The Environmental Performance of the European Brewing Sector

KWA

Campden BRI

The Brewers of Europe

KWA Bedrijfsadviseurs B.V.

KWA Bedrijfsadviseurs B.V. is a business consultancy company specialised in energy, water, soil, environment, health, safety and quality. KWA has a lot of experience in the brewing sector. In 2000, 2004 and 2008 KWA carried out the World Wide energy benchmark for the brewing sector. They advise (mainly Dutch) brewers on energy, water and cost reduction and they developed a software tool for brewing companies to save energy and water.

Campden BRI

Campden BRI is the UK's largest independent membership-based organisation carrying out research and development for the food and drinks industry worldwide. It is committed to providing industry with the research, technical and advisory services needed to ensure product safety and quality, process efficiency and product and process innovation.

A study commissioned by The Brewers of Europe

The Brewers of Europe is the trade confederation for the brewing sector in Europe and its voice towards the European institutions and international organisations. Founded in 1958, it has 28 members, comprising 24 national brewer associations from the EU, Croatia, Norway, Switzerland and Turkey.

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Foreword

Foreword by the President of The Brewers of Europe

I am delighted to welcome The Brewers of Europe's first ever report on 'The Environmental Performance of the European Brewing Sector'. For thousands of years Europe's brewers have relied on the highest quality ingredients of **natural origin** to brew beer. This report highlights the steps we are taking to protect these important resources, improve our environmental performance and ensure that brewers can continue to produce high quality beers in the many years to come.

In particular, this pan-European study shines a light on the important work that brewers across Europe are undertaking to decrease water use, effluent output and CO_2 emissions. The report highlights that brewers **are using fewer natural resources, producing less waste and consistently reusing secondary materials such as brewers' grains**.

We are proud to launch the report during the European Commission's **Green Week 2012**, whose theme is 'Every Drop Counts - The Water Challenge' in order to highlight a 4.5% decrease achieved across the sector in water use per litre of beer produced. As water makes up over 90% of beer, brewers must ensure an excellent supply and take steps to safeguard this resource.

Our **efficiency efforts** do not stop with water. Brewers have found innovative ways to save resources while producing the same traditional product. The report notes that energy use decreased by 3.8% and CO_2 emissions decreased by 7.1%.

In November 2011, we welcomed European Commission President Barroso to our annual 'Beer Serves Europe' event. He stressed that the Commission looks to our sector as a "key partner in pushing forward our growth agenda towards more **smart, inclusive and sustainable Europe**." I am very pleased to report that we are taking the necessary steps to help ensure a sustainable future.

This first report of its kind will be a platform for the brewing sector's work in this area over the years and decades to come. We will continue to innovate to ensure a sustainable future and to be environmentally responsible, also by doing what citizens have done for years **'reducing, reusing, recycling'**. Through best practice sharing, innovation and hard work, the great steps taken can be built upon further.

Alberto da Ponte
President of The Brewers of Europe

About the Study

About the Study

Introduction

Brewers depend highly on the environment for resources, both in quality and in quantity. A high level of environmental awareness is not only important to ensure that sufficient resources of high quality are available, both now and in the future, but also to meet the general public's environmental expectations. Therefore, The Brewers of Europe commissioned a study to describe the environmental performance of the brewing sector in Europe.

This report presents the changes and trends in the environmental performance in the key areas over the years 2008 to 2010. This quantitative data is supported and illustrated by a selection of prominent case studies.

Environmental performance

The environmental performance is examined by addressing the following key areas: water, energy and greenhouse gases, secondary products, waste and wastewater, and packaging.

Water. Breweries use water in the product but it is also used for other purposes such as cleaning. The volume of water used per hectolitre of product produced is an important indicator of environmental performance for the beverage sector.

Energy and Greenhouse Gases. Breweries use electricity and fuels to produce beer. There is a need to consider not only overall energy usage, but also the successful application of "green energy" such as energy from renewable sources. Greenhouse Gases are measured in carbon equivalents resulting from the energy used by the brewery.

Secondary Products. These are the outputs from the brewery other than beer. Secondary products include brewers' grains, brewers' yeast, undersize malt particles, excess protein and brewers' hops. These may then be used in other sectors e.g. as cattle feed.

Waste and Wastewater. Waste is made up of outputs from the brewing products which are not beer and are not used as secondary products. Wastewater is the water which is not beer and not usable for other purposes.

Packaging. Breweries use various materials for packaging. For example, bottles, cans and kegs. The type of packaging varies from country to country, including whether packaging is recycled or reused..

Relevant national contexts

The varying brewing landscape across Europe means that it is difficult to compare countries. Such variations include:

- The mix of beverage containers (e.g. returnable glass bottles require further heat & water consumption, PET impacts on electricity etc.);
- The mix of beverages (e.g. water & soft drinks are not brewed, fermented or filtered, so leading to lower specific consumption figures etc.);
- The restrictions of usage of ingredients (e.g. the German Purity law);
- The size of breweries (e.g. countries with a greater proportion of larger breweries may benefit from greater economies of scale);
- The climate influences requirements re. heating and cooling;
- Technology status (modern equipment can save energy, but may require very significant investments).

Therefore, it is necessary to relate the specific consumption to those factors mentioned and to also consider the spread of performances.

Executive Summary

Executive Summary

European brewers place a lot of emphasis on improving the sector's environmental impact. They highly depend on the environment for resources, both in quality and in quantity. A high level of environmental awareness is not only important to ensure that sufficient resources of good quality are available, now and in the future, but also to meet the general public's environmental expectations. To this end, The Brewers of Europe commissioned a study to quantify key performance indicators and also to look for trends over the period 2008 to 2010. Data on environmental performance was obtained from 156 breweries, representing 62% of the total beer production volume (in 2010) in the 30 European countries approached (EU-27 plus Norway, Switzerland and Turkey). Responses involved quantitative data plus narrative case studies from small breweries to national initiatives.

Key messages on the environmental performance of the European brewing sector

Over the period 2008-2010:

Water

- 4.5% less water was used per hectolitre of beer produced, resulting in an equal decrease of wastewater output.

Energy and Greenhouse Gases

- 3.8% less energy was used for the production of each hectolitre of beer.
- Influence on the climate, measured as the combined Scope One and Two CO2 emissions, was reduced by a substantial 7.1%.

Secondary Products

- Overall biogas collected from secondary products and wastewater treatment increased by 7.0%.
- Certain secondary products, such as brewers' grains and brewers' yeast, were used as animal feed. Contributions to animal feed have remained significant at 15.5 kg for every hectolitre of beer.

Waste and Wastewater

- The production of wastewater was reduced by 6.9% to 2.7 hl/hl beer produced.
- Biogas production increased by 7.0% to 92 m^3/1,000 hl of beer produced.

Packaging

- The use of returnable glass bottles has decreased by 2% with a switch to non returnable (including recyclable) bottles, cans, kegs and tank beer.

The trends in the report and a selection of case studies show the considerable steps taken by the brewing sector in Europe to improve environmental performance.

Table 1: Key performance indicators of European brewing sector over the time period 2008 - 2010

	Units	2008	2009	2010	change
Total Production in EU-27 + 3	Million hl	419	401	399	- 4.8 %
Production represented (including other beverages)	%	64.1	64.8	64.8	+ 0.7 %
Production represented which is not beer ‡	%	2.3	2.8	2.6	+ 0.3 %
Water					
Specific Water Consumption	hl/hl†	4.4	4.4	4.2	- 4.5 %
Wastewater Production	hl/hl†	2.9	2.8	2.7	- 6.9 %
Energy and Greenhouse Gases					
Total direct energy	MJ/hl†	121.4	119.5	116.8	- 3.8 %
Renewable energy	%	5.0	4.8	5.3	+ 0.3 %
Carbon emissions from brewery (Scope One)	kg/hl†	4.9	4.7	4.6	- 6.1 %
Carbon emissions electricity usage (Scope Two)	kg/hl†	3.5	3.3	3.2	- 8.6 %
Total carbon emissions (Scope One and Two)	kg/hl†	8.4	8.0	7.8	- 7.1 %
Secondary Products					
Animal Feed	kg/hl†	15.6	15.2	15.5	- 0.6 %
Biogas Production	m^3/1,000 hl†	86	83	92	+7.0 %

* Based on 2010 data when compared to 2008.

† Per hectolitre of beer produced

‡ In some production facilities beer is not the only beverage that is being produced. Data which was gathered represented all beverage production. This table shows what was represented by other beverages so that the significance of beer production can be seen.

01 Water

Water

- Reduction in specific water use was 4.5% over the three year timeframe of this study.
- On average, 4.2 litres of water was used to make one litre of beer. The range for aggregated national data was from 2.5 to 6.4 litres of water for one litre of beer.

