%. The cullet that cannot be used is landfilled and while the actual landfilling of glass has no CO_2 attached to it (other than the transport and associated energy that results from landfilling), if the glass cullet can be used to make glass that would otherwise be made from raw materials, then there are

[194] Kevin Williams, James Ross Consulting Ltd, pers.comm April 2006: estimate based on data gathered for WRAP Container Lite project

[195] *A Study into the Interaction of Imported Wine Bottles and the UK's Cullet Supply Project code: GLA0059*, written by Glass Technology Services for WRAP, 31 December 2005

[196] Will Peskett, Diageo, personal communication, May 2006

clearly CO_2 savings to be had. In addition landfilling creates a range of other social and environmental problems.

One way of doing this is to use green glass (made from recycled cullet) where otherwise clear glass (with a lower percentage of cullet inclusion) would have been used. Hence in addition to its work on bulk importing, WRAP has also explored the potential for encouraging people to buy more foods packaged in green glass. The Colourite project, as it is called, examined people's attitudes to different foods packaged in different coloured glass containers. The results make interesting reading. Both at a conscious and unconscious level the research found that people have a variety of views both about the food contained in the glass. For instance for some foods, the green colouring can make people perceive the food (such as milk) as 'off' or 'mouldy' in some way. For other foods and drinks, particularly where green glass is seen as typical for a particular product type, green glass is seen to be acceptable and even desirable.

However on the whole the report concludes that the glass industry tends to overestimate people's ability to notice very slight variations in colour and thus 'over-engineers' its products as regards colour integrity. On the whole people tend to take more note of labels and other features than they do of the colour of the glass.

The Colourite project also examined the technical feasibility of decolourising mixed batches of glass. It found that, with the use of commercially available decolourisers, clear glass of an acceptable quality can be produced cost effectively from feedstock that contains significant proportions of colour-contaminated flint cullet.

Reuse

One option which is sometimes considered is the reuse of bottles. Almost no beer bottles are reused in the UK. This is in marked contrast with other countries; Heineken for example states[197] that in 76% of its markets, beers and soft drinks are distributed predominantly in returnable packaging (of all types, not just glass) while for SAB Miller 61% of all the bottles it uses are returnable.[198]

The environmental merits of returnable bottles are often debated and the issue is complicated by the fact that returnable bottles can be compared not with disposable bottles but also with other forms of packaging including plastic and LDPE 'Tetrabrik' containers. The use of PET containers is technically possible for lager and cider and while beer is rarely sold in plastic bottles here in the UK, it is fairly common for cider.

As regards disposable versus non-disposable *glass* bottles the arguments, put simply, are these: on the one hand, for returnables, less glass production-related energy use is required since the same bottle is used many times. On the other hand, returnables tend to be heavier and more robust than non returnables and so more transport energy is required to move a given volume. Washing and sterilising of the bottles before reuse is also an energy intensive process. At the heart of the debate on reusables versus disposables are the assumptions one makes about the breakage rate for returnables – the number of cycles a given bottle can perform before someone breaks it – and the transport distances involved.

[197] http://www.heinekeninternational.com/pages/article/s2/12230000000050-13660000000072/environmentpolicies.aspx

[198] http://www.sabmiller.com/NR/rdonlyres/64831D80-8AD5-4F02-88C0-C091CAEFC78A/3506/EnvironmentReview2005FINAL.pdf

One study of 25cl beer bottles[199] finds that for breakage rates below 5%, returnable glass bottles are environmentally preferable to non-returnables, even for quite long distribution distances (up to 1000km). But how realistic is a breakage rate of 5%? One US study of many forms of milk packaging cites studies which report reuse rates of between ten and fifty, in other words of between 2% and 10%. By this token 5% is fairly realistic. According to Dairy UK, the body representing the dairy industry, the average milk bottle is reused nine times (a breakage rate of 11%) but can be reused up to 40 times before breaking. [200] Another LCA - this time of beer bottles[201] assumes breakage rates to be much higher, at around 15%. Milk bottles tend to be more robust than beer bottles (even those that are returnable), in addition to which people's behaviour (general level of carefulness and so forth) around milk and around beer is likely to be different.

When considering the reusables versus disposables debate however, it should be remembered that the numbers being considered are very small. At the same time many commercial, economic and trade interests are stacked against reusing systems. The question that needs considering is whether the environmental gains achievable by reuse systems are such that they are worth the effort of altering the status quo – or whether efforts might more usefully directed in other areas, such as emissions in the hospitality sector, or transport (see below) or indeed in reducing absolute alcohol consumption per se, as is discussed in 3.2.

