

THE EXETER MBA

Assessing the Carbon Footprint of Pebblebed wine

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to the University of Exeter as a Dissertation towards the
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**I certify that all material in this dissertation, which is not my own work has been
identified and that no material is included for which a degree has previously been
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Executive Summary

This dissertation discusses the issue of climate change and how this relates to a small business. It reviews how carbon emissions could be reduced by both regulatory and consumer driven methods. One of the objectives of this dissertation was to determine the carbon footprint of a bottle of wine produced by a local Devonshire vineyard. This was achieved by conducting a life cycle assessment based on the Carbon Trusts Methodology. Conducting of the assessment proved to be a complex task and the reference data required proved difficult to obtain. In conclusion it was suggested that the company should follow a strategy of environmental product differentiation.

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1 Introduction

1.1 Objective

The main objective of this research project is to measure the carbon footprint of a bottle of wine produced by a local Devonshire vineyard. A further objective is to identify possible issues that a small company may face when performing such an assessment and to review what the results mean for the company.

1.2 Background

Although there is still much disagreement surrounding many environmental debates there does seem to be a growing consensus that human activities are having an effect on the environment.

One of the most commonly publicised environmental issues is ‘Global Warming’ caused by the greenhouse effect. It is estimated that food is responsible for about a fifth of a ‘developed’ country’s greenhouse gas emissions (mostly carbon dioxide through fossil energy use) (White, 2007).

Over the last fifty years, there have been dramatic changes in the UK’s food production and its supporting supply chain. One of the most dramatic changes has been the globalisation of the food industry, with an increase in food trade (imports and exports) and wider sourcing of food within the UK and overseas. This change has led to a large increase in the distance food travels from the farm to consumer, which has become known as “food miles”. Since 1978, the annual amount of food moved in the UK by heavy goods vehicles has increased by 23%, and the average distance for each trip has increased by over 50% (Watkiss, 2005)

One product consumed in the UK that that has often travels a large number of ‘food miles’ is wine. The UK accounts for circa 18% of world wine imports by volume and over 20% by value. Australia and France are the two largest exporters of wine to the UK, accounting for over 40% of the 1.2 billion litres imported into the UK each year (Winefacts, 2007) English wine only represents 0.25% of consumption in the UK but demand is growing (Horsham District Council, 2005).

The measurement of a products environmental impact by food miles alone has been criticised due to transport being only one component of the total impact. One suggested answer to this issue is to measure a products carbon footprint. A carbon footprint is a "measure of the impact human activities have on the environment in terms of the amount of green house gases produced, measured in units of carbon dioxide (Carbon Footprint, 2007).

1.3 The company

It was decided to choose either a food or drink product for the assessment, as it is a tangible product and something most people would consume. After approaching a number of small food and drink producers in Devon, the product chosen to assess was a bottle of wine produced by a company called Pebblebed.

Pebblebed wine started as a community project in 1999 when Geoff Bowen and friends planted a vineyard on the sandy marl that underlies the Budleigh Salterton pebble beds at Ebford near Topsham in East Devon. The success of the project led to further commercial plantings at Ebford in 2002 and directly on the Pebble beds at West Hill in 2005 and 2006. In 2007 a further 8 acres of vineyards were planted at Clyst St George close to Topsham that took the total acres under vines to over 22.

1.4 The product

Pebblebed produces a white wine and rose wine. The wine is produced using organic procedures which are currently undergoing certification with the Soil Association with the expectation that the 2007 vintage processing to be fully certified. Current production is 12,000 bottles per year.

2 Methodology

Both qualitative and quantitative methods were used to conduct this research project.

2.1 Qualitative methods

The first stage of the project was the collection of existing information on the subject area being investigated and also about the company used for the study.

2.1.1 Literature search and review

A search for secondary data was conducted to understand the current views and issues related to the research question previously stated. Data has been accessed through Exeter University Library and the electronic journal collections. Other Information Service such as Internet search engines and websites have also been used.

There is very limited data published by wine producers about their energy usage or CO₂ emissions. In most cases they tend to claim to be looking at reducing energy consumption rather than providing actual facts or figures.

2.1.2 Interview

An interview was conducted with the owner of the business, used as the case study, to understand the business profile and the current business strategy. A transcript of the interview can be found in Appendix A.

2.2 Quantitative methods

2.2.1 Carbon Trust Methodology

The Carbon Trusts Carbon Measurement Methodology was used as the basis to calculate an estimate of the carbon emissions of a bottle of wine. This methodology is currently being developed in partnership with Defra and the British Standards Institute.

The main steps of the methodology are:

Step 1 – Analysis of the internal product data

Step 2 – Build a supply chain process map

Step 3 – Define the boundary conditions and identify data requirements

Step 4 – Collect the primary and secondary data

Step 5 – Calculate GHG emissions by supply chain process steps

This methodology is discussed in more detail in section 3.4.

The production process and supply chain of the business was mapped by visiting the various locations used by the business and by conducting interviews with the key people who operated those processes. Each part of the process was analysed to identify both the activities involved and the material inputs. The resources required were then estimated for the production of 100,000 bottles of wine. The data on the activities involved within the processes enables the CO₂ emissions due to direct energy use to be estimate. The data on the material inputs of the processes enables the embodied CO₂ emissions to be estimated. These two estimates are then combined to give the total CO₂ emissions. Although using primary data would be preferable, measuring was unfeasible due to the scope and time constraints therefore estimates were made for all of the activities and inputs.

For each activity the amount of energy required to complete the process was multiplied by a conversion factor to gives an estimated value of kg of CO₂ produced. A conversion factor is an estimate of the amount of CO₂ released per unit energy. The conversion factors used were taken from Defra.

The amount of material inputs required in each process was estimated and multiplied by an estimated embodied carbon value to give the total embodied carbon. All but one of the estimates for the embodied carbon in materials where taken from the Inventory of Carbon and Energy (ICE) Version 1.5a Beta. This inventory comes from a database that has been developed by the Department of Mechanical Engineering at the University of Bath. The main driver for creation of the database came from research into embodied carbon in the building industry. Where a material used in the wine production process was not detailed within the ICE the nearest alternative was selected. The only estimate of embodied carbon not take from the ICE was for the wine bottle. A value from a report by Centre of Research for Energy Resources and Consumption (Aranda et al 2005) was used.

2.2.2 Glass recycling

The estimate used for the production of the bottle of wine involved the use of raw materials and did not factor in the use of recycled material.

The current Carbon Trust Methodology does not allow for the inclusion of emission savings from outputs used as inputs into new products. This is currently under review and for this research project a life cycle assessment was conducted using both the exclusion and inclusion of the emission savings from recycling glass to produce new glass bottles.

3 Literature Search and Review

This chapter covers the literature research and review that focuses on four main areas. The first section covers the area of climate change, looking at the definition, causes and impacts. The second section looks at various options available to address the issues identified, including the role of the state and individual companies. The third section looks at the use of consumer labelling and its role in influencing consumer behaviour. The final section looks at the use of life cycle assessment as a process to develop a companies understanding of its carbon emissions and allows it to communicate this to its consumers.

3.1 Climate Change

Climate change has been described as ‘the single most important issue that we face as a global community’ (Blair 2004).

3.1.1 What is climate change?

Weather is the fluctuating state of the atmosphere around us. Climate is the ‘average weather’ (it is a statistical description of weather, including variability and extremes as well as averages); climate involves the other components of the climate system in addition to the atmosphere (Met Office 2007). The term ‘climate change’ encapsulates a wide variety of accompanying impacts on temperature, weather patterns and other natural systems. Climate change describes changes that occur over time scales ranging from decades to millions of years, the classical period is 30 years as defined by the World Meteorological Organisation (WMO).

3.1.2 What are the causes?

The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere and the biosphere, and the interactions between them. According to the Intergovernmental Panel on Climate Change (IPCC) the climate system evolves in time under its own influence of its own internal dynamics and because of external forcings such as volcanic eruptions, and to human induced forcings such as changing composition of the atmosphere (IPCC, 2007).