1.1 Introduction

Water is the most important raw material used by the brewing sector. On average, water makes up about 92% of beer, with ethanol and extract from raw materials making up the remaining 8%. Water is also used for cleaning, in steam production, as cooling water and in heat exchangers for temperature control. Water is equally a resource to local communities, hence why the brewing sector has been successfully striving to minimise the amount of water which is required to make beer.

WATER RECOVERY

SABMiller's Ursus breweries in Romania reduced water consumption by 15%. This was achieved by recovering water throughout the brewing process to be used in cleaning processes that do not require high quality water.

1.2 Water Sources

Water comes from three main sources: groundwater, surface water and city (municipal) water. Groundwater is pumped from a private well or borehole directly into the brewery. Surface water is sourced from rivers and lakes. Finally, city water comes from a well or surface water source that supplies the local area. Figure 1.1 summarises the data for this study and shows the sources of water used for brewing in Europe in 2010. Most water is sourced from well/borehole water (54%) or city water (42%) while 4% is sourced from surface water.

The source of water can have an impact on the overall water use of a brewery since, depending on the source, additional treatments may be needed.

WATER SAVINGS

AB InBev Europe made a combined 4.1% reduction in water use in the period 2009-2010. This was attributed to recovery of water for secondary use and optimisation of cleaning processes, while maintaining quality standards. Investments were also made in new equipment to use less water.

The brewery also recognised that employee participation is important; employees at all levels are made aware of water usage. All employees were invited to take part in discussions on water issues, such as the "Best Water Saving Ideas" contest launched on World Water Day in March 2010. 356 ideas were collected to help reduce water consumption. The winning idea in Leuven brewery saves 47,000 m^3 of water a year by narrowing the diameter of nozzles.

AB InBev has also partnered with the United Nations' World Environment Day to focus on water conservation and watershed problems. This involves working with governments, NGOs, communities and employees on water issues.

Sources of Brewing Water in 2010

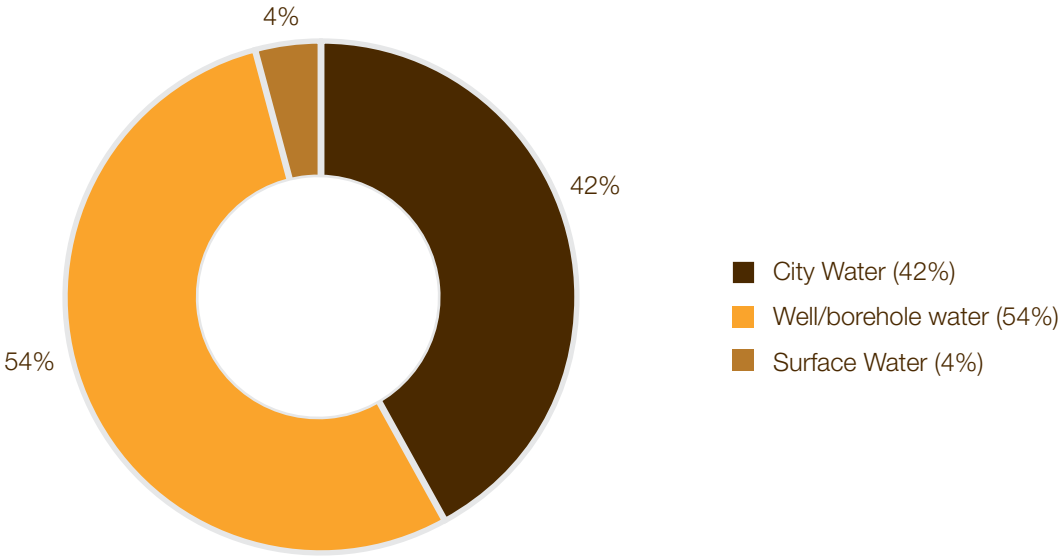


Figure 1.1: Sources of Brewing Water for the Brewing Sector in Europe in 2010. Data gathered from the questionnaire.

1.3 Water Consumption

Figure 1.1. shows combined data for water consumption for breweries in Europe (expressed as percent change in hl of water/hl of beer produced, compared against 2008 data). Data was gathered from the questionnaire.

There is an ongoing trend in the reduction of water used by breweries. The specific water consumption has dropped by 4.5% over the timeframe of this study from 2008 to 2010 (figure 1.2). Specific water consumption aggregated from national production data varied from 2.5 to 6.4 hl/hl with an average of 4.2 hl/hl in 2010.

WATER SAVINGS

Heineken Spain's new brewery in Seville was built in 2008. The brewery produces 30% more than the old brewery while using 30% less water and 25% less electric and thermal energy. By staying close to the city deliveries could still be made while travelling a short distance but without causing any congestion.

WATER USE BENCHMARK

The Deutscher Brauer-Bund (German Brewers Association) has made several publications to its members on minimising environmental impact of water use. One publication involved a national survey which benchmarked water use and costs throughout Germany. Such benchmarking enables breweries to compare their performance with others and identify areas for improvement.

Specific Water Consumption by Breweries in Europe

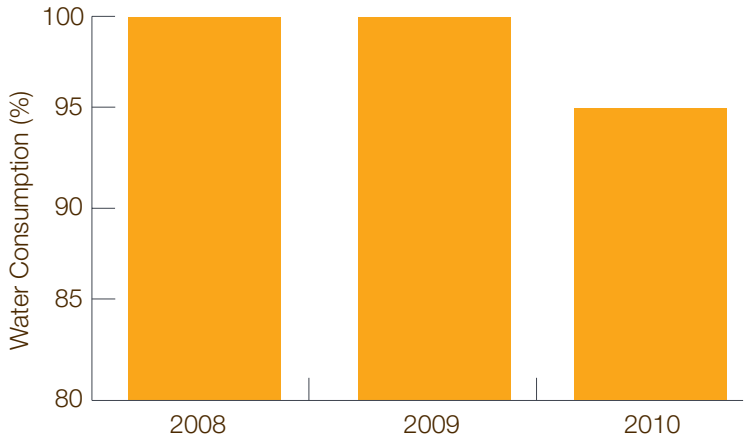


Figure 1.2: Combined water consumption (hl/hl) for breweries in Europe expressed as a percentage compared to 2008 reference data. Data gathered from the questionnaire.

1.4 Factors affecting Water Use

Overall water consumption in breweries is affected by several processes: for example, the amount of water used for cleaning brewing equipment and in the packaging process. Some water is lost as it is contained in secondary products which leave the brewery. Pasteurisation can use significant amounts of water. However, significant improvements have been made in the pasteurisation process, where some breweries have moved from tunnel pasteurisation to flash pasteurisation which uses less water. Water consumption in breweries has been decreased through optimising water usage and the introduction of new technology in all of the above processes.

WATER SOURCE

Brouwerij Lindemans sourced an average of 80 m^3 of its water requirements a year from rain water in 2008, 2009 and 2010. A plan which is expected to re-use up to 1,000 m^3 of rain water a year has been implemented, saving 4.3% of water usage from other sources.