In 2005 the British Beer and Pub Association published a study into the viability of reverse haul within the UK hospitality sector.[202] In essence the study was trying to establish whether reverse hauling (whereby a vehicle drops off an alcohol delivery at a licensed premise and then loads the glass waste onto the now empty vehicle) could be both technically and commercially feasible. The study concluded that reverse hauling is viable on both these counts notwithstanding several obstacles which it identified. Interestingly the study noted that 11% of establishments are responsible for 45% of the glass waste generated by the sector. It estimated that it would be possible to establish collection systems for around 40% of this 11%, which would result in the collection of 18% of total hospitality sector glass waste arisings. Of the 89% of smaller players who collectively generated the remaining 55% of glass waste, it estimated that 62% could be engaged in collection schemes, meaning a saving of 34% of all glass waste from these smaller players. Taken together 52% of all glass waste from the hospitality sector could realistically be collected for recycling. Nothing has happened, however following the publication of this report.

Cans

The calculations in tables 36 and 37 show that cans are less CO_2 intensive than bottles per unit of alcohol drunk. This reflects the reasonably high recycling rates for cans. More recycling would of course reduce emissions further.

---

199 Van Doorsselaer K and Lox F. Estimation of the Energy Needs in Life Cycle Analysis of One-way and Returnable Glass Packaging, Packag. Technol. Sci. 12, 235-239, 1999

200 Dairy UK, news release 27 March 2006

201 Mata T. M. and Costa C. A V. Life Cycle Assessment of Different Reuse Percentages for Glass Beer *Int J LCA* 6 (5) 307 – 319 (2001)

202 *An Analysis of the Viability of Reverse Haul within the UK Hospitality Sector*, report written by Oakdene Hollins for the British Beer and Pub Association, London, March 2005

3.1.d.Transport

Transport has been shown to be the second key CO_2 hotspot in the life cycle of both wine and beer. Alcohol transport accounts for more than a quarter of all alcohol related emissions and for 0.36% of the UK's total greenhouse gas emissions.

Notwithstanding its importance, this research did not find any activities aimed at reducing alcohol related mileage in absolute terms and only a few which focused on improving logistical efficiency, which are discussed below.

As regards absolute transport mileage, the discussions in the sections above all highlighted the fact that imports and exports were growing. They also asked whether consolidation in the brewery sector has had a positive or negative impact on total transport related CO_2 and concluded that it was not possible to make a clear judgement.

Transport and the alcohol industry

It is striking to note how little information the major breweries appear to have or at least publish on transport. Both Scottish & Newcastle and InBev note that they need more information in this area. SAB Miller does not mention transport at all and nor do the other top dominant breweries -Coors, Anheuser-Busch or Heineken,[203] [204] [205] Carlsberg highlights its Eco-driving initiative (in Sweden only) but other than this makes no mention of transport.[206] As regards the main spirits companies, Diageo's Corporate Citizenship Report mentions transport only in the context of lightweighting bottles[207] while Pernod Ricard does not cover the issue at all. [208]

Logistical efficiency

As regards energy efficiency, a current Department for Transport funded project aims to gauge the logistical efficiency of and stimulate improvements in the alcohol industry. The plan is to develop a series of key performance indicators and to assess companies against these indicators. Two surveys of participating drinks industries are being carried out, two years apart, and the efficiency of individual companies are being measured in a range of operational areas. The intention is, that by benchmarking themselves against others, companies will be better able to understand, monitor and improve the efficiency of their energy use.

Another Department for Transport-funded project may also have some relevance to the alcohol sector given its internationalised supply chain structure. The Global Sourcing and Logistics project (LP 0507) examines the trend towards off-shore outsourcing from a 'total cost perspective.' Its four main objectives are to:

1. Gain a better understanding of why and how companies make offshore outsourcing decisions

---

[203] Corporate Accountability Report, SAB Miller, 2005 http://www.sabmiller.com/NR/rdonlyres/64831D80-8AD5-4F02-88C0-C091CAEFC78A/3506/EnvironmentReview2005FINAL.pdf

[204] Anheuser-Busch Environmental Outreach http://www.abenvironment.com/litterrecycling.asp

[205] http://www.heinekeninternational.com/pages/article/S2/sustainability20042005.aspx

[206] Environment Report 2003-4, Carlsberg http://info.carlsberg.com/NR/rdonlyres/ew4kysqhq4475fvwsvspjg2di5zw3lnasi2jcmxyipanjssmtgxi35b7rfpergjma5idg2tr6kmqvb/Environmentalreport2003-2004.pdf

[207] Corporate Citizenship Report, Diageo, 2005 http://www.diageo.com/NR/rdonlyres/58633733-BC4D-4955-9BC0-815A1CF9DF00/0/Diageo2005final.pdf

[208] Pernod Ricard http://www.pernod-ricard.com/

2. Uncover the hidden costs and risks of offshore outsourcing
3. Assess the environmental and infrastructural implications of offshore outsourcing for the UK
4. Develop a model that can support offshore outsourcing decisions, based on a holistic analysis of the implications

It is intended that the main output will be a model to enable companies to make better outsourcing decisions, by providing them with a complete picture of all the costs and risks involved. As a secondary objective the project findings should provide insights for public policy in relation to the impact of global trade on the environment.