The general state of the Earth's climate is largely affected by how much heat is stored in the atmosphere. Processes that affect this storage of heat can cause the climate of the Earth to change. The temperature of the earth is determined by the balance of energy coming in from the sun in the form of visible radiation, sunlight, and the energy emitted from the surface of the Earth to outer space in the form of invisible infrared radiation. The energy coming in from the Sun can pass through the clear atmosphere pretty much unchanged and therefore heat the surface of the Earth. Infrared radiation emanating from the surface of the Earth is partly absorbed by some gases in the atmosphere, and some of it is re-emitted downwards. The effect of this is to warm the surface of the Earth and lower part of the atmosphere. The gases that do this work in the natural atmosphere are primarily water vapour (responsible for about two-thirds of the effect) and carbon dioxide. This is known as the 'Greenhouse Effect'. This effect is what keeps the earth habitable, as without it, the temperature would be 30 degrees centigrade cooler (Met Office 2005). Changes in the amount of green house gases have occurred naturally during the history of the Earth.

Although water vapour is the most important contributor to the greenhouse effect it only persists in the atmosphere for an average of a few days. This rapid turnover means that if human activity was directly adding or removing significant amounts of water vapor there would be no slow build-up (New Scientist 2007). The main impact on the greenhouse effect is from Carbon Dioxide (CO₂). In general, CO₂ is exhaled by animals and utilized by plants during photosynthesis but additional CO₂ is created by the combustion of fossil fuels or vegetable matter. The level of water vapor in the atmosphere is determined mainly by temperature, and any excess is rapidly lost. The level of CO₂ is determined by the balance between sources and sinks (New Scientist 2007).

Carbon is continuously cycled between reservoirs in the ocean, on the land, and in the atmosphere, where it occurs primarily as carbon dioxide. On land, carbon occurs primarily in living biota and decaying organic matter. In the ocean, the main form of carbon is dissolved carbon dioxide and small creatures, such as plankton. The atmosphere, biota, soils, and the upper ocean are strongly linked. The exchange of carbon between this fast-responding system and the deep ocean takes much longer (several hundred years).

The ocean takes up carbon dioxide when it is cold, at higher latitudes, and releases it near the tropics. Photosynthesis takes carbon dioxide from the atmosphere and transfers it to vegetation, while respiration releases carbon dioxide back into the atmosphere. Although natural transfers of carbon dioxide are approximately 20 times greater than those due to human activity, they are in near balance, with the magnitude of carbon sources closely matching those of the sinks (Met Office 2005). The concern is that the emissions from human activities cause the greenhouse gas concentrations to rise well above their natural levels this in turn causes an increase in global temperature. The recent Fourth Assessment Report (AR4) of the IPCC further confirms scientific agreement that human activity is the primary driver of the observed changes in climate.

3.1.3 What are the impacts?

On 19 July 2005 the Chancellor of the Exchequer, Gordon Brown announced that he had asked Sir Nicholas Stern to lead a major review of the economics of climate change, to understand more comprehensively the nature of the economic challenges and how they can be met, in the UK and globally (HM Treasury 2005).

The Stern Review on the Economics of Climate Change was released on the 30th of October 2006. The report states that '*Climate change threatens the basic elements of life for people around the world - access to water, food production, health, and use of land and the environment.*'

The review estimates that, on current trends, average global temperatures will rise by 2-3 degrees centigrade within the next fifty years or so but the Earth will be committed to several degrees more warming if emissions continue to grow.

The report states that warming will have several impacts often mediated through water:

- Melting glaciers will initially increase flood risk and then strongly reduce water supplies, eventually threatening one-sixth of the world's population, predominantly in the Indian sub-continent, parts of China, and the Andes in South America.
- Declining crop yields, especially in Africa, could leave hundreds of millions without the ability to produce or purchase sufficient food. At mid to high latitudes, crop yields may increase for moderate temperature rises (2 - 3°C), but then decline with greater amounts of warming. At 4°C and above, global food production is likely to be seriously affected.

- In higher latitudes, cold-related deaths will decrease but climate change will increase worldwide deaths from malnutrition and heat stress. Vector-borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place.
- Rising sea levels will result in tens to hundreds of millions more people flooded each year with warming of 3 or 4°C. There will be serious risks and increasing pressures for coastal protection in South East Asia (Bangladesh and Vietnam), small islands in the Caribbean and the Pacific, and large coastal cities, such as Tokyo, New York, Cairo and London.
- Ecosystems will be particularly vulnerable to climate change, with around 15 - 40% of species potentially facing extinction after only 2°C of warming.
- Ocean acidification, a direct result of rising carbon dioxide levels, will have major effects on marine ecosystems, with possible adverse consequences on fish stocks.

Looking into the future, the report argues that if society was to take action, we could not only avoid a looming environmental catastrophe, but do so at a relatively modest cost. It claims that immediate aggressive regulation would stimulate rapid technological improvements that would lead to ever-increasing reductions in emissions at virtually no additional cost. This is not the first report of its kind and economists have long argued that aggressive near-term policies lead to abatement costs that out-weigh the avoided climate damages. They argue that efficient policies should slow climate change this century but not stop it. The question arises why there are two such different views (Mendelsohn, 2006).

The Stern review has been criticised by many for the assumptions it has made. They argue that these assumptions make the estimated damages from climate change to be far more severe than previous estimates and also lower the estimated abatement costs.

The follow assumptions are the most heavily criticised and many believe make the estimate damages from climate change to be considerably higher than before.

Demographics. The report examines only one baseline of demographic change over the next two centuries. The scenario used assumes a rapid population growth in the low latitudes which is the most sensitive region to global warming

Discount rate. The report assumes that the discount rate (the “price” of time) for the cost of global change is 0.1 percent above the rate of growth consumption. The report argues that the use of a higher discount rate would be unfair to future generations. However, the use of a lower discount rate implies that far future events are important in the near term. Despite using the lower rate in impact analysis the report does not use it when evaluating the cost of mitigation. The opportunity cost of investing in mitigation is not valued using the same discount rate. Society can lose income that it could have gained from other valuable projects.

Adaptation. The report talks about the importance of human adaptation to climate change but the damage estimates do not take this into account. For example, the probability that people will build dams to control flooding.

The Stern report argues that it is far less costly to control greenhouse gases than economist earlier estimated. It claims that spending just 1 percent of income every year would be enough to stabilise atmospheric concentrations by 2050. The report suggests that cuts in emissions are technologically possible through combinations of energy technology and non-carbon emissions reduction. The energy technology gains can be achieved by adding renewable energy sources (42 percent from primarily wind, solar, and bio-fuels), nuclear power (15 percent), carbon recapture (15 percent), and increased energy efficiency (27 percent). The non-carbon reductions can be met through a combination of eliminating deforestation, reforestation, burning waste for energy in place of fossil fuels, and reducing agricultural emissions. These assumptions are also criticised due to unproven technologies such as carbon recapture and problems associated with using large quantities of land for renewable energy (Mendelsohn, 2006).

Although there is disagreement over the figures of the Stern report there is greater agreement that action on climate change needs to be taken. With so many factors involved, there is a high level of uncertainty of both the damages of climate change and the cost of abatement. It is left to policy makers to decide how aggressive policies need to be. It is argued that the risk of climate damages go up with ever-higher stabilisation targets, but the mitigation costs fall rapidly. Society needs to settle on the best trade off (Mendelsohn, 2006).

3.1.4 Legislation

As climate change is a global issue with global consequences an international treaty was proposed to agree the targets of emission reductions that are required. Stemming from this, governments around the world started to introduce legislation intended to reduce the amount of emissions that their countries produce.

3.1.4.1 The Kyoto Protocol

The Kyoto Protocol is an international agreement setting targets for industrialised countries to cut their greenhouse gas emissions. The protocol was agreed in 1997, based on the United Nations Framework Convention on Climate Change signed in 1992.