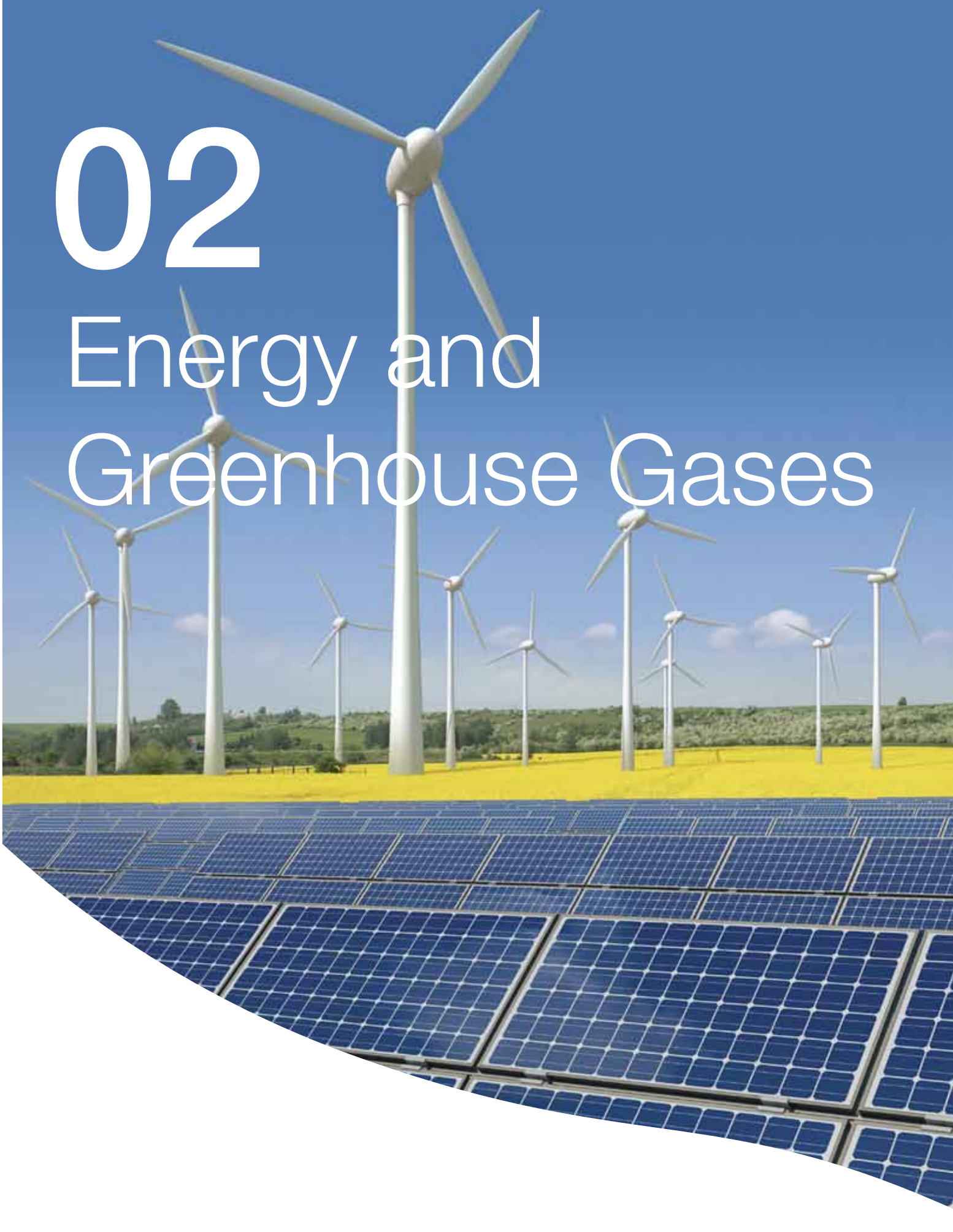
It is important to note that water consumption will also be significantly affected by, for example:

- The packaging mix since this affects washing requirements; in general, single-trip glass bottles require less water usage than returnable bottles. However, this phenomenon could not be distilled from the data of this study.
- Incoming poor quality water will result in decreased efficiency and increased water losses from water treatment plants.

WATER SAVING TECHNOLOGY

Warsteiner Brewery made important water savings in the bottling process. It installed a Liquid Efficiency Spraying System (LESS) which slows down pumps used on the bottling line for cleaning; cleaning takes place during periods when the conveyor belt is temporarily stopped. Water usage was significantly lowered and savings were made.

02 Energy and Greenhouse Gases



2. Energy and Greenhouse Gases

- The total energy required to brew one litre of beer dropped by 3.8% to 116.8 MJ/hl (calculated on an LCV basis) over the three year timeframe of this study.
- Total energy consumed by aggregated national data ranges from 70.6 MJ/hl to 234.1 MJ/hl.
- Renewable energy accounts for 5.3% of total energy consumption in Europe in 2010. Breweries can produce biogas from wastewater and secondary products (such as the brewers' grains).
- There was a 7.1% drop in Greenhouse Gas (GHG) emissions per hl of beer from 2008-2010. In some European countries the opportunity for GHG reduction and renewable energy use is enhanced by the opportunity to trade Green Certificates.

2.1 Introduction

Energy use is an important issue for the brewing sector and is one of the most significant indicators for environmental performance. It consists of electrical and thermal energy which together make up total energy use. By improving energy efficiency both CO_2 emissions and the general environmental impact of brewing are reduced. Energy is used for operating brewing equipment, temperature control, non-brewing appliances and internal logistics. The brewing sector is constantly striving to reduce energy consumption and also to move towards using renewable energy to run breweries. Some breweries now obtain 100% of their energy and fuel from renewable sources.

2.2 Sources of Energy

The brewing sector receives most of its energy from non-renewable sources but there is an increasing reliance on renewable energy; the data in this survey shows that renewable energy use increased from 5.0% in 2008 to 5.3% in 2010.

Common renewable energy sources are wind, solar, hydro and biofuels. Some biofuels are produced on site in breweries which makes breweries more self-sustainable while turning potential wastes into valuable products. Breweries can also take wastes from other industries to be used as energy sources, which have an enhanced positive effect on the environment.

LEAN UTILITIES

Carlsberg breweries in Western Europe have implemented a programme which minimises the energy of the equipment used. The programme, called "Lean Utilities", uses efficiency measures such as frequency at which machines are used during low-season and setting personal targets for utility consumption on the work floor. A 5% reduction in energy consumption has been achieved since 2009. The programme is expected to encourage more significant reductions in energy consumption as it is rolled out across the rest of Europe and best practice techniques are shared among the group.

Looking beyond the breweries, Carlsberg has taken further steps to reduce its environmental impact. A warehouse in Denmark had relied on a dehumidifying system to prevent labels getting wet and to stop bottle caps from rusting. Originally the dehumidifying system operated by drying the air inside the warehouse. However, a new solution was implemented whereby fresh air from outside the warehouse would be drawn in to replace the humid air inside the warehouse. The project was a massive success, drastically reducing CO_2 emissions and costs.

2.3 Energy Consumption

In 2010, the average specific energy consumption of breweries was 116.8 MJ/hl (calculated on a LCV basis). This is a decrease of 3.8% since 2008 (figure 2.1).

Specific Energy Consumption by Breweries in Europe

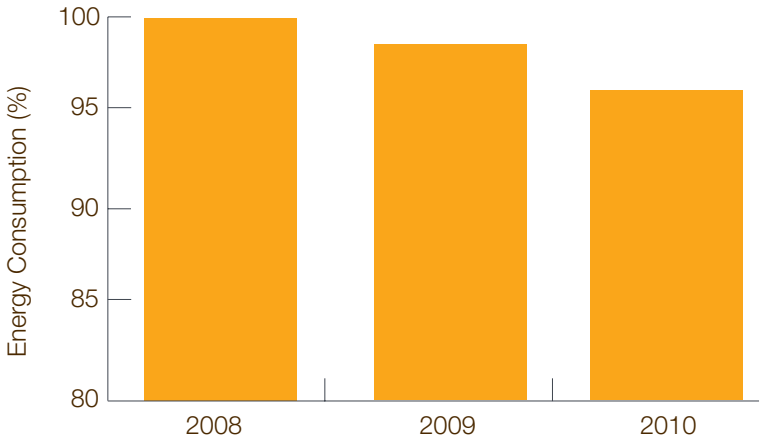


Figure 2.1: Combined total energy consumption (MJ/hl) for breweries in Europe expressed as a percentage compared to 2008 reference data. Data gathered from the questionnaire.

Combined Heat and Power (CHP) installations generated 9.6% of the total electricity consumption in 2010. Data on the amount of biogas which is used by the CHPs is not available. CHP in the brewing sector is a promising prospect, with some breweries already moving to this source of power.

Another example is the use of heat recovery systems in breweries. These systems operate by capturing the heat from the steam produced by boiling operations; the heat can then be reused for other processes. Another example is the use of "wort-stripping" technology which increases the speed of removal of unwanted compounds during wort boiling which can result in the boiling process taking half the time, with reduced energy input and reduced evaporation.

Further reductions in energy use come from improving refrigeration systems in breweries; these are responsible for most of the electrical energy consumption in a brewery. Having recognised this, the brewing sector has focused on improving the efficiency of their cooling systems. This has been achieved through pre-cooling of liquids that need to be cooled down and the use of more efficient refrigerants. Ammonia is a refrigerant growing in popularity in breweries due to its high efficiency and the fact that it is not a greenhouse gas.

EDUCATING EMPLOYEES

Heineken Italia recognised the significance of educating employees in the importance of environmental responsibility. An example of this was a handbook which was distributed to staff with information and advice on how to improve energy efficiency throughout the brewery. The handbook also contained information on other processes such as wastewater treatment plants and CO_2 recovery. Educating the employees helps them understand why any changes are being made within the brewery and encourages input for further improvements.

It is difficult to quantify the amount of renewable energy that is used since it is complicated by the different situations in different countries. In some countries the use of Green Certificates is a suitable measure. However others, for example Norway, do not employ Green Certificates because the majority of their electricity is from renewable sources.

Benchmarking of energy use can also be used to identify areas for improvement. There are breweries across Europe which perform regular benchmarks, usually yearly, reflecting their intent to improve the energy efficiency of their processes.

RECTIFYING COLUMN

Alpirsbacher Klosterbrau installed a rectifying column on the wort boiler. Rectifying columns are usually associated with the distilling process and increase the speed at which unwanted compounds are removed. The rectifying column is compatible with almost any boiler. Total energy savings were 80% in the boiling process and 25% across the brewery. Evaporation loss was also reduced to 2%, resulting in savings in water.