At this early stage it is not possible to see how prominently the environmental issues will feature in the final analysis. What is clearly lacking within the DfT, however, is a freight research project which specifically focuses on the environmental implications of concentration in the supply chain.

Rail

Alcohol is well suited to rail transport since it is not highly perishable nor can it be classed as a fast moving good with highly fluctuating demand.

Alcohol is often moved by rail in Europe although data showing the volumes moved are not available. It is hard to know precisely how much travels by rail in the UK since, following rail privatisation, official records of what gets moved where are no longer kept. However it is very unlikely that much alcohol at all is moved in this way.

As regards the supermarkets, Marks and Spencer's European wines are delivered twice a week by rail via the Channel Tunnel directly into its distribution centre in Daventry in Northamptonshire.[209] Once in the UK however, distribution is by road. Tesco has recently received a grant from the Department for Transport and the Scottish Executive to move goods (it does not specify what kind) from the Daventry centre six times a week up to Scotland. Waitrose finds rail to be logistically and economically unviable[210] largely because most of its stores are located in the south of the country where distances are shorter and the rail network more congested. From a reading of their corporate social responsibility reports, Sainsbury's and Somerfield do not appear to move anything by rail while Morrison's makes no mention of transport of any kind at all.

It is not known to what extent the major brewers or wine and spirit companies move goods by rail either here or overseas.

3.1.e. Energy use in pubs and other premises

Improving energy efficiency in the hospitality industry is clearly a major challenge. Around 80% of pubs are run as small businesses and so there will be massive diversity in energy related practices and attitudes. Any savings made by individual businesses will be small relative to the overall size of the sector.

At present the main initiative in place to promote energy efficiency in the hospitality sector, the Hospitable Climates programme, is both small in scale and voluntary. Set

[209] http://www2.marksandspencer.com/thecompany/ourcommitmenttosociety/environment/transport.shtml
[210] Corporate Social Responsibility Report 2004, Waitrose http://www.waitrose.com/pdfs/CSR_Report_2004.pdf

up by the Hotel and Catering International Management Association and the Carbon Trust, Hospitable Climates offers energy efficiency advice and benchmarking tools to the hotels, pubs, restaurants, leisure centres and other such premises. It has also signed up to the voluntary Energy Efficiency Agreement, the goal being to reduce carbon emissions resulting from the sector's use of electricity and fossil fuels. Specifically the target is to reduce carbon emissions by 15% below 1999 levels by the end of the year 2010. The agreement aims to recruit 7,500 establishments (predominantly hotels) as members to ensure that they meet this target. Hospitable Climates estimates 130387 tonnes carbon (equivalent to 0.07% of the UK's GHG emissions) have already been saved since the scheme started in 2000. Since the scope of HC is the entire hospitality industry - from pubs to restaurants to hotels to leisure centres - it is difficult to know how significant a saving this is in terms of the industry's total carbon emissions. Note that the estimate for hospitality related energy use given in 2.5.b above considers only alcohol related emissions.

The existing 5000 members - and even the hoped-for 7500 – represent a tiny fraction of the 88000 thousand fully licensed premises in the UK, such as pubs and hotels and the additional 11000 premises with restricted or other forms of license.[211] While the Hospitable Climates initiative represents a necessary start, it is difficult to see how major CO_2 reductions might be achieved from this sector while the scheme remains voluntary and the numbers small.

In some ways it seems that consumption stage energy use is suffering from a kind of double whammy. On the other hand, as the brewing and beer industry point out, the growth in alcohol consumption at home has led to a rise in the energy intensity of beer because of the increase in sales of packaged beer. [212] On the other hand, the pubs, restaurants and other hospitality-related infrastructure is still there. In essence we now have a double infrastructure – one serving all the pubs, clubs and restaurants for the times when we drink out of the home and another serving the off sales market.

3.2. OPTIONS FOR EMISSIONS REDUCTION: BEHAVIOURAL CHANGE

The main concern of existing measures to reduce emissions from the alcohol sector relate to energy efficiency. What these measures do not address is consumer demand: what and how much we drink and how and where we drink it. As regards government policy on alcohol and its environmental impact this is the responsibility of Defra. Defra's role here, however, is as an industry sponsor (within the Food and Drink division) and as the controlling body behind the Climate Change Agreements (Climate Change Division). It does not concern itself with the environmental impact of the alcohol sector along its *whole* life cycle.