The objective of the protocol is:

“...the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.” (UNFCCC 2007)

The Kyoto is underwritten by governments and governed by global legislation. Governments are separated into either developed countries or developing countries. Developed countries that ratified the protocol commit to reduce their emissions of carbon dioxide and five other green house gases, or engage in emissions trading if they maintain or increase emissions. The US is one of the few signatory nations that have not ratified the act. President Bush claimed that the treaty requirements would harm the US economy leading to economic loses and costing jobs.

3.1.4.2 UK Government policy

In order to meet its obligations to the Kyoto protocol the UK Government introduced the Climate Change Bill. The Bill, published on the 13th of March 2007, is a draft law aimed at moving the United Kingdom to a ‘low-carbon economy’. The key component of the legislation is would be a mandatory 60% cut in the UK’s carbon emission by 2050 (compared to 1990 levels). Other components of the legislation are five-year carbon budgets, the set up of a Committee on Climate Change, enabling powers to introduce new trading schemes and reporting requirements of performance in meeting the targets.

The bill followed a campaign by Friends of the Earth, 'The Big Ask', which called for politicians to take action on climate change. Although the bill is welcome by many environmental groups, the targets set are seen to be too low (BBC, 2006). Friends of the Earth are calling for at least a 3% reduction a year, amounting to a total cut of around 80% by 2050.

3.2 Regulation and Competitive advantage

This section of the literature review covers the use of regulation to manage negative aspects within society. It also looks at other market forces that may control these aspects and the response companies may make to these forces.

3.2.1 Negative externalities

In economics, an externality is defined as a cost or benefit resulting from a transaction that is borne or received by parties not directly involved in the transaction, hence, externalities can be either positive or negative. Pollution is an example of a negative externality. The production of a good can benefit the buyer and seller of the good but the pollution that is created by the production process affects everybody that breaths polluted air or is required to pay for polluted water to be treated before reuse. In these situations the marginal social benefit of consumption is less than the marginal private benefit of consumption. This leads to the good or service being over consumed relative to social optimum. Without intervention the good will be under priced and the negative externality will not be taken into account. One approach to dealing with negative externalities is regulation.

3.2.2 Regulation

Although there are a large variety of environmental policies, Leveque (1996) argues they can be classified into three generic modes of regulation: public regulation, self-regulation and co-regulation.

3.2.2.1 Public regulation

Public regulation is primarily an administrative process where the environmental objective and the train of measures to achieve it are both set by public authorities. To be successful, public regulation requires sufficient power of coercion of the regulator to resist the obstruction power of the regulated firms. Public regulation takes place when the market does not provide incentives to firms to increase expenditure to curb negative externalities. Within public regulation a government agency faces various problems including incomplete information and insufficient monitoring capacity. The costs of overcoming these problems, if at all, may render the system inefficient and potentially prohibitive. The regulators choices can also be affected due to lobbying from industry.

3.2.2.2 Self regulation

Regulatory pressures are not the only incentives that may push firms to adopt a more benign behaviour towards the environment. In certain circumstances firms may undertake a collective action to cope with environmental issue without direct government intervention. Self-regulation also has its issues, the major two being free riding and a lack of credibility. Free riding can occur when a firm does not adhere to the regulations for that industry, thus saving costs whilst benefiting from the collective action of others. To overcome this issue, the coalitions must implement control and policy measures, hence, act as a regulatory agency. The second issue is the poor image of self-regulation. The absence of an impartial third party can lead to scepticism among consumers as to the validity of the regulation compliance. An answer to this issue can come from third parties as environmental associations.

3.2.2.3 Co-regulation

Co-regulation is a hybrid form between self and public regulation. The set of measures to achieve the environmental target is set by industry whereas, like public regulation, the environmental objective continues to be set by public authorities. Two facts characterise the circumstance of co-regulation: shared uncertainty between players and a gain for firms from collective gain. Examples include new legislation to control pollution such as car or packaging waste recycling. With this type of regulation firms are unable to assess the abatement costs. The only thing they are sure of is that policy will be passed due to the strong commitment of policy makers or pressure groups.

This type of regulation has two main benefits. Compared with self-regulation, public intervention reduces free riding and compared to public regulation, the advantage is more cost effective measures.

3.2.3 UK Regulation

In the United Kingdom the Environment Agency is responsible for regulation to control pollution and environmental damage. The agency takes European Directives and translates them into UK law through a set of regulations. European Directives require member states to achieve specific environmental objectives with examples including air pollution prevention and control.

Current UK regulation in place attempting to control the emission of green house gases is the Climate Change Levy (CCL). The CCL is a tax on the use of energy by businesses and the public sector that is paid through their energy bills.

3.2.4 Green and Competitive

In 'Green and Competitive: Ending the Stalemate' Porter and van der Linde (1995) discuss that a common statement is 'the need for regulation to protect the environment gets wide spread but grudging acceptance: widespread because everybody wants a liveable planet, grudging because of the lingering belief that environmental regulations erode competitiveness'. The prevailing view is that there is an inherent and fixed trade off: ecology versus the economy. Progress on environmental quality is seen as a fight with one side wanting tougher standards and the other side wanting them rolled back. They argue that this static view of environmental regulation is incorrect and that companies operate in a world of dynamic competition and are constantly finding innovative solutions to pressures from competitors, customers and regulators. In fact, properly designed regulation can trigger innovations that lower the total of a product or improve its value. This argument is also used in the Stern report.

Porter (1991) argues that even though market forces can cause a reduction in environmental damage, regulation is still required in the following reasons:

- To create pressure that motivates companies to innovate.
- To improve environmental quality in cases in which innovation and the resulting improvements does not offset the cost of compliance.
- To alert and educated companies about likely resource inefficiencies.
- To raise the likelihood that that product innovations and process innovations in general will be environmentally friendly
- To create demand for environmental improvement until companies and customers are able to perceive and measure the resources inefficiencies of pollution better
- To level the playing field during the transition period to innovation based environmental solutions.

As well as the issue of the possible high costs of regulation previously mentioned, it is argued that an adversarial regulatory process can cause companies to focus on compliance rather than innovation.

The debate about business and the environment is polarised. Porter's (1991) argument that countries adopting stricter regulations can achieve competitive advantage by stimulating socially desirable innovations and gaining first mover advantages for their firms which can, in turn, be exploited in other markets is known as the Porter 'win-win' hypothesis. The hypothesis has been criticised as being difficult to test empirically and for being too anecdotal (Jaffe and Palmer, 1997).

The alternative view emphasises that firms exist to serve their shareholders. It is believed that managers who lose their focus by chasing environmental objectives cannot compete effectively with those who keep their eyes on the goal of shareholder value. According to Reinhardt (1999) the debate has been framed in the wrong terms. Instead of asking whether it pays to be green, we ought to be asking about under the circumstances under which it might pay, to move from the question of 'whether or not' corporations can offset the costs of environmental investments to the question of "when" it's possible to do so. Reinhart's view is that a business should decide the way in which it deals with the environmental challenge. He argues that a business's behaviour with respect to the environment, like any other aspect of strategy or management, should be considered in the light of the basic economic situation of the business: the structure of the industry in which it competes, its own position within that industry, and its internal organizational capabilities. 'It is necessary to understand this basic economic context in order to think sensibly about businesses' response to the environmental challenge'. Without this understanding, prescribing environmental policies for firms is just sloganeering.'

There are two leading schools on sources of competitive advantage: Porter's "Positioning school" and the "Resourced-Based View" of the firm. According to the Resource-Based View of the firm, competitive advantage should not be seen as a function of industrial structure but as resulting from the ability of firms to use resources, which are distributed across competing firms and tend to be stable over time. When compared with the Porter's "positioning" perspective, the Resource-Based View does not constrain the choices available to firms to the structure of the industry. Instead it considers competitive advantage as resulting from the capabilities of firms to acquire and manage resources, such as technical capabilities and ownership of intellectual property that can be deployed to serve the goal of creating competitive advantage around environmental innovation

As the Resource Based View highlights the influence organisational process exert on competitiveness, Waddock and Bodwell (2004) argue that this would explain the suggestion from academics and consultants that Environmental Management Systems (EMS) would generate competitive advantage. They also makes comparisons between EMS and Total quality management, stating that since the 1980s, competitive pressure and widespread consumer attention to quality have meant that companies cannot compete successfully without paying close attention to the quality of their products and services. Today, similar demands are for enhanced corporate responsibility, are emerging.