RENEWABLE ENERGY

Clemens Härle brewery from Leutkirch produces all of its beer from 100% renewable energy. It was the first brewery in Germany to make all its beer from green energy. Achieving this level of environmental performance has been a gradual process carried out over 15 years. The first step was producing a document detailing a lifecycle assessment of the brewery, which could then be used to formulate a plan to move towards the ambitious goal.

Following a life cycle assessment, the decision to use biodiesel as fuel for its twelve trucks and four cars was made. The biodiesel was all to be produced in Germany and did not compete with food crops. The largest investment the brewery made was the installation of a combustion plant which used wood chips to provide all the brewery's heat. The combustion plant also provides heat for five surrounding businesses. Photovoltaic panels have also been installed on the plant, which make up 12% of electricity requirements. The remaining electricity requirements are purchased from renewable sources including hydro, solar and wind.

In total the brewery has removed 900 tonnes of CO_2 emissions per year. The brewery's business plan has been honoured with rewards such as the German Sustainability Award and the German Solar Prize.

ENERGY SAVINGS

Shepherd Neame brewery has taken some novel approaches to reduce its environmental impact. The first approach was the purchase of a modern boiling system. It was the first brewery to install the system which has resulted in shorter operating times, less frequent cleaning and more consistent beer. Energy has been reduced by 47% for every hectolitre produced. Water consumption also dropped, as has the effluent load in wastewater.

The second novel approach taken by Shepherd Neame was providing a free bicycle to any employee who lives within four miles of the brewery. This resulted in a reduction of the carbon footprint of the employees.

In addition a flash pasteuriser was installed in 2009 which decreased the heating requirements by 18%.

In the future changes are going to be made to the refrigeration system by using ammonia as a coolant. Ammonia is a very efficient coolant and has a Global Warming Potential rating of zero.

2.4 Greenhouse Gases

The combustion of fuel results in the emission of greenhouse gases (GHGs). CO_2 equivalents are calculated from energy use to enable comparability of data. Two scopes are used to measure CO_2 equivalents. Scope One is made up of all the greenhouse gas emissions caused directly by a brewery such as burning fuel, excluding refrigerant losses in this study. Scope Two is the emissions which result from electricity purchased by the brewery. The data from this study has shown that the brewing sector has steadily been decreasing CO_2 emissions (Figure 2.2) This has been achieved through optimizing processes to use less fuel and electricity and through using more environmentally friendly sources of energy.

Scope Two is highly influenced by the trade in Green Certificates and the specific CO_2 emission of the national electricity grid. Both Scope One and Scope Two have been reduced in Europe. The data from this study shows that there has been a reduction of 7.1% of CO_2 equivalents (Scope One and Two combined) for every litre of beer produced from 2008-2010.

BEST AVAILABLE TECHNIQUES (BAT)

The brewing sector in Spain has produced a comprehensive document of Best Available Techniques (BATs). The brewing sector and the Ministry of Environment combined their expertise to design the most accurate and up-to-date BATs possible. In addition to providing guidance on best techniques, the document also makes the point that sustainable management is important to be included in any economic growth plan and should be a factor in any decisions going forward. Further benefits of BAT documents are that they can be used as common reference resources to make realistic commitments to environmental targets in the future.

Scope One and Two CO_2 Emissions

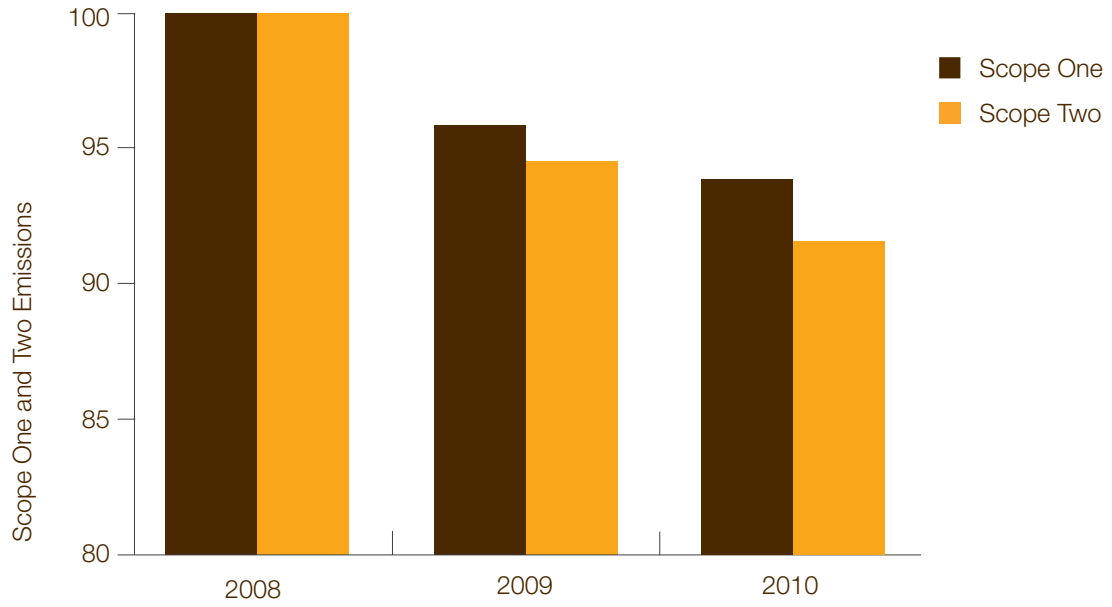


Figure 2.2: Change in Scope One and Two CO_2 equivalents (kg/hl) for breweries in Europe measured as a percentage compared to 2008 reference data. Data gathered from the questionnaire.

SUSTAINABILITY COMMITMENTS

The British Beer & Pub Association (BBPA) represents the brewing sector in the UK. One of the BBPA's most important objectives is supporting the reduction of energy and water use in the brewery. This has been carried out since the 1970s. In 2010 the BBPA published a report entitled Brewing Green - Our Commitment Towards A Sustainable Future for Britain's Beer which has 10 focus points relating to sustainability. The report also contains benchmarking trends since 1990, targets for up to 2020 and has case studies from some of the best performing breweries.

NATIONAL PROGRAM BELGIUM

The Belgian breweries through the 'Belgian Brewers' federation are also member of the Belgian Federation of the Food Industry (Fevia). Through Fevia Belgian breweries take part in two energy agreements at regional level: "Benchmarking Convenant Energie Vlaanderen" (Flanders) and "Accord de Branche Wallonie" (Wallonia). In addition, the 'Belgian Brewers', in collaboration with Fevia, carried out a benchmarking project of energy use (gas and electricity) in the breweries situated in Flanders. Fifteen member-breweries participated, of which one received a free energy audit that helped the brewery in question to improve its energy efficiency. Furthermore, the results of the benchmarking project, together with solutions for how to improve the energy efficiency, were presented to all breweries.

03 Secondary Products

3. Secondary Products

- Data from the breweries which participated in this study showed that 15.5 kg of brewers' grains was used as animal feed for every hectolitre of beer produced in 2010.
- By utilising potential waste as secondary products breweries can minimise waste going to landfill.

3.1 Introduction

Although beer is the main product, there are also several other valuable products (called secondary products) which may be produced in the brewing process. The brewing sector has a long tradition of looking for the most valuable applications of such products; this reduces waste, has benefits to local markets and limits the waste produced by breweries to primarily wastewater and packaging waste.

3.2 Secondary Product Sources

The most important sources of secondary products are brewers' grains, brewers' yeast and surplus beer.

Brewers' grains comprise the materials which remain after starch has been solubilised from grains

Brewers' yeast is used for fermenting beer and during the fermentation process the yeast multiplies several times. A portion of this is reused in subsequent fermentations but large amounts remain available for other uses.

Surplus beer is produced from unavoidable beer losses throughout the brewing process; this is still a valuable product and may be used to enhance animal feed.

Other, less significant, sources of secondary products are brewers' hops and trub (proteins) which are formed at different stages of brewing.

ENERGY SAVINGS

Plzenský Prazdroj brewery took a holistic approach to its environmental impact in 2010. It used evaporated liquid CO_2 for cooling glycol and water. This combined with shortening and insulating steam pipes has led to an 8% reduction in energy consumption per hl of beer produced. Emissions have also reduced by light weighting packaging and making use of rail transport to distribute its beer.

The brewery also collaborated with a local University to create a tool for making best use of its secondary products. It is currently being used for the Plzeský Prazdroj brewery and if successful will provide a blueprint from which other breweries can work.

3.3 Increasing the Value of Brewing

The largest volume of secondary products from brewing is brewers' grains (Figure 3.1), which are usually used as animal feed. Other secondary products such as brewers' yeast, feed beer, brewers' hops and filter aids may also be used in animal feed. Brewers' yeast and feed beer are highly nutritional making them excellent enhancers for animal feed.