This section attempts to explore the connection between how *much* and *how* we consume, and the implications for greenhouse gas emissions. More specifically, it examines whether there might be a connection between health/societal and environmental goals. In essence what is discussed here is this: if we were to consume at levels more in line with current health recommendations, what might the effect be on the UK's greenhouse gas emissions?

---

[211] *Statistical Handbook 2004*, British Beer and Pub Association, 2004
[212] *Twenty years of environmental improvement in the British brewing industry 1976-1996*, British Beer and Pub Association, http://www.beerandpub.com/content.asp?id_Content=942

To date within government there has been little practical attempt to develop such connections as do exist between the goals of improving public health and those of improving environmental sustainability, notwithstanding the recommendations of the Curry report[213] and the subsequent response of government in its *Strategy for Sustainable Farming and Food*.[214]

This section suggests that for alcohol consumption there are indeed synergies between health and environmental goals which could be exploited. It is possible that linked efforts between departments to tackle the issue in conjunction may yield more benefits than individual measures alone and this holds true for other areas of food consumption too. At this stage however it is too early to say what course of action might be possible or desirable.

It is of course entirely valid to point out that if people choose not to change their drinking behaviour 'for their own good' – their health and wellbeing – then they certainly will not do so for environmental reasons. On the other hand personal choice is shaped to a large extent by the context within which these choices are made. Concerted efforts to change this context have not yet been made and as such the real potential for effecting change remains unexplored.

The following sections begin by summarising government health guidelines for drinking, before going on to look at how we actually drink. A short discussion of government health policy on alcohol follows after which an environmental perspective is offered. This section does not address *how* people's behaviour might be changed. This is a massive subject in itself and one that it is hoped will be tackled in another FCRN discussion paper.

3.2.a. How much should we drink?

Since 1995 the Department of Health has recommended a maximum limit of 2-3 units a day for women and 3-4 units for men. Two alcohol free days are also advised after periods of heavy drinking. Some groups, such as pregnant women and those engaging in potentially dangerous activities (such as operating heavy machinery), should drink less or nothing at all. A unit of alcohol contains around 8g or 10 ml of pure alcohol and, roughly speaking, equates to half a pint of medium strength beer or a single pub measure of spirits. One small 125 ml glass of wine is also assumed to represent a unit but in fact normally contains around 1.5 units or more, added to which glasses can often hold considerably more than 125ml.

These daily upper limits replace the previous weekly guidelines of 14 units for women and 21 for men. The rationale behind this change is to underscore the fact that drinking nothing all week and then downing the whole weekly allowance in one or two sessions at the weekend is unacceptable both from a health and from a societal perspective. It should be noted that the previous weekly limits are still relevant; the two guidelines work in combination. Those drinking regularly at the upper limits of daily consumption – 21 units a week for women and 28 units for men - and therefore exceeding the previous weekly guidelines are borderline heavy drinkers.

There has been much media focus on the potential health benefits of alcohol. In fact the gain from (moderate) alcohol consumption tends to be limited to a relatively small

---

[213] *Farming and Food: a sustainable future*, Report of the Policy Commission on the Future of Farming and Food January 2002

[214] *Strategy for Sustainable Farming and Food* - Facing the Future, Defra, December 2002

section of the population[215] – men over 45 years of age and post menopausal women[216] and the quantities of alcohol required to reap these benefits are small.

Since the benefits from alcohol tend to be limited to a fairly specific section of the population, the Government funded Alcohol Education and Research Council has actually explored the possibility of introducing age-related guidelines for alcohol consumption, based on the health gains or risks associated with consumption at particular ages.[217] It finds that for men and women aged 16-34, there is no benefit from alcohol at all from drinking and indeed those at lowest risk (defined in terms of mortality) are non-drinkers. Presumably this low risk reflects the avoided risk of alcohol-induced accidents and other mishaps. The AERC goes on to suggest that a recommended limit could be defined as levels of consumption that allow a 5% increase in risk above the lowest risk. For women aged 16-24 this translates into 8 units a week, increasing to 11.5 units between 45-54 and to 20 units a week for women aged over 85. For men the recommended limits are 5 units a week at ages 16-24 increasing to 21 units between 45 and 54 and up to 34 units a week over the age of 85.

Clearly these recommendations are in direct contrast to the way we actually drink. Drinking levels tend to be most extreme among younger age groups and most particularly young men – that is, while they are less likely to drink on a daily basis than older men, when they do drink they are more likely to drink a lot. [218]

3.2.b. The Government's strategy on alcohol

In 2004 the Strategy Unit published its Alcohol Harm Reduction Policy,[219] which set out how government proposes to tackle the harm caused by alcohol in the UK. The focus is overwhelmingly on tackling hazardous drinking practices - underage drinking, binge drinking and chronic over-consumption. Binge drinking is defined as drinking more than twice the recommended daily maximum in one day and chronic drinking as sustained drinking at very high levels which are likely to lead to long term damage.