Although similarities exist, there is fundamental difference between ‘quality’ and ‘environmental’ issues. Quality is embedded in a product or service that allows it to become a private profit where as environmental protection is a public good that cannot be directly transferred to products and services.

3.2.5 Environmental Strategy

Orsato (2006) proposes a framework to decouple the elements involved in competitive environmental management. The first step towards an answer “When does it pay to be green?” requires the classification of environmental-related investments according to their potential to become sources of competitive. He argues that the structure of the industry which a firm operates, its position in that industry, types of markets the company serves and its capabilities will suggest the appropriate competitive focus and the potential source of competitive advantage for a firm.

3.2.5.1 Strategy 1: Eco-Efficiency

In the early 1990s, Porter reemphasised that productivity is the key element to companies to gain competitiveness. Organisations should be able to transform costs into profits by identifying opportunities for innovation resulting in more efficient processes. Concentrating on material usage, increase process yields and better utilization of by products would reduce waste. This approach could be applied to finding hidden opportunities to profit from environmental investments and eventually transform such investments into sources of competitive advantage.

Some small firms may not pay for EMS certification but implement a system a less bureaucratic EMS than the ones using guidelines of ISO 14001. The objective is still to reduce costs and if they supply a relatively small number of other firms then they could avoid the cost of certification by getting them to audit their systems.

3.2.5.2 Strategy 2: Beyond Compliance Leadership

Some companies not only want to increase the efficiency of their processes but also want customers and then general public to acknowledge their efforts. The adoption of certification schemes such as EMS, the subscribing to business codes of environmental management and a willingness to publicise these efforts can differentiate corporations from competitors. For companies supplying to large organisations that may demand certification then a first mover advantage can be gained. The advantage can be short lived as it becomes a mere 'licence to operate' and what was once a differentiator becomes the norm and non-competitive practice.

3.2.5.3 Strategy 3: Eco-Branding

This strategy uses marketing differentiation based on environmental attributes. The idea is a business creates products that provide greater environmental benefits, or that impose smaller environmental costs, than similar products. These changes in the product can increase cost but they also enable it to command a price premium in the market place or to capture additional market share. The changes undertaken to improve environmental performance might comprise some product attribute, other than low price, about which consumers care about such as quality or convenience. Again the idea being that consumers are willing to trade off these attributes in order to purchase the environmentally preferable product.

Reinhart (1998) argues that while differentiating products on environmental lines is a conceptually straightforward way to reconcile conflicting political demands for environmental improvement with shareholder value creation, all attempts to do so have not succeeded.

He suggests in order for a strategy of environmental product differentiation to succeed, a business must satisfy three requirements:

- The business must find, or create, a willingness among customers to pay for environmental quality;
- The business must establish credible information about the environmental attributes of its products; and
- Its innovation must be defensible against imitation by competitors.

3.2.5.4 Strategy 4: Environmental Cost Leadership

In mature markets where margins are low and there is a constant tightening of environmental regulations; a strategy that could be adopted is to focus on radical product innovations. Options such as material substitution can make more sense than focusing on incremental process innovation. Even though consumers may appreciate products green credentials the main purchasing decision will be cost.

3.3 Consumer labelling

When negative externalities are generated as a result of imperfect information, this can lead to over consumption of a good. One approach to addressing this problem is to provide consumers with more information on the negative effects. The aim is that a consumer who is more informed of all the associated external costs with a particular product or service, may be persuaded to consider this information in their purchasing decision. In order for consumers to make informed decisions they need to be aware of relevant issues.

The information required to make these decisions often already exists, however it is not always readily available and sometimes need to be sought out. Consumers have neither the time to amass this information nor the expertise to comprehend some of the data (Collins-Chobanian, 2001). The Government often plays a role in creating public awareness through agencies, such as the Department for Environmental Food and Rural Affairs or the Food Standards Agency (FSA). It is not only Government bodies that attempt to create consumer awareness on certain issues and other sources include Non-Government Organisations (NGO), such as Friends of the Earth, industry associations and individual companies. These different groups may have conflicting objectives and this can lead to conflicting messages.

3.3.1 Eco-labels

Once consumer's awareness of the choices they can make concerning environmental issues has been created then a method for differentiating between products at the point of purchase is required. The most common method for informing consumers is via the packaging of a product. Bjorner et al (2004) argue that one important distinction between different types of information provision programs concerns the motivation of the end users of the information. They state that there are two types of labels. The first is a label that gives information that is directly applicable to the end-user. An example would be a hazard label, such as those on cigarettes that are intended to protect the user and those around him. The second label, often know as an eco-label, is a label that gives information that is applicable only to the extent that the user has some concern for wider, more diffuse environmental effects. In this case, the product has attributes that do not yield consumers significant direct benefits but relies on altruistic motives.

Collins-Chobanian (2001) argues that the foremost goal of an environmental label is to inform consumers of the real cost of consumption and the increase in autonomy that information provides. It empowers people to discriminate between products that are harmful to the environment and those more compatible with environmental objectives. One issue with labels is the question of which environmental factor is most important (Case, 2004). A solution to this issue is the use of symbolic or indicating labels used to present complex environmental information. Some of the first eco-labels introduced in the late 90's such as the German Blue label, the Nordic Swan and the European Flower were introduced by governments and are applicable to a wide range of products. They were introduced to give consumers wider choice and to encourage producers to adopt sustainable practices by rewarding them with certified and potentially more lucrative brands.

Sceptics have been concerned that such programmes may not significantly influence the behaviour of consumers. For instance, although consumers in opinion surveys would suggest that consumers are willing choose environmentally friendly products there is little evidence to suggest that this is true (Bjorner et al, 2004).

Bjorner et al (2004) argue that environmental labels can make a difference to consumer behaviour. They under took a study to quantify the effect of a certified environmental label on consumers' brand choice of toilet paper, paper towels and detergents. The study took place in Denmark and the certified environmental label they chose was the Nordic Swan.

The Swan is the official Nordic eco-label, introduced by the Nordic Council of Ministers. The logo aims to demonstrate that a product is a good environmental choice. The green symbol is available for around 60 product groups for which it is felt that eco-labelling is needed and will be beneficial. Everything from washing-up liquid to furniture and hotels can carry the Swan label. In order to gain the logo a product must fulfil certain criteria using methods such as samples from independent laboratories, certificates and control visits. The label is usually valid for three years, after which the criteria are revised and the company must reapply for a licence in an attempt to ensure that products better suited to the environment are constantly being developed. The audit to achieve the logo takes into consideration the product's impact on the environment

from the raw material to waste as well as criteria with regard to quality and performance.

The study concluded that the Swan label had a significant effect on consumers' brand choice for toilet paper, corresponding to a marginal willingness to pay for the certified environmental label of 13-18% of the price. It also concluded that a number of conditions conducive to the success of environmental labels are to be found in Denmark. Most prominently, there is a great confidence in the government (which certifies the label), environmental issues receive substantial attention in the media, and there appears to be wide acceptance of a policy of pursuing relatively ambitious environmental goals. This left an important, but unanswered question whether the positive effect of the environmental Swan label found in the Danish market will also be found in other countries, especially those outside the Nordic group.

Despite the success of the Swan label on consumer purchases, Collins-Chobanian (2001) criticises environmental labels that act as a "stamp of approval". She suggests that the label assuages to the consumers' consciences rather than effectively educating them of the cost of consumption.

The structure of an eco-labelling scheme raises a number of issues. If a standard is not absolute but relative with products compared against others in the same product category, the definition of the "category" is absolutely critical. The particular selection criteria matter as well. Manufacturers whose products are disadvantaged by an eco-labelling criterion are quick to charge that it is politically biased in favour of local producers, and that it serves as a form of eco-protectionism (Reinhart, 1999).