Brewer's Grains used as Animal Feed

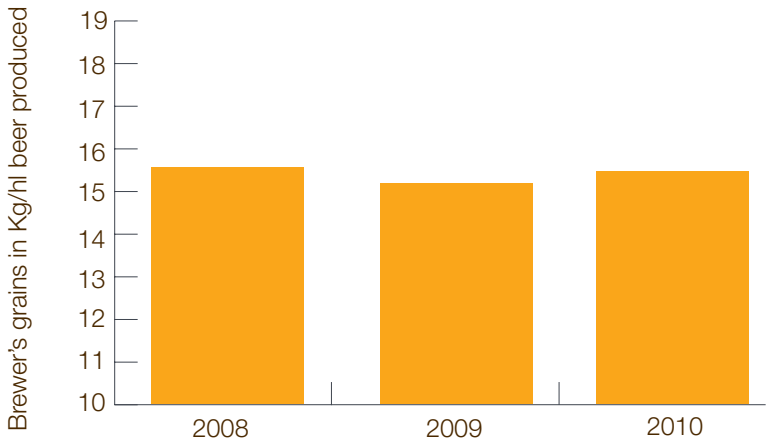


Figure 3.1. Brewers' grains provided by breweries which have been used as animal feed. Values are measured in kg/hl of beer produced. Data gathered from questionnaire.

Biogas from wastewater using anaerobic digesters is a more recent development. Anaerobic digesters improve the quality of wastewater leaving the brewery, and the biogas produced can be used in Combined Heat and Power (CHP) boilers on site, or can be sold, or used to produce green energy for the brewery.

Biomass may be produced from solid waste streams from breweries. In some cases brewers' grains are used in boilers to power the brewery, providing a renewable energy source.

Brewers' grains and brewers' yeast can also be used as soil improvers, enriching the nutrients in the soil.

Brewers' grains have equally been used as an additional ingredient in bread, enzyme production, ferulic acid production, paper, bricks and to make fuel grade ethanol. It depends on what is economically and geographically most suitable for individual breweries.

Brewer's yeast has several possible uses as well as in animal feed; it has also been used to produce human food in the form of yeast extract spreads or may be used in distilleries.

The fermentation process produces CO_2 gas which can be collected and used to carbonate beer or can be provided to soft drinks and sparkling water companies. Liquefied CO_2 can also be used for cooling purposes in the brewery.

Brewers' hops and trub may be part of brewers' grains.

There is the possibility of using certain filter aids that can be recovered and reused which reduces the amount of spent filter aids.

3.4 Alternative to Secondary Products

Any product stream which it is not possible to use in any secondary products such as label pulps or waste packaging may be recycled. If it is not possible to recycle them then breweries may use waste incineration (with or without heat recovery).

The result of all the efforts to minimise waste has resulted in some breweries committing to zero waste to landfill.

04 Waste and Wastewater

4. Waste and Wastewater

- The production of wastewater in Europe was reduced by 6.9% to 2.7 hl/hl beer produced in the period 2008-2010.
- Wastewater produced as aggregated national data ranges from 1.1 hl/hl to 6.0 hl/hl.
- Anaerobic digestion has created over 23.6 million m^3 of biogas per year in Europe (2010).
- Biogas production increased by 7.0% to 92 m^3/1,000 hl of beer produced in the period 2008-2010.

4.1 Introduction

All the water which is not contained in packaged beer or in secondary products and which is not lost by evaporation will be wastewater. This has the potential to pollute and hence is a high priority for breweries. Some breweries reduce their polluting potential by treating their wastewater on site in their own wastewater treatment plants (WWTP). Others pay to have it treated by third parties, either at a communal or a private WWTP. In the breweries participating in this study all wastewater is treated and there is no wastewater ending up in the environment untreated.

The source of water used and the packaging mix (e.g. single-trip compared to multi-trip packages) will affect wastewater quantity and quality. There is a large variation in the quality of wastewater.

BIOGAS

AB InBev has invested in wastewater treatment plants throughout Europe. In 2010, 61% of wastewater from the brewing process in Europe was treated in AB InBev's own Bio-Treatment Systems on the site of breweries. It consists of an anaerobic stage which produces biogas which is collected and used in heat and electricity production. In 2010, 4 million m^3 of biogas was collected.

Mahou-San Miguel Group in Spain has focused on its Cleaning in Place (CIP) and is also optimising heat exchangers to reduce water and energy consumption. An average 1.5 million m^3 of biogas was produced in the wastewater treatment plant over 2008, 2009 and 2010 and this helped to achieve 11.7% of the brewery's energy demands as renewable energy.

4.2 Volume

In 2010, for every one litre of beer that was produced an average of 2.7 litres of wastewater was produced. This is a reduction of 5.9% from 2008 (Figure 4.1).

The amount of water used varies from brewery to brewery since individual brewing sites have characteristics that may significantly affect water consumption. For example, if the incoming water is high in suspended solids then the filtration processes in the water treatment plant will require more frequent regeneration processes and this consumes more water. Also, breweries using returnable bottles must wash and clean bottles for reuse which uses more water. However, this phenomenon could not be distilled from the data of this study.

Wastewater Production by Breweries in Europe

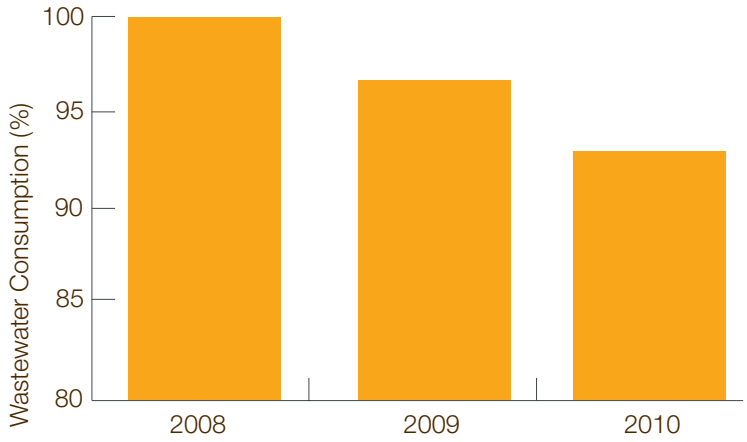


Figure 4.1: Combined wastewater production (hl/hl) for breweries in Europe expressed as a percentage compared to 2008 reference data. Data gathered from the questionnaire.

4.3 Legislation

Brewers pay for the water which is used for the brewing process. They also pay for treating the water after it has been used. Wastewater is treated in compliance with the Water Framework Directive (WFD) (2000/60/EC) and the Urban Water Directive (91/271/EEC). The WFD aims for all water bodies to reach at least good status by 2015 and follows a "polluter pays" policy, while the Urban Water Directive provides more specific guidelines for industries.

4.4 Minimising Environmental Impact

Brewers take several approaches to minimise the environmental impact of wastewater. For example, they take the necessary measures to avoid brewers' grain and yeast being mixed up with wastewater. Although these methods improve the quality of water leaving the brewery, further treatment is applied at wastewater treatment plants (WWTP).

4.5 Wastewater Treatment Plants (WWTP)

Although expensive to install and run, breweries are commonly installing their own WWTP. There are many different types of WWTP which perform at different standards. The number of treatment processes makes it complicated for breweries to decide which is the most appropriate to install for their requirements; it is common for breweries to use more than one type of treatment to get the best quality wastewater.

Certain types of wastewater treatment plants provide additional benefits such as the production of biogas, which can be used at the brewery or can be sold. The treated water may also be recycled so it may be used in non brewing processes, such as for cleaning

ANAEROBIC TREATMENT

The Deutscher Brauer-Bund (German Brewers Association) compared wastewater with effluent charges between provinces. They published a guide entitled "Anaerobic Sewage Treatment Plants in the Brewery" which encourages the use of anaerobic wastewater treatment. Brewery wastewater is said to be the most suitable for anaerobic treatment.

REDUCTION OF WASTEWATER TREATMENT PLANT (WWTP) LOAD

Heineken's Czech brewery Krusovice has a Wastewater Treatment Plant (WWTP) on site with both aerobic and anaerobic treatment and the collected biogas provides 10% of its thermal capacity. In addition, to make processes within the brewery more environmentally friendly action has been taken to reduce the load on the WWTP by raising extract efficiency, lowering the amount of waste yeast discharged to wastewater and decreasing the amount of chemicals used for cleaning. Projects are ongoing to further reduce the wastewater load by recycling caustic and by reconstructing Cleaning in Place (CIP) stations.

Ottakringer brewery in Vienna focused on CIP optimisation allowing the chemicals to be reduced in the effluent wastewater without significant investment. Furthermore, by controlling wastewater from the fermentation, storage and the brewhouse, peaks in pH were reduced making it easier to treat the wastewater.