The measures set out in the Strategy document (and built upon in the subsequent *Choosing Health White Paper* [220]) emphasise the need for public information, education and awareness, better services provision for those at risk, measures to tackle anti-social behaviour and better enforcement regarding under-age sales, drink driving and so forth.

The strategy document is emphatic that the 'vast majority of people enjoy alcohol without causing harm to themselves or to others – indeed they can also gain some health and social benefits from moderate use.[221] It does not dwell on the rise in *average* consumption levels over recent years nor does it make explicit the

---

[215] Public health: the demon drink *Nature*, Volume 428 April 8 2004 Number 6983 p598
[216] White, I. R. , Altmann, D. R. & Nanchahal, K. *Br. Med. J.* **325**, 191–197 (2002).
[217] '*Optimal' levels of alcohol consumption for men and women at different ages*, Alcohol Insight 15, Alcohol Education and Research Council, London, October 2002
[218] *Statistics on alcohol England 2004*, DH/ONS, 2004. http://www.dh.gov.uk/PublicationsAndStatistics/Statistics/StatisticalWorkAreas/StatisticalPublicHealth/StatisticalPublicHealthArticle/fs/en?CONTENT_ID=4095318&chk=vg4R24
[219] *Alcohol Harm Reduction Strategy for England*, Strategy Unit, 2004 http://www.strategy.gov.uk/downloads/su/alcohol/index.htm
[220] *Choosing Health: making healthier choices easier*, Department of Health 2004
[221] *Alcohol Harm Reduction Strategy for England*, Strategy Unit, 2004 http://www.strategy.gov.uk/downloads/su/alcohol/index.htm

connection between the rise in average drinking levels and the incidence of binge drinking and chronic over-consumption.

This, in the view of the some observers [222] [223] is a mistake. According to the Alcohol Education Research Centre,

'consumption is a useful proxy measure of cultural changes. The risk of becoming a hazardous drinker depends, to some extent, upon the "wetness" of the drinking culture to which the person belongs. The drinking habits of a person living in an environment where drink is cheap, freely available and where heavier drinking is the norm, will tend to be more hazardous than those of a person living in a relatively dry environment. There is not a perfect relationship but populations with lower mean consumption levels tend to have lower proportions of heavy drinkers. …Since mean alcohol consumption provides a proxy measure of the "wetness" of a society then one objective might be to ensure that per capita consumption does not increase dramatically.

At the most basic level, a rise in average consumption levels means a rise in the contribution of alcohol to the UK's greenhouse gas emissions from what it would have been had drinking patterns remained constant or in decline. Although improvements in energy efficiency mean that alcohol production-related emissions *per litre* of alcohol consumed are likely to have been higher in 1969 when average annual consumption was only 5.1 litres per head (although for transport the picture is less clear),[224] it is also the case that since we now have this improved technology, the combination of improved technology and reduced consumption would have yielded a double dividend. Clearly this has not been achieved given the rise in our consumption. Put simply, 5 litres a head at today's level of energy efficiency would mean that GHG emissions from alcohol would be half what they are now.

3.2.c. How much do we actually drink and what are the implications for greenhouse gas emissions?

So how much do we actually drink? Section one gave some broad headline indicators; 9.1 litres of pure alcohol per person per year (2003) or 11.2 litres if the under fifteens are excluded.[225] To be realistic, it is probably necessary to include underage drinkers since of the 20-27% of children aged 11-15 who do drink, average weekly consumption is 10.5 units.

Using the 9.1 litres a day figure, this equates to 910 units of alcohol a year, or 2.5 units per person a day. Assuming adult consumption only (sixteen or over) this figure goes up to an even higher 3 units per person per day.

This figure is much higher than the alcohol consumption figures provided by the Office for National Statistics (ONS) which report average weekly consumption for

---

[222] *Alcohol policy: the need for evidence based policy: The response by the Alcohol Education and Research Council to the Consultation on the National Alcohol Harm Reduction Strategy*, Alcohol Education and Research Council 2003, http://www.strategy.gov.uk/downloads/su/alcohol/submissions/hay2.pdf

[223] Alcohol Harm Reduction Strategy for England: response by the Institute of Alcohol Studies, 2004 http://www.ias.org.uk/iaspapers/ahrs_july04.pdf .