3.3.2 Product differentiation

As discussed previously, one environmental strategy to gain competitive advantage is Eco-branding. Some companies like Ecocover, who supply cleaning products, encompass environmental credibility within their brand so covering all their products. Other companies choose to include environmental information on existing products labels. One of the requirements, Reinhart argued, that business must satisfy is that they must establish credible information about the environmental attributes of its products. Although eco-labels can go some way to satisfying this requirement they do not fully solve the problem. Some of the difficulties are direct consequences of scientific uncertainty.

Others arise from uncertainty about the relative values of various un-priced environmental impacts: for example, additional carbon dioxide versus additional solid waste to landfills.

In response to environmental and social concerns a number of voluntary certification and labelling programmes have been developed over the past ten years by non-governmental organizations (NGOs) and industry associations. Gulbrandsen (2006) challenges the idea that the proliferation of voluntary certification and labelling schemes for environmentally and socially responsible production is often seen as driven by companies and consumer demand. Drawing on a political consumerism perspective, he argues that trans-national environmental pressure groups with their targeting of firms were key to the emergence of non-state eco-labelling schemes. Most firms decided to support or participate in such schemes only after intensive environmental group pressure. The rational economic perspective on labelling, he argues, is the emergence of codes of practice is driven by a businesses desire to protect their reputation, provide credible information to consumers and gain competitive advantages. Peer pressure from within an industry to protect the reputation of the industry and the anticipation of stronger public policy regulations also has an influence.

The alternative perspective focuses less on economic gains and the rational calculative choices of firms and more on political conflicts about controlling and regulating global capitalism, ethically and politically motivated consumption, and strategic actions by environmental organisations. From this perspective, consumer influence is not primarily a matter of willingness to pay a price premium for eco-labelled products, and firms are not the key actors behind the rise of labelling schemes. According to the notion of 'political consumerism' ethically and politically motivated consumers may force policy reform or persuade producers to abandon questionable practices through their choice of producers and products.

3.3.3 Food miles

Over the last fifty years, there have been dramatic changes in the food production and supply chain in the UK. One of the most dramatic changes has been the globalisation of the food industry, with an increase in food trade (imports and exports) and wider sourcing of food within the UK and overseas. We have also seen a concentration of the food supply base into fewer, larger suppliers, partly to meet demand for bulk year-round

supply of uniform produce. This in turn has caused major changes in delivery patterns with most goods now routed through supermarket regional distribution centres, and a trend towards use of larger Heavy Goods Vehicles (HGV). The habits of consumers has also changed with a switch from frequent food shopping (on foot) at small local shops to weekly shopping by car at large out of town supermarkets. These trends have led to a large increase in the distance food travels from the farm to consumer, known as “food miles”. Indeed, since 1978, the annual amount of food moved in the UK by HGVs has increased by 23%, and the average distance for each trip has increased by over 50% (DEFRA, 2006). The rise in food miles has led to increases in the environmental, social and economic burdens associated with transport. These include carbon dioxide emissions, air pollution, congestion, accidents and noise.

A study by Watkiss (2005) for the Department for Environment, Food and Rural Affairs concluded that a single indicator based on total food kilometres is an inadequate indicator of sustainability. The impacts of food transport are complex, and involve many trade-offs between different factors. A single indicator based on total food kilometres travelled would not be a valid indicator of sustainability.

One suggested solution to the problem of indicating the environmental impact that food has on the environment is a measure of greenhouse gas emissions of a product through its life. This approach leads to the display of a carbon label. This measurement, although taking a wider view of the products environmental impact, does not reflect the social and economic burdens such as congestion, accidents and noise.

3.3.4 A Carbon Label

According to the UK Energy centre (UKERC, 2007) ‘the aim of any carbon labelling strategy developed would be to reduce greenhouse gas (GHG) emissions across the whole chain, through informing and influencing producers, retailers and users’.

3.3.4.1 Carbon Trust label

One of the main organisations that back the introduction of a carbon label is the Carbon Trust. The Carbon Trust is an independent private company funded by the Government that aims to help businesses and public organisations to reduce their emissions of carbon dioxide. The Carbon Trust works with businesses to identify energy saving opportunities in turn reducing carbon emissions. They also work with larger organisations to perform ‘Carbon Management’ which aims to manage and reduce

carbon emissions (Carbon Trust, 2006). Although its aim is to help businesses reduce their emissions the Carbon Trust has been criticised by the director general of the British Chambers of Commerce for failing to work with small firms. He argued that all business need to reduce their emissions and should be offer support to achieve this. As an example, he attacked the trust policy for only offering free energy efficiency audits to businesses consuming more than £50,000 of gas and electricity each year (Tyler, 2007).

In March 2007 the Carbon Trust launched a label that aims to show the volume of greenhouse gases released in the manufacture. The label shows the amount of carbon dioxide in grams and a downward arrow to indicate that the company is committed to lower their products carbon emissions.

According to Euan Murray of the Carbon Trust:

“.... The carbon foot printing of products and its communication via the label offers companies the opportunity tackle the indirect carbon emissions from products and help consumers understand the climate impacts of the purchasing decisions they make.”

(Carbon Trust, 2007)

Although the Carbon Trust label is in the early stages of development there have been a number of issues identified. Many of the issues come from the labels use of a statement of fact relating to a measured value of carbon emission rather than an indicating or ‘stamp of approval’ method. The main objective of the label is informing consumers of the impact a particular product has on the environment. As all products will have some degree of impact on the environment consumers are not in a position to choose whether to have an impact on the environment but only the degree of that impact. On its own the label only provides a single piece of data. In order to translate this data into useable information it requires consumers to have a relevant knowledge of how a varying amount of carbon varies the impacts on the environment. This involves a great deal of complexity due to a number of factors including scientific uncertainty and disagreement, comparisons over multiple product types and the fact that the value is supplied per pack and not by weight.

It can be argued that carbon emission measurements allow consumers to compare environmental impact between brands but again without a scale of magnitude the comparison becomes difficult. What real difference to the environment does a 10% difference in carbon emission make? The evaluation of the carbon emissions is also being made with a number of other valuations. For example, is a poor dietary product with a low carbon value better than a healthy product with a high carbon value?

In order to make a comparison between products requires a large percentage of products to display the label. The Carbon Trust label is voluntary and will only be used by companies who are willing to pay for it. For the label to become a legal requirement legislation would have to be introduced by the EU rather than the UK Government.

3.4 Environmental Assessment

As previously discussed, the concept of measuring a products environmental credibility on such indicators as food miles is inadequate and a more detailed assessment is required. From the perspective of a products impact on global warming it is important to assess its carbon emissions.

A report by the University of Surrey (2005) found that the view of carbon emissions was traditionally been seen from a production perspective. From this perspective, categories such as Electricity production and Iron and Steel are the most carbon intensive industries. However, from the alternative perspective of consumer demand, electricity and iron and steel are not consumed directly but are ‘primary inputs’ in the satisfaction of a wide variety of consumer needs. The satisfaction of the consumer needs is ultimately driving the associated carbon emissions. From this perspective it is important to review the carbon emissions that can be attributed to the provision of a product demanded by consumers.

3.4.1 Life Cycle Assessment

In order to assess the environmental impact of a product from the consumption perspective it is necessary to conduct a Life Cycle Assessment (LCA). LCA is a methodology for analysing the environmental interactions of a technological system with the environment. In the late 1990s ISO 14040 was released as a development of the ISO 14000 Environmental Management Standards. These standards provide ground rules for conducting a LCA and defined the terminology to be used. ISO 14040 (1997) defines Life Cycle Assessment as:

- “A technique for assessing the environmental aspects and potential impacts associated with a product.”

The application of LCA involves four distinct phases:

1. Initial phase: setting the system boundaries, defining the problem and establishing an inventory of important parameters
2. Inventory Phase: a detailed description of raw materials and energy inputs used at all points and the emissions, effluent and solid waste outputs.

Examples of output are resource depletion (e.g. material and energy), pollutant emissions and discharges of chemical or physical load (e.g. substances, heat, and noise).