MEMBRANE BIO REACTOR (MBR) TECHNOLOGY

Batemans brewery in Wainfleet, UK realised it was necessary to upgrade the wastewater treatment plant. It had the option of upgrading their previous Moving Bed Bio Reactor (MBBR) with a more modern system or installing an entire new treatment plant, the Membrane Bio Reactor (MBR). This is an aerobic process which filters effluent through a membrane on which microorganisms are immobilised, thus combining two different types of wastewater treatment. At the time of installation it was a unique form of wastewater treatment for a brewery. Following installation of the MBR, there was a 98% reduction in Chemical Oxygen Demand (COD) in the wastewater. The water is so clean that it can be used for some non-brewing processes within the plant.

Brouwerij der Trappisten van Westmalle installed a new Membrane Bio Reactor (MBR) in 2011. The MBR replaced the older biological treatment plant. Cleaner wastewater will be achieved, with the possibility of water recycling. Sludge from treatment plants which was used as land improver is now sent to a biogas production plant.

WASTE WATER TREATMENT PLANTS (WWTP) RENOVATION

Carlsberg Poland's Okocim brewery has had its own wastewater treatment plant since 1960 to treat its brewery wastewater and also municipal water. Following increased production the brewery required a higher throughput in its wastewater treatment plant so a three year project was implemented which involved a complete overhaul of the treatment plant. The result was a plant which could process 10,000 m^3 of wastewater a day. The project was honoured by the Polish Ecological Chamber.

In Serbia, Carlsberg installed a state-of-the-art wastewater treatment plant at its Celarevo brewery which previously did not have one. In addition to treating water on site, water consumption was reduced by 9.2% and biogas was produced which could be used as an energy source in the brewery. Furthermore, the biogas reduces the CO_2 emissions from the brewery.

Bergenbier brewery completed a project in 2010 which increased the possible throughput of the wastewater tenfold. This allowed all wastewater on site to be treated. Biogas is now also collected and makes up 10% of the fuel required by the brewery.

05 Packaging

5. Packaging

- Packaging varies significantly between countries.
- There is a decrease of 2% for returnable bottles and an increase of one way bottles. The other types of packaging used did not change significantly over the three year timeframe of this study.
- The case studies collected in this survey show that breweries are striving to reduce their environmental impact by switching to, for example, lightweight bottles, PET bottles (which has a smaller carbon footprint) and plastic kegs (which saves on return logistics, cleaning and cleaning equipment).

5.1 Introduction

Packaging is essential to the brewing sector to provide safe and fresh delivery of beer to consumers. In recent years there has been a move to reduce the amount of materials in packaging, i.e. light-weighting; for example by minimising the amount of glass used in glass bottles. There is a balance between reducing the weight of packaging/recycled content to reduce environmental impact and ensuring product safety and minimal waste due to breakages.

The data from this study showed that there is a variation in packaging materials and volumes (Figure 5.1); this is a reflection on consumer preference, culture, climate and the geographical area where the beer is being consumed. All packaging materials which are used are recyclable and some are reusable. The materials most commonly used are steel, glass, aluminium and the plastic polyethylene terephthalate (PET). Package volumes vary from 0.25L-1.0l for most packaging formats. However, a pub/restaurant may purchase beer in kegs from 20l to 60l. Every country has a different approach to packaging for serving beer. However, the challenges each country faces are still largely the same in minimising the environmental impact of packaging. The main focus areas are in using reusable packaging, recycling, light weighting and increasing the proportion of recycled materials in newly made packaging.

The packaging mix in a given region is also affected by other drivers, such as:

- Product appeal and marketability that has the package as a major factor.
- Customer expectations regarding the beer product. For example, plastic beer bottles are much more acceptable in some countries than others.
- Regional legislation; for example packaging taxes and deposit schemes.

DEPOSIT SYSTEM

In Denmark a deposit system for beverage packaging has been put in place at the initiative of Danish brewers due to a voluntary agreement. Under this system a deposit is paid for every beverage container which is purchased. The deposit rate is either 1 DKK, 1.5 DKK or 3 DKK depending on the size of the packaging. The deposit may then be claimed back when the packaging is returned to a redemption centre. The breweries pay a small collection fee for each packaging that is collected.

The result of using this system in Denmark is that nearly 100% of refillable bottles (both glass and PET) are collected for refilling and 89% of all one-way packaging (metal, glass and PET) is collected for recycling.

There is a myriad of packaging collection systems throughout Europe, each taking account of the specificities in a given market, all meeting and often exceeding the recycling and recovery targets set in the European legislation.

5.2 Packaging Materials

Packaging used by European Breweries

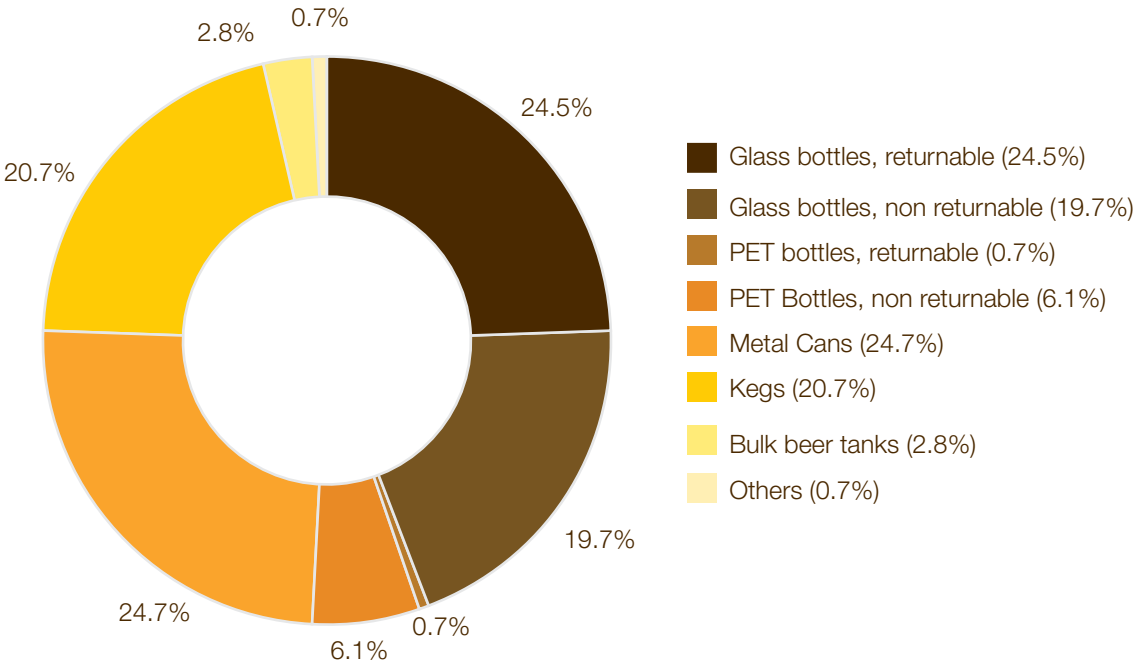


Figure 5.1: The breakdown of packaging materials used by the breweries included in this study in 2010. Data gathered from the questionnaire.

5.2.1 Glass bottles

Some countries predominately use reusable bottles while others may use single trip bottles and, of course, a combination of both is usually available. Reusable bottles have the benefit of reducing the manufacturing required as each bottle can be used multiple times. But they require heavier bottles for durability, collection systems to send bottles back for filling and the bottles must be more thoroughly cleaned before reuse. On the other hand single trip bottles require more energy intensive manufacturing. The decision on which bottle type to use may be more dependent on geography and the (legal) system already in place. For breweries involved in this study returnable glass bottles accounted for 24.5% of the volume of beer packaged in 2010 while non-returnable glass bottles accounted for 19.7% of beer packaged in 2010 (Figure 5.1).

5.2.2 Metal Cans

Cans are usually made from aluminium due to its light weight and ease of recycling. They may also be made from steel. For breweries involved in this study metal cans, both aluminium and steel, accounted for 24.7% of the volume of beer packaged in 2010 (Figure 5.1).

PET

Martens brewery in Belgium installed a bottling line capable of filling up to 80,000 PET bottles an hour. This produced a smaller carbon footprint (since PET bottles only weigh 22.4g) and also had benefits through the entire supply chain.

5.2.3 Polyethylene terephthalate (PET)

PET is a relative newcomer to the beer sector. It is both very light in weight yet durable and easily recyclable. However, the PET bottles are not always accepted by the consumers. For breweries involved in this study PET (returnable and non-returnable combined) accounted for 6.8% of beer packaged in 2010 (Figure 5.1).

5.2.4 Kegs

Draught beer has the best ratio of weight to beer volume. Kegs are most commonly made of stainless steel but there are also some made from aluminium or PET. Metal kegs are capable of multi-trips while PET kegs are single-trip, but are attractive due to their low weight. For breweries involved in this study metal kegs accounted for about 21% of the volume of beer packaged in 2010 (Figure 5.1).