[224] On the one hand distances would have been shorter but on the other hand vehicles would have been less fuel efficient

[225] *Statistical Handbook 2004*, British Beer and Pub Association, 2004

men to be 17 units and women 7.6 units a week,[226] the average being 12.3. This works out at about 1.76 units a day, clearly much lower than the figure given above. However the ONS figures are derived from a drinking survey and underreporting is a notorious feature of all surveys involving food and drink. According to Andrew Neill of the Institute of Alcohol Studies only 60% of alcohol consumed tends to be reported in which case the three units a day figure for over sixteens is about right.[227]

In fact, alcohol consumption are per *drinking* person is likely to be higher still, since 4.5 million people (a little under 10% of the 48 million adults in the UK)[228] do not, for religious or other reasons, drink anything at all.

If these 4.5 million teetotal adults are subtracted from the total number of adults in the UK, then average per capita alcohol consumption levels rises from 11.2 litres of alcohol per adult a year to 12.35 litres per drinking adult per year, or 3.38 units on average, a day. This is 24 units a week – over the recommended weekly maximum for men. Subtracting non drinkers from the population as a whole (including those aged 15 and under) yields a slightly lower figure of 9.8 units a week or 2.7 units a day.

By these calculations everyone in the UK is, on average, a moderate to heavy drinker.

This situation is patently not the case and clearly average figures mask a huge variation in drinking habits. A proportion of the population does not drink at all, as has already been noted. Many people drink very little. A considerable proportion of the alcohol consumed in the UK is drunk by a relatively small number of people.

According to the ONS/DH statistics,[229] 27% of adult men (for these purposes aged 16 or over), or 13.44 million drink 22 or more units a week. For women aged sixteen or over the figure is 17% or 8.16 million.[230]

As an experiment the following paragraphs explore what would happen to overall alcohol consumption if we all consumed at levels in keeping with government recommendations. It should be stressed that Government has in fact set no targets for a reduction in drinking, nor has it specified dates by which time it would aim to see a certain proportion of heavy or chronic over drinking reduced. It has, however, indicated habits or patterns of drinking that are undesirable and therefore it is legitimate to explore what the impact would be were such undesirable and damaging patterns eliminated.

The calculations focus on the adult population; a fuller exploration would also need to modify the approach to include under sixteens.

As stated, 27% of men and 17% women drink too much. But there is wide variation in the degree of over-consumption, as these tables show.

---

[226] *Statistics on alcohol England 2004*, DH/ONS, 2004. http://www.dh.gov.uk/PublicationsAndStatistics/Statistics/StatisticalWorkAreas/StatisticalPublicHealth/StatisticalPublicHealthArticle/fs/en?CONTENT_ID=4095318&chk=vg4R24
[227] Andrew McNeill, personal communication, October 2005
[228] *Statistical Handbook 2004*, British Beer and Pub Association, 2004 using 2002 ONS data.
[229] *Statistics on alcohol England 2004*, DH/ONS, 2004. http://www.dh.gov.uk/PublicationsAndStatistics/Statistics/StatisticalWorkAreas/StatisticalPublicHealth/StatisticalPublicHealthArticle/fs/en?CONTENT_ID=4095318&chk=vg4R24
[230] This assumes a rough fifty:fifty split between men and women in the population. In fact the ratio is nearer 95:100 men:women but the figure is good enough to be getting on with

Table 35: Alcohol intakes – men

Alcohol intake – weekly units - men	% of population
22-35 units	14
36-50 units	6
51+ units	7
Total	**27**

Table 36: Alcohol intakes – women

Alcohol intake – weekly units - women	% of population
15-25 units	10
26-35 units	3
36 + units	3
Total	**17***

Source: *Drinking: Adults' Behaviour and Knowledge in 2004*, ONS
http://www.dh.gov.uk/assetRoot/04/09/79/01/04097901.pdf

**NB: the ONS statistics give a figure of 17% due to rounding although the figures above add up only to 16%.*

From these figures it is clear that most people who over-drink do so by only a glass or so extra a day. This said, these weekly averages will also hide bouts of binge drinking.

The figures do not show whether those men who drink, say, between 22 and 35 units a week drink at the lower or the upper end of the spectrum and so to make the calculation simpler, it is assumed that that most of them tend to drink at levels more or less half way in between. So for men consuming between 22-35 units a week, it is assumed here that most drink 28 units a week. For women consuming between 15 and 25, it is assumed that they drink 20 units. And so on.

In order to calculate how alcohol consumption might decline if we kept to government recommendations is necessary to multiply the weekly number of units over-consumed by the number of people consuming them, multiply that figure by 52 (to obtain the annual sum), convert the units into litres of pure alcohol and then deduct that figure from the total volume of alcohol consumed. The number of people who do not drink will also need to be deducted from the total population. Appendix 4, which shows details of this calculation, suggests that the total quantity of alcohol consumed (and therefore produced) would decline by about 14%. It also brings average daily drinking levels (using Customs & Excise data) for those of the adult population who do drink down to 9.5 litres – nearly two litres less than the norm. Once non drinking adults are excluded the average per capita levels work out at 10.5 litres, down from 12.1 litres per drinking adult per annum.