3. Impact Assessment Phase: relating the identified inputs and outputs to the environmental impacts. It involves the following components:
 - Selection of impact categories, category indicators and characterisation models. Impact categories are selected and defined with respect to the goal and scope of the LCA.
 - Assignment of LCA results (Classification). The environmental loads are classified according to the impact categories. (Some environmental loads belong to more than one impact category.)
 - Calculation of category indicator results (Characterisation). The category indicator is modelled for the different environmental loads that cause environmental impacts e.g. the Global Warming Potential.
4. Improvement Phase: using information obtained in analysis to improve overall environmental performance.

3.4.1.1 System boundary

The boundary definition of a LCA is important since it defines what will be considered in the analysis, ignoring the rest of the activities. A narrow boundary definition could lead to significant underestimation of the total discharge inventory. A wide boundary definition could make the analysis intractable.

LCA is often referred to as the cradle-to-grave. This approach incorporates all materials used in the making of a product from the extraction of materials and energy to the return of the materials to earth when the product is finally discarded. Other types of analysis include cradle-to-gate, up to the point where the product or service is delivered, and cradle-to-cradle, to include the re-use of one products grave to become the cradle of another.

The cradle-to-grave approach would give the most complete analysis of a products environmental impact with the inclusion of consumer use-phase data. This could include activities such as getting the product home, storing and using the product that can be a carbon-intensive stage of the product life cycle. An issue with this approach is how to allocate a figure for actual household energy use to specific products, because there are so many permutations. Taking how a product is cooked for example, it may be microwaved or oven cooked. The cooker may be gas or electric and, therefore, contribute differently to greenhouse emissions. The same issue occurs with the

inclusion of waste and recycling. Waste in the production cycle can be measured and included in the emission figures (this can become more complex when waste becomes another product). However, waste generated by consumers, good food not eaten for example, would be difficult to measure or even estimate. Assumptions would also be required for the end of a product life cycle as the method of disposal (recycled or landfill) is down to the consumer.

3.4.1.2 Costs

Even with a simple supply chain and production process a LCA can be very complex. When a company has hundreds of product line and hundreds of suppliers that complexity is multiplied numerous times. This makes the LCA process both time consuming and costly. For example, the Chrysler Ford, General Motors of LCA of an automobile is estimated to have taken five years and cost \$2.7 million.

3.4.1.3 Data accuracy

The most time consuming and costly part of a LCA is the data collection. This will also rely on data provided by suppliers within the supply chain. The collection of data needs to be 'fit for purpose'. A lower level of accuracy would be required for a product life cycle where the objective is to identify process stages to concentrate improvement activities. Where data is used for a consumer label then a higher level of accuracy would be required to avoid legal challenges. If data supplied by a third party is found to be inaccurate then the legitimacy of the end producer's consumer label is compromised. This may require auditing of third parties to ensure data collection procedures are compliant with the end producers adding further cost.

3.4.1.4 Impact Assessment

According to Matthews et al, (2002) "LCA has floundered at the stage of translating an inventory of environmental discharges into estimates of impact on health and environment." They argue that without a full impact analysis policymakers must revert to some simple rule, such as that all discharges, regardless of which chemical, which medium, and where they are discharged, are all equally toxic. To solve this issue they suggest that risk analysis could be conducted to quantify at least some of the impacts by estimating the health effects of the discharges.

3.4.2 Carbon Trust Methodology

The Carbon Trust defines a Carbon Footprint as:

"...a methodology to estimate the total emission of greenhouse gases (GHG) in carbon equivalents from a product across its life cycle from the production of raw material used in its manufacture, to disposal of the finished product (excluding in-use emissions).

"...a technique for identifying and measuring the individual greenhouse gas emissions from each activity within a supply chain process step and the framework for attributing these to each output product (we [The Carbon Trust] will refer to this as the product's 'carbon footprint')." (Carbon Trust 2007)

In order to establish the carbon footprint of a product the Carbon Trust has developed its own methodology. The Carbon Trusts methodology comprises five steps, with each step covering several activities and building on the previous steps. The key steps are:

Step 1 – Analysis of the internal product data

Step 2 – Build a supply chain process map

Step 3 – Define the boundary conditions and identify data requirements

Step 4 – Collect the primary and secondary data

Step 5 – Calculate GHG emissions by supply chain process steps

3.4.2.1 Boundary definition

The Carbon Trust Methodology uses the cradle to grave approach but currently excludes certain stages. It includes steps up to the arrival of the product at the retail store plus disposal. Emissions in-store, for example heating, lighting and refrigeration are not included. Emissions of the product in use are not included in the assessment, as the company has limited influence in use behaviour. One issue with the boundaries used is that it could lead companies to developing products that are low emissions in production but high in usage.

Within the current version of the methodology the savings gain by using a waste product as the raw material of a new product cannot be included in the calculation of the total emissions of a product. In the case of Pebblebed the main waste product is the glass bottle after the consumer has used the original product.

According to Defra, Recycling of glass can yield significant greenhouse gas benefits dependent on the processing route, with closed loop recycling (e.g. container glass

recycled as containers) offering significantly greater benefits than lower grade uses (such as in aggregate substitutes), which may yield only marginal benefits.

Glass manufacture is a high-temperature energy-intensive process. When using raw materials, glass is manufactured from sand, limestone and soda ash, all of which are abundant natural minerals. However, both limestone and soda ash are carbonates that liberate additional CO₂ during the melting process. One of the virtues of glass is that it can be endlessly re-melted and recycled without any loss in quality. The glass industry has long since realised the benefits of using recycled glass (cullet) in its processes. If more recycled glass can be reprocessed into new bottles then fewer raw materials need be quarried. Each tonne of glass returned to the melting furnaces reduces our demand on raw materials by 1.2 tonnes (GTS 2004). Using recycled glass to produce new items reduces CO₂ emissions in two ways:

- it is easier to melt than the individual raw materials so uses less fuel
- it contains no carbonates so it does not release any CO₂ during the melting process

It is easy to see that with a waste product such as a glass bottles the impact that eventually disposal method and the use of this waste can have a significant impact on total emissions.

3.4.2.2 Reference Data

The methodology states that ideally primary data should be used but where this is not possible that secondary data can be used. The Carbon Trust does not provide any secondary data or suggest where the responsibility for creating secondary data should lie. If companies with limited resources wish to produce an emission estimate then they would rely heavily on secondary data. The need of a reference data set is clear but who pays for the creation and management up for debate.

3.4.3 Other environmental factors

The LCA as defined in ISO 14000 states that the identified inputs and outputs of the assessment should be assigned to the impact on various categories of impact to the environment. The Carbon Trust only applies to the affect on the green house effect. If companies are attempting to conduct an environmental impact assessment then other environmental impacts should be considered.

4 Results

The results of the Life Cycle Assessment conducted for a bottle of Pebblebed wine produced an estimate of 525g of CO₂ emissions per bottle. The full sets of results are shown in Appendix B.

4.1 The Life Cycle

The life cycle of a bottle of Pebblebed wine was mapped as the below 9 steps:

1. **Conversation of the land**
Ploughing of ground, installation of ground cover and installation of vine supports
2. **Growing on (Pre-production)**
General maintenance for three years prior to first yield
3. **Production of grapes**
Picking of grapes, transport of grapes to winery
4. **Processing of grapes**
Activities at the winery
5. **Bottling**
Production and importing of bottle
6. **Selling of wine**
Distribution and marketing activities
7. **Retailer activities**
Storage, heating and lighting of store
8. **Consumer actions**
Collection from retailers and storage
9. **Disposal**
Landfill and recycling

4.2 Setting of boundaries

As stated in the Carbon Trust Methodology the products carbon footprint used in the product label includes steps up to the arrival of the product at the retail store plus disposal. Emissions in-store, for example heating, lighting and refrigeration are not included. Emissions of the product in use are not included in the assessment, as the company has limited influence in use behaviour. Therefore sections 7 and 8 of the mapped steps were not included in the emissions assessment.

4.3 Analysis by process step

As figure1 shows the actual production of the bottles is by far the most significant stage.