PLASTIC KEGS

Plastic kegs are intended for single use dispensing and subsequently to be recycled. This saves on return logistics, cleaning and cleaning equipment for kegs. Storage is also easier as the kegs can be kept in a flat-pack pre-form and then the final moulding can be blown on site just before filling; this reduces transport costs.

5.2.5 Bulk/Tank beer

Beer may leave a brewery in large tanks. There are several reasons for this. Firstly, there are pubs in Europe that have a beer tank system instead of kegs. A beer tank has a few advantages; for example, there are no changes (as there are with beer in kegs) and the delivery of beer is easier. Secondly, some breweries send beer for packaging on other sites. Thirdly, large volumes of exports are more conveniently transported in bulk volumes. In our survey bulk/tank beer represented 2.8% of beer packaged in 2010 (Figure 5.1).

5.3 Minimising Environmental Impact

The environmental impact of packaging in the European brewing sector has been reduced through reusing, recycling and other methods.

For example, light weighting of glass bottles has reduced the environmental impact of beer packaging and has been implemented extensively across the brewing industry. Light weighting has combined benefits of both producing more packaging from fewer materials and also reducing the weight of packaging of beer for transport.

ENVIRONMENTALLY FRIENDLY PACKAGING

The brewing sector in the UK has worked with the Waste & Resource Action Programme (WRAP) towards more environmentally friendly packaging. Breweries working with WRAP have been able to reduce the amount of bottles ending up as waste by 31,800 tonnes. Reductions in weight of 14,000 tonnes were also achieved.

Increasing the proportion of recycled materials in packaging has also been implemented. This has the benefit of reducing the amount of raw materials which need to be extracted and also reducing materials going to waste.

5.4 Legislation

Recycling is encouraged in every country, driven both locally and by the European Union, which has set minimum targets for recovery and recycling of packaging and packaging waste. The targets have been laid down in the European Parliament and Council Directive 94/62/EC.

The Directive has been well adopted across the EU with no countries currently falling outside the targets. However, some new member countries have been allowed derogations as they have had less time to comply.

LIGHT WEIGHTING

At Diageo light weighting was extended to bottle caps that seal their glass bottles. By reducing the weight of material in their bottle caps from 2.1 g to 2.0 g it is estimated that 100 tonnes of steel will be saved annually.

RECYCLING AND LIGHT WEIGHTING

Mahou-San Miguel Group encourages recycling of packaging among their suppliers. For example, a partnership with chemical suppliers has resulted in the chemicals being delivered in recyclable packaging. Also, specific agreements have been made so that waste bottles must be accepted by glass companies to achieve high recycling rates. Primary packaging and secondary packaging have both been light weighted. The use of plastic pallets rather than wooden has been adopted; these are lighter, more durable and recyclable.

Conclusions

Conclusions

This first ever study on the environmental performance of the European brewing sector collected quantitative data and key performance indicators, supported by case studies, from national brewers associations and 156 breweries representing 28 countries and 62% of the total beer production volume in Europe.

The key results are that over the period 2008-2010:

- The amount of water used per hectolitre of beer has decreased by 4.5%, with a corresponding decrease in wastewater produced.
- There has been a 3.8% reduction in the amount of energy used per hectolitre of beer produced.
- Greenhouse gas emissions (measured as combined scope 1 and scope 2 emissions) have been reduced by a substantial 7.1%.
- There was a 7% increase in biogas produced from secondary products and wastewater, lessening the amount of waste produced and reducing demand for energy from other sources.
- An average of over 15kg of secondary products from each hectolitre of beer produced was sent for animal feed, further reducing the amount of materials sent to waste.
- Breweries continued to strive to reduce the environmental impact of packaging by switching to, for example, lighter weight bottles, PET bottles (which have a smaller carbon footprint) and plastic kegs (which save on return logistics, cleaning and cleaning equipment).

Europe's 3500 breweries highly depend on the environment for resources, both in terms of quality and quantity, and have a high level of environmental awareness. What this report, and particularly the case studies, show are that the brewing sector continues to improve its environmental performance and that, through the investments made in new equipment in recent years and the further spread of these best practises, brewers will continue to improve their performance in the future.

Annex 1: Methodology

Annex 1: Methodology

In 2010 there were around 3,638 breweries of varying sizes in the participating countries. Combined they produced 399 million hectolitres of beer, making Europe one of the most important beer producing regions in the world.

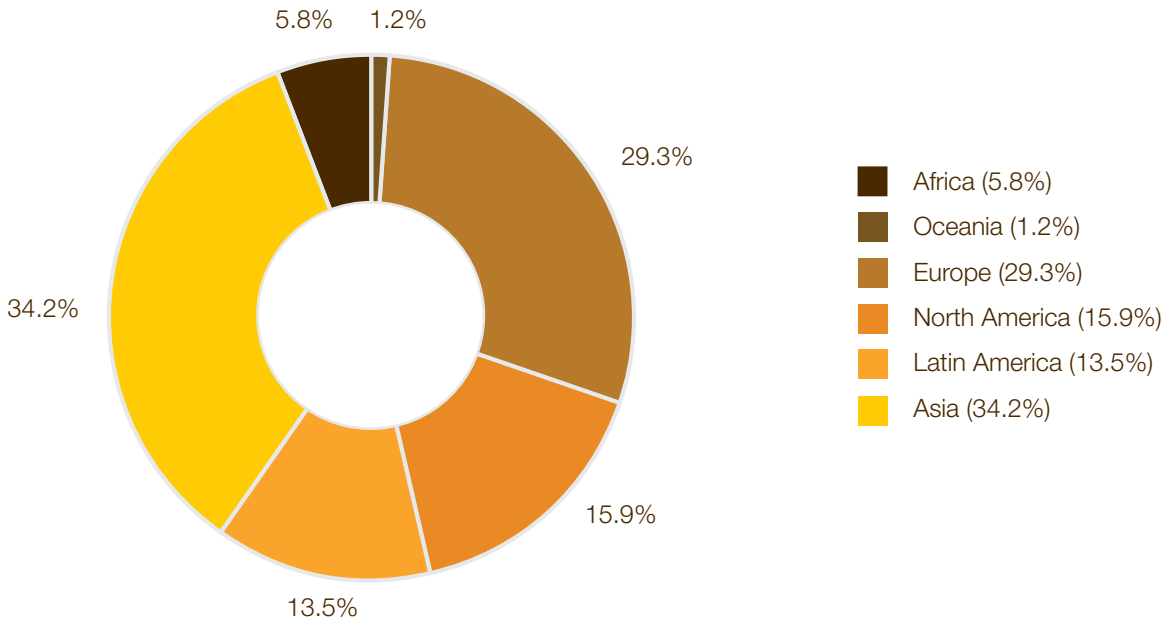


Figure A1.1/ Global beer production by region (%). From the Barth Report. Hops 2010/2011. Published by Barth-Haas Group.

Breweries were requested to share quantitative data and business case studies in each of the four key areas related to environmental performance. Data was collected either via national brewers' associations or directly from the breweries. 156 breweries from 28 different countries responded; this included 25 countries in the EU-27 plus Norway, Switzerland and Turkey. No data was obtained from Slovenia and Cyprus. The responses represent 12% of the total number of breweries (including both micro and macro breweries) and 62% of the total beer production volume, excluding soft drinks, or 65% including soft drinks, in 2010. 90% of the production volume from the responding breweries was represented by members of a brewery group, while the remaining 10% was represented by independent breweries.

All breweries were asked to present their production volume of beer and also to indicate the production volume of other drinks, such as soft drinks, cider and other alcoholic beverages. On average "other drinks" represented approximately 3% of the total production volume of breweries participating in this study. The Scandinavian countries show relatively high percentages of other drinks. In this report key performance indicators, expressed as specific consumptions (e.g. hl/hl, MJ/hl), refer to the total production volume including other drinks.

There might have been some differences in interpreting questions and definitions in the questionnaire from brewery to brewery or country to country. However, this will have minimal impact on the resulting absolute figures and trends over the time period 2008 – 2010.

The responding breweries in this study represent 62% (only beer) of the total European beer production volume in 2010. Figure 1.2 shows volumes represented in individual countries.