A sizeable number of people also drinks more than the *daily* recommended limits – in other words they binge drink. In the ONS survey 39% of men and 23% of women binge-drank on at least one day during the week in record. If one assumes that this 39% of men and 23% of women binge drink at least once a fortnight (probably a cautious estimate) the total reduction in alcohol consumption would increase from 14% to around 18%. This figure does not take into account the fact that the weekly over-consumption figures might need to be adjusted down (since those units are already included in the weekly reporting of alcohol over-consumption as set out in tables 39 and 40). One might therefore argue that the 18% reduction is an overestimate. On the other hand, people who drink within the weekly guidelines also binge drink at times and the first over-drinking calculations do not take these units into account. As such the 18% is, in our view, fairly reasonable.

A similar approach could be adopted for alcohol consumption amongst the under fifteen age group.

The underreporting factor should also be borne in mind. It may be that the extent of over-drinking is higher than the reported over-drinking figures suggest. If so drinking in line with government guidelines would lead to a reduction in overall alcohol consumption of more than 18%.

A reduction in alcohol consumption is not impossible to achieve. The statistics show that this is already happening in most European countries and there are very recent signs that it may be happening here too.[231] It may of course be too simplistic to make a straightforward correlation between alcohol consumption and alcohol production levels. The alcohol industry is international in its reach and a decline in consumption here in the UK might simply lead to greater marketing efforts overseas. However it is also true to say that as there is nevertheless *some* relationship between consumption and production, as current trends in declining UK beer production and their fairly straightforward correlation with declining beer consumption demonstrate.

It should also be noted that measures to deal with the consequences of alcohol misuse such as medical attention, police action and the emergency services will also have an environmental impact. These impacts have not been quantified here. Doing so is a legitimate approach however and one that has recently been adopted by, for example Defra in its publication of its recent Food Miles report[232].

Finally, there is the 'rebound' effect to consider. If people chose to drink less alcohol they may end up drinking more soft drinks instead; or, instead of going to the pub they might decide to use their saved cash on a trip to the cinema or the shops. All these alternative activities consume energy, perhaps more than that embodied in the foregone alcoholic drink. Rebound consumption is a very real possibility and one that needs to be considered not just in the context of alcoholic drinks but in all areas of consumption. If people were to choose not to fly abroad on holiday, for example, they may spend that money on home improvements for example, or electronic equipment – again, all with an energy and emissions 'cost.'

In short, for almost every area of consumption it is possible to argue that 'the alternative might be even worse.' The risk of rebound consumption is not an argument for doing nothing. On the contrary it shows that measures to reduce public consumption of particular goods and services need to be situated in and form part of an overall policy context which seeks to reduce consumption in all areas of life. To date, such policy focus as exists on consumption emphasises the need to 'consume differently.' It shies away from the more contentious need to 'consume less,' but it is hard to see how the 60% to 80% cut in overall emissions are to be achieved unless we fundamentally reassess not just *what* we consume, but *how much*.

---

231 *Statistical Handbook 2006*, British Beer and Pub, 2006 note that this book was published just as this paper was nearing completion so it has not been possible to incorporate new data.
232 *The Validity of Food Miles as an Indicator of Sustainable Development*, report prepared by AEA Technology for Defra, July 2005

PART FOUR

4.1. DISCUSSION AND CONCLUSIONS

This paper has tried to show that the contribution made by the alcohol sector to the UK's greenhouse gases is significant at nearly 1.5% of the UK's emissions total. For reasons articulated in the report this is likely to be an underestimate.

The differences between the alcohol types are slight and easily accountable for by the margins of error within the (partial) data that has been obtained. Moreover various factors, such as the packaging type (for beer) and the place of consumption will alter the relative balance.

Overall the consumption stage – by which we mean energy use in beer, pubs, restaurants, clubs and hotels – emerges as a key hotspot in the life cycle of alcohol in general. For the beer the this stage is clearly the most significant, followed by transport and then packaging. For wine, unsurprisingly, the transport stage shows the highest relative impacts followed by the agricultural and consumption stages. For spirits, impacts are very evenly distributed along the supply chain.

While when speaking of alcohol in general packaging is less significant than may sometimes be supposed this is a general conclusion and for packaged (especially bottled) beers its relative importance is certainly much greater.

Trends both in how we produce and how we consume alcohol point towards greater energy demand and hence higher emissions. These trends include the alcohol industry's and its increasingly internationalised supply structure, which means more transport; the growing demand for canned and bottled (rather than draught) beer, meaning more packaging; and the preference for drinks to be served very cold, meaning more refrigeration. On the other hand improved energy efficiency in malting, brewing, distilling and refrigeration technology could offset these trends. How the two 'sides' balance out is at present uncertain.