Figure 1: CO₂ emissions per bottle of wine by life cycle stage

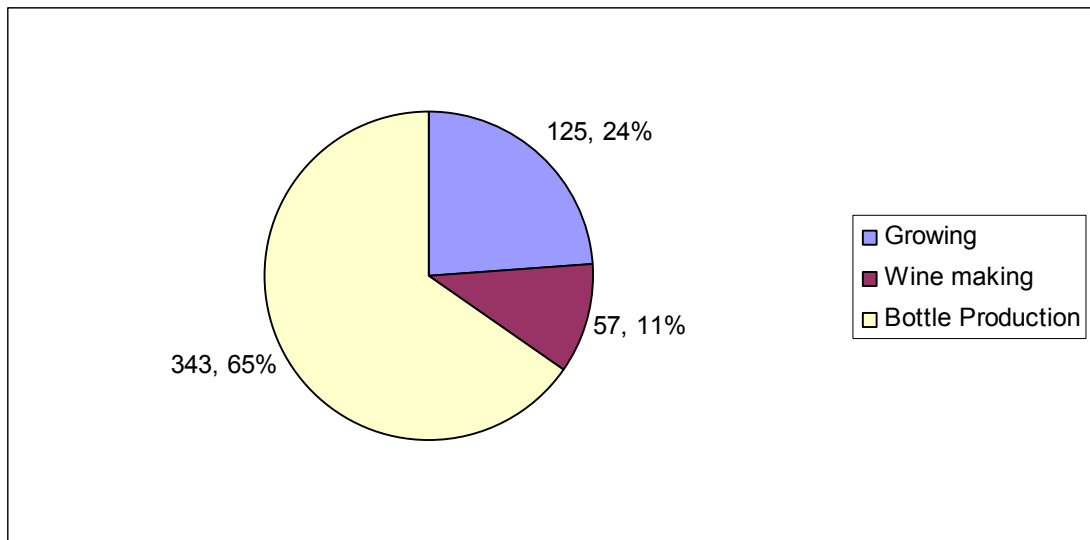
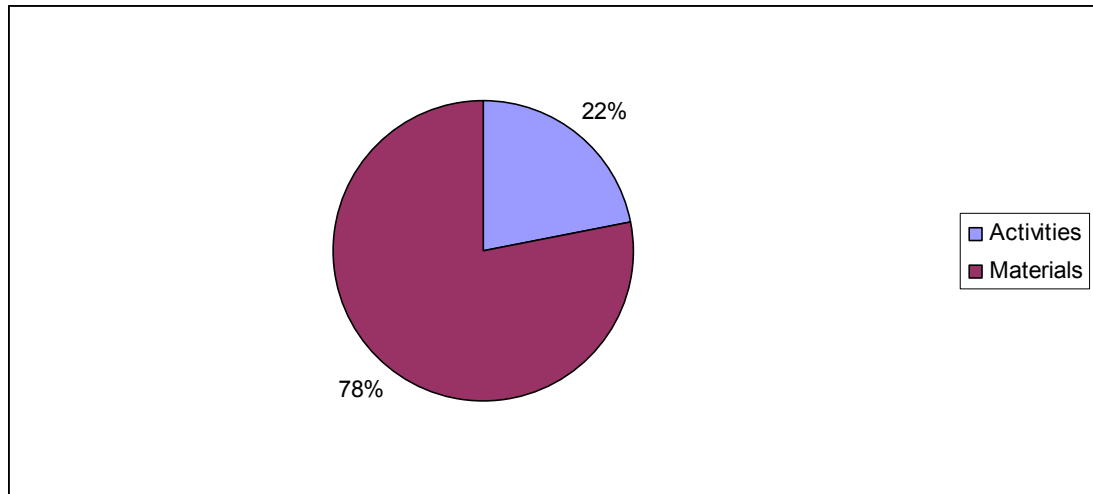


Figure 2 shows that within the growing process the embodied carbon in the materials requires is much larger than the emissions as a result of the required activities.

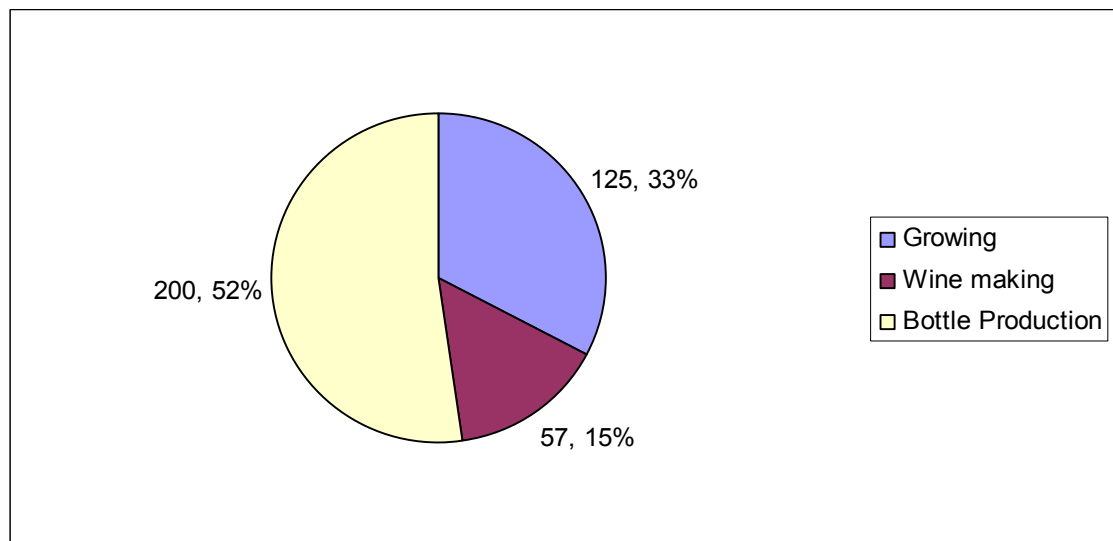
Figure 2: Percentage of CO₂ emissions by type within growing process



4.4 Including recycling

When including the reduction provided by re-cycling glass gives a lower product estimation of 382 grams. Figure 3 shows that the production of the bottle still contributes the most carbon emissions to the total.

Figure 3: CO₂ emissions per bottle of wine by life cycle stage including recycling



5 Discussion

5.1 Business Drivers

The consensus that human activity is having an impact on climate change is certainly growing. There still remains debate over the scale of this impact and the costs of abatement but there seems a general agreement that something needs to be done.

The ratification of the Kyoto Protocol by many of the world's nations has provided a framework for a combined effort to reduce the impact that human activity has on climate change. The UK Government is still in the early stages of developing its plan to tackle green house emissions, however it has already set the targets for emission reductions that it plans to achieve. The commissioning of the Stern Report was the first step in the attempt to gain an understanding of the issues involved and the level of action require. So far the main regulation introduced has been the Climate Change Levy to tax business and the public sector for their energy use.

For businesses there are a number of drivers in terms of both threats and opportunities to involve environmental issues in day-to-day business and strategic decisions. How these drivers are perceived and acted on will depend on a number of factors.

The main drivers can be grouped into three headings:

Regulation

As discussed regulation can be an important tool in controlling negative externalities especially when the consequences have such a large affect on the whole population over such a long time frame. In the first instance companies must allocate resources to comply with existing regulation. Companies must also review the risk and opportunities that new regulation may bring.

Cost reduction

While attempting to reduce a company's environmental impact it can at the same time reduce its costs. The reduction in energy usage brings both cost savings and emission reductions. With ever increasing energy costs and the introduction of taxation such as the CCL there is an increase imperative to reduce energy usage.

Reputation

For a long time now the reputation of a company has been seen as an important factor for long-term success but more and more the ability to simply compete in many markets. Previous practices such as dumping of toxic waste and the use of child labour have been significantly reduced due to a combination of regulation and consumer pressure. The attributes required for good reputation are increasing from simple adherence to regulation to proactive development of best practice in environmental and ethical issues.