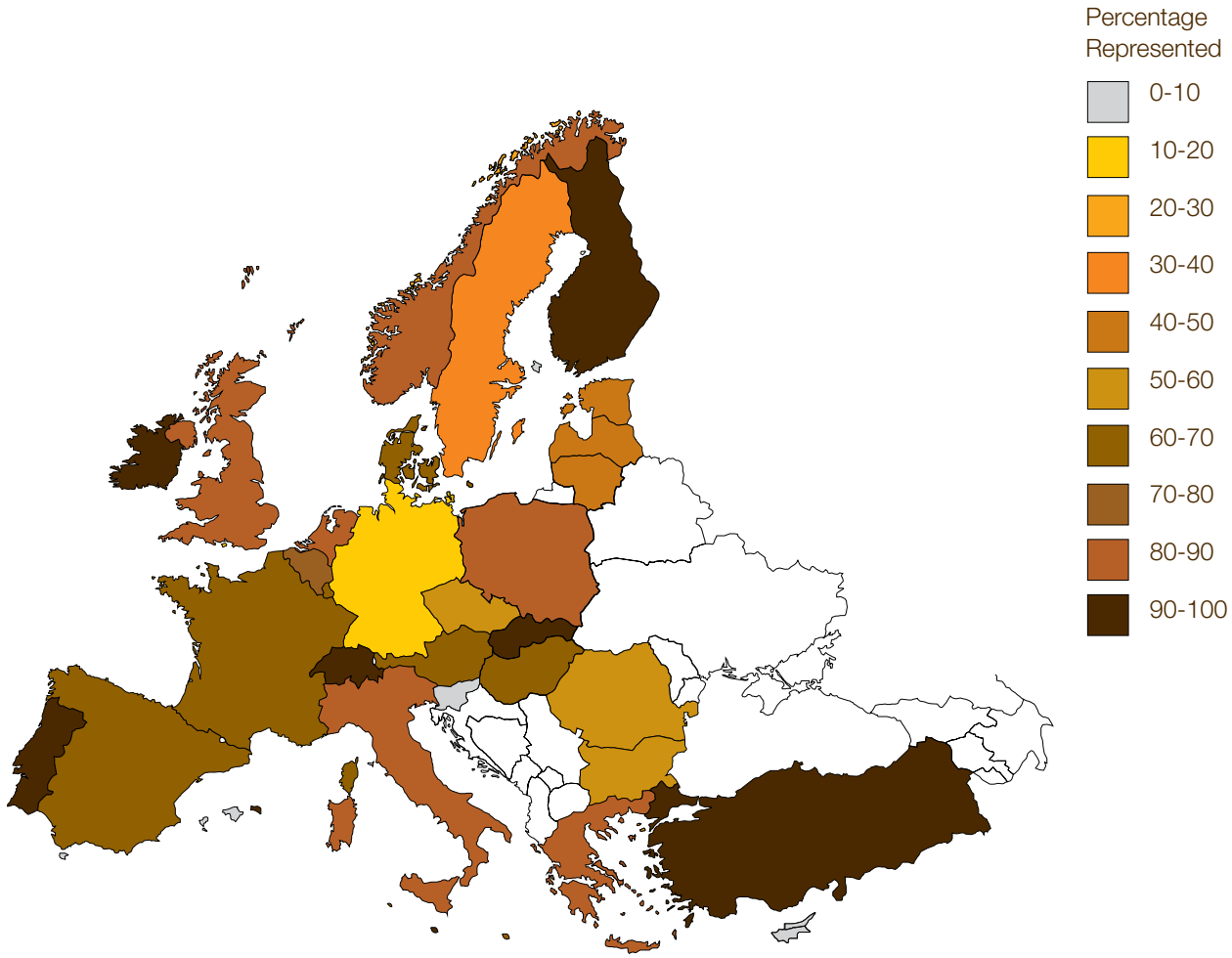


Figure A2.2: Response to request for quantitative data expressed as % of national beer production volume represented by each country (this study).

This report presents the changes and trends in the environmental performance in the key areas over the years 2008 to 2010. These quantitative data are supported and illustrated by a selection of prominent case studies from individual breweries, brewery groups, national bodies and official publications.

Annex 2: Glossary

Annex 2: Glossary

Aerobic. In the context of waste treatment a process whereby the waste is processed by microorganisms in the presence of oxygen. The result is treated wastewater that may be to a high treatment standard.

Anaerobic. In the context of waste treatment a process whereby the waste is processed by micro-organisms in the absence of oxygen. The result is partially treated wastewater and the production of biogas.

Benchmarking. In this context this is a process by which a brewing site can compare its performance metrics including key performance indicators against other brewing sites. It may be possible to apply "normalisation factors" that enable comparison whilst allowing for factors that are outside the brewer's control.

Biogas. A mixture of methane (akin to natural gas) and carbon dioxide that is produced by anaerobic digestion of organic matter.

Boiling. May refer to either steam raising or the process of wort boiling. The latter is employed in all breweries and is necessary for several reasons, one of which is that this part of the process is where the hops are added in conventional brewing.

Brewers' grains. The remainder of the cereal material that is separated off after extraction with hot water in the brewing process.

Brew house. Comprises the brewing process prior to fermentation, simplistically the "hot" part of the process. Typical sequence: Malt milling – mashing (extraction with hot water) – wort separation – boiling-trub separation - cooling.

Caustic. Alkaline chemicals containing hydroxide ions, commonly as sodium hydroxide. Employed as detergents for cleaning purposes.

CIP. Cleaning in-place. The process equipment for cleaning of the plant is built into the process.

CO_2 emission Scope 1. All CO_2 emitted as a direct consequence of fossil energy use at the site, including internal transport. Refrigerant losses are not included in this study.

CO_2 emission Scope 2. Fossil energy used outside the site for production of electricity, steam and heat. Each country has its specific CO_2 emission per kWh.

Combined Heat and Power (CHP). An electricity generating station in which the hot exhaust gases from the turbine or engine supply heat to the production site or other demands.

Electricity consumption. All electricity used on site. It includes purchased electricity from the grid (including green certificates), own electricity from CHP, photovoltaic cells or wind.

Energy consumption. The amount of energy used for all activities on site, including internal transport, excluding external transport. It concerns fossil fuels, renewable fuels, electricity, purchased heat and steam.

Extract. In this context a measure of the material that is extractable from the raw materials into the wort. At each processing stage there will be a loss of extract. Hence there is the potential to calculate extract efficiency as the percentage remaining in beer that was extractable from the raw materials.

Feed. Secondary products such as brewers' grains which have been provided as animal feed.

Fermentation. The process by which brewer's yeast is employed to convert carbohydrate from the raw materials into ethanol, carbon dioxide and other, often flavoursome, products.

Filter Aids. Most beer is filtered to make it clearer to the consumer. Most beer filtration operations employ filter aids that are processing aids that enable the filtration operation to proceed efficiently.

GJ. Unit of energy. In this study 1,000 kWh = 1 MWh = 3.6 GJ.

Hectolitre. A volume of one hundred litres. The unit of volume most commonly employed in the brewing sector.

Keg. A large beer final package (typically between 25 and 60 litres) most commonly used in commercial beer outlets. Usually stainless steel and are returned to the brewery and washed and re-used. Less commonly they are aluminium or plastic, in the latter case they may be single-trip.

kWh. Unit of electrical energy. 1 kWh = 3.6 MJ.

LCV. Lower calorific value.

Lifecycle assessment (LCA). A systematic process by which the environmental impacts of products may be measured.

Malt. A grain product (mostly but not exclusively from barley in the context of beer) that has been malted, that is to say partially germinated and then dried to make it more amenable to the brewing process and the manufacture of quality beers.

Mashing. The process by which the milled raw materials are mixed with warm water and allowed to react. The result is conversion of starch to sugars and other processes.

Pasteurisation. Heat treatment of beer to significantly reduce (kill) any unwanted micro-organisms present. Flash pasteurisation is heating by heat exchanger immediately before filling into final package. Tunnel pasteurisation involves heating smallpack (e.g. bottles or cans) by warm water sprays as they move along a conveyor.

Photovoltaic. One method of capturing solar energy. Often abbreviated to PV.

Production volume. Production and packaging of beer and other beverages, including bulk delivery directly to clients. Specific consumptions (e.g. hl/hl, MJ/hl) are related to total production volume including other beverages like soft drinks, flavoured alcoholic beverages etc.

Renewable. When applied to energy, refers to sources of energy that are naturally replenished. For example includes wind, tidal, solar, biogas and biofuels. Excludes fossil fuels and nuclear power.

Specific. In parts this refers to a metric that is scaled according to the production volume. In other words, a measurement of, for example, water or energy expressed as "per hectolitre of beer".

Trub. A solid precipitate from beer or wort. Most significantly it is produced during wort boiling. A large constituent of trub is protein, therefore after separation it has value as animal feed.

Wastewater treatment. Any treatment that results in Chemical Oxygen Demand removal. It does not include only neutralization.

Water consumption. The amount of water used for brewing and all other activities on the site, including treatment of incoming water.

Wort. The liquid extract produced by mashing and wort separation. Wort separation refers to separation of the wort from the brewer's grains.

Zero Waste. When all brewery products or materials resulting from brewing activities are reused in some way, then it is considered that the brewery produces zero waste.

Notes

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