To date, considerable energy efficiency improvements have been achieved in the malting, brewing and distilling sectors[233] and this could suggest that overall emissions are likely to decline. The problem is, however, that the contribution these sectors make to overall alcohol related greenhouse gas emissions is relatively small. While any savings that can be made are of course useful they will not help cut emissions where the impacts are greatest – at the transport and consumption stages. And it is with these areas where emissions could grow.

Global and (within the UK) national-scale supply chains are now the norm for many categories of food and drink and in the context of today's internationalised economic climate it seems very difficult to see how the growth in transport might be tackled. Tackled it needs to be however if any serious emissions reductions are to be achieved. A present there is little sign that government is making any serious attempts to do so.

Hospitality related emissions are the other main area of concern. There are a very large number of licensed and partially licensed premises in the UK and most of these premises are independently owned or at least independently managed. This

[233] There may be improvements at the wine production stage too but these were not explored.

presents a major challenge since policy cannot simply be made at headquarters and rolled out to all premises - there is no single HQ. The Hospitable Climates initiative is a useful step in the right direction but needs to be expanded substantially if real cuts in emissions are to be achieved. It is hoped too that industry-led Food Industry Sustainability Strategy will develop strategies to improve efficiency in this sector but at present there is little sign of action. In short, a clear government policy focus on the hospitality sector is urgently needed.

What is government doing to tackle alcohol related emissions? So far activity appears to be limited largely to the Climate Change Agreements, which affect the malting, brewing and distilling sectors, and to a transport efficiency project being run by the Department for Transport, both of which have been highlighted above. While the CCAs have indeed been helpful they have no influence whatsoever on those areas which are together responsible for the bulk of alcohol related emissions, freight and the hospitality sector. The freight efficiency project is voluntary and focuses only on distribution within the UK.

It is recommended here that further work be undertaken in the areas of transport and hospitality both to assess more accurately their impacts but, more importantly, to examine ways in which these impacts could be reduced.

This paper has also argued that in addition to measures to improve energy efficiency a complementary approach would be to take steps to get people to drink less. A reduction in heavy drinking (based on weekly guidelines) and in binge drinking (based on daily guidelines) could reduce alcohol consumption by 18%. This, all other things remaining the would bring emissions down to 1.2% of the UK total. If alcohol consumption declined to the levels seen in the late 1960s and early 1970s, the contribution would be lower still at 0.9% of the UK's greenhouse gas total.

Reductions such as these would save far more energy and reduce emissions far more substantially than anything that the Climate Change Agreements alone would achieve. It is also important to emphasise that today's drinking levels are not immutable. Trends can go one way but they can also go the other. In most other European levels alcohol consumption is on the decline. What, crucially, appears to be lacking in the UK is a sense that the levels of consumption by 'normal' people (whoever they are) as opposed to heavy or binge drinkers need also to be reduced. A reduction in alcohol consumption needs to form part of an overall government policy which aims not just to get people to 'consume differently;' but also and more fundamentally, to consume less.

Finally there is little or no recognition that alcohol over-consumption carries with it environmental, as well as health burdens. This is a connection that needs to be made more specific.

Acknowledgements

Many thanks indeed for all the help given in the preparation of this paper to the following: Andy Tighe (British Beer and Pub Association), Iain Loe (Campaign for Real Ale), David Long (British Beer and Pub Association), Andy Hartley (Glass Technology Services Ltd), Scotch Whisky Association, Gin and Vodka Association, Wine and Spirit Trade Association, Kevin Williams (James Ross Consulting), Adrian Williams (Cranfield University) Peter Hanson (Home Grown Cereals Authority), Peter Darby (East Malling Research Centre), Bill Handley (Home Grown Cereals Authority), Tim Jackson (University of Surrey), Almudena Hospido (University of Surrey), Llorenç Milà i Canals (University of Surrey), Ivor Murrell (Maltsters'

Association of Great Britain), Andrew Bright (Scottish & Newcastle), David Grant (SAB Miller), Richard Heathcote (Bulmer Cider), Corus Steel, Alfed, Tony Woods (Metal Packaging Manufacturers' Association), Roger Worth (Department for Transport), Andrew McNeill (Institute of Alcohol Studies), the Portman Group, Andrew Garnett , Christina Gazulla (ESCI, Spain), Christina Galitsky (Lawrence Berkeley National Laboratory, California), Roland Clift (University of Surrey), Alfonso Aranda (University of Zaragoza, Spain), Nicola Jenkin (Waste Resources Action Programme), Will Peskett (Diageo), Kath Dalmeny, Sustain.