5.2 Conducting the assessment

The response to these drivers requires a number of decisions to be taken in both the short term and long term. For a company like Pebblebed conducting a Life Cycle Assessment is one way of providing some of the required information to make informed decisions and be as prepared as possible for the uncertainties associated.

One of the benefits of conducting a LCA is to formally record the supply chain and production processes. When the processes are broken down to include estimates or measurements of the energy consumption and material inputs it becomes easier to identify 'hot spots'. This allows process improvement effort to be concentrated in the most effect way and hence provide the greatest cost reductions. Having these measurements also prepares the company for possible future regulation for example on emission quotas or reporting requirements. By just undertaking the LCA the company can show its commitment to environmental issues. If the LCA shows an existing low impact to the environment then this can be levered to enhance its reputation further.

The main concept of the Life Cycle Assessment is that it covers the full life cycle and not just the processes of the company conducting the assessment. Even though Pebblebed produces the main raw material input for its end product it still relies on a large amount of secondary data. The most ideal situation would be to use data from suppliers who have taken their own measurements, however, very few companies provide embodied emission data for products they produce. This means that general material data has to be used but the availability of this secondary data is very limited and often requires compromises to be made by using the most suitable data published.

Pebblebed is a small company with only one full time employee. To carry out a LCA with limited resources necessitates a large number of assumptions and estimates to be made. The combination of the required estimations and the use of secondary data could suggest that the confidence in the estimation is questionable.

5.3 Suitable Strategy

The objective of this research project was to measure the carbon footprint of a bottle of wine produced by Pebblebed Wines. This was achieved by conducting the Life Cycle Assessment and gave a carbon footprint estimate of 525 grams of CO₂ per bottle. A further objective was to understand what this meant for the company. Using the information gathered from the LCA, the interview with the company and the existing academic theory I have evaluated the suitability of the four Environmental Strategies suggested by Orsato (2006) and discussed in Section 4.5

Eco-efficiency

In terms of productivity, there are areas identified by the LCA that could be improved and in turn reduce costs.

Transport

The transport of the grapes to the winery and bottles to the cellar are responsible for a relatively small percentage of the total carbon emissions. The current process involves multiple journeys of small batches made by car. As production increases it may be more economical transport larger batches in a larger vehicle.

Production

Currently the processing of the grapes is done by a third party which Pebblebed has little control over and power in the supply chain would not be significant to change this. As the Pebbled Vineyard increases in size the economies of scale would allow for the investment in its own winery. With the current process the running of the diesel generator to produce the wine contributes 46% of the total emissions from activities. By starting a winery Pebblebed could gain greater control of the production process for creating the wine and using renewable energy such as Solar Photovoltaic Panels we reduce both running costs and emissions. If the winery were built near the vineyards then this would also reduce the current transport requirement to and from the winery in Bickleigh.

Packaging

Although the production of the wine bottle is the most carbon intensive part of the production process the actual cost of the bottle is less than 1% of the cost price.

As discussed in the interview with Pebblebed, the product is targeted at the high to medium end of the wine market. Due to the market segment that Pebblebed targets, the product is relatively price elastic and with the magnitude of cost savings achievable it would suggest that this would not generate a competitive advantage. Even though this would not be recommended as a suitable strategy, any opportunities to reduce cost and emissions should be investigated to increase profits.

Beyond Compliance Leadership

In the food and beverage market that Pebblebed operates in, the current environmental legislation is mainly around pollution into the land and waterways. It tends to focus on management of hazardous materials and not on the production of green house gases. As a business to consumer company the probability of compliance to schemes such as ISO 14000 as a 'license to operate' is low. This would suggest that compliance leadership would not be suitable due to the market that Pebblebed supplies.

Environmental Cost Leadership

This strategy is suggested for markets where margins are low and there is a constant tightening of environmental regulations. This would suggest that environmental cost leadership would not be suitable due to the market that Pebblebed supplies.

Eco-Branding

This strategy uses marketing differentiation based on environmental attributes. Orsato assumes that this strategy will lead to higher costs but that this would allow the product to command a price premium in the market place. It may be possible for Pebblebed to achieve this differentiation at no extra cost due to its main competitors incurring negative environmental attributes due to the physical distance to market. As identified in the LCA, the production of the bottle is the greatest contributor to the overall carbon emissions. Alternative packaging could be investigated but this could compromise the image of the product. English wine already suffers from a historically poor quality reputation and the introduction of substitute packaging such as a plastic bottle or cardboard carton may prove detrimental. Pebblebed is currently investigating the re-use of its wine

bottles by high pressured cleaning rather than traditional recycling. If this was to succeed then this could provide further environmental benefit and further differentiation.

It is interesting to note that due to the association with wine production and the need for hot climates that global warming could be seen as a benefit to the reputation of English wine production.

As suggested in section 3.2, for this strategy to be successful, Pebblebed needs to satisfy the three requirements:

The business must find, or create, a willingness among customers to pay for environmental quality.

The willingness to pay for environmental quality is being drive by both the public and private sector. With climate change continuing to rise up the political agenda and the creation of NGOs such as the Carbon Trust there is continual promotion of the importance of businesses and citizens to take personal responsibility of their own carbon footprint. According to Oxfam (2007) the number of weather-related disasters has quadrupled over the past twenty years. The increasing media coverage of these events could be another factor in increase the public's awareness and interest in Global Warming.

A poll of 1200 people conducted by the Carbon Trust found that three-quarters of consumers were concerned about climate change and their own carbon footprint. They also found that environmental concerns influenced more than 50% of buying decisions. As discussed previously, there is often a contradiction between consumers stated actions and their actual actions. Although the study of the Nordic Swan showed that consumers were willing to pay a premium price for an environmentally superior product this only cover a limited product range and there is still the question of the influence of the attitude of consumers in the Nordic countries.

The business must establish credible information about the environmental attributes of its products.

The question arises whether Pebblebed could declare its own carbon emissions or whether it would require the association with a third party organisation. It could be assumed that the Carbon Trust label would provide this credibility but it does so at a

cost. There is no publicly available data on the costs involved being accredited by the Carbon Trust but early adaptors of the label such as Walkers crisp and Boots shampoo would suggest a sizable investment.

This assumption may also not be that clear-cut. It is still open to debate if consumers would understand a label stating the value of products CO₂ emissions if it were provided. Reinhardt states that business must establish credible information about the environmental attributes of its products but does not consider the credibility of the environmental issue itself. Although the consensus that action is required on climate change, the response required is still being debated. It seems that with issue that is so complex and with so many uncertainties that providing a measurement of CO₂ emissions could be seen as unsuitable.

Its innovation must be defensible against imitation by competitors.

Due to the lack of publicly available information on the carbon footprint of wine produced by other vineyards it is difficult to say whether this value is 'good' or 'bad'.

An article that appeared on in The Times (2005) recommended, as part of a 'Low Carbon Diet', that consumers should buy a bottle of French wine instead of New Zealand vintage. This led to a number of defensive articles by wine producers and academics within New Zealand claiming that the report was 'inaccurate and misleading'.

Even though food miles are seen as an inadequate measure of a products impact, it is an easier concept for consumers to understand than a carbon label. For that reason, with wine, it would seem that the onus to prove the environmental credentials would lie with the 'New World' wine producers. To reduce the carbon impact of wine coming from thousand of miles away producers are amending their processes such as shipping wine in bulk containers and bottling in the UK. To this extent the environmental advantage of UK wine will be reduced but probably not completely removed.

It would seem that Eco-branding would be the most appropriate for strategy for Pebblebed to adopt. It would also complement the existing product differentiation provided due to its organic status and that it is produced locally.

6 Conclusion

Climate change is a complex issue. There is still debate whether global warming is part of the earth's natural cycle or whether it's caused by human activity. Those that do agree that human activity is to blame still debate what the long term affects will be and what should be done to about it.

An issue such as climate change, which has a global impact into the far-reaching future, requires intervention of the state. It is the role of each country's Government to balance both the growth and sustainability of their economies. To do this effectively requires the use of regulation and a reliance on market forces.

As with all changes in a market that a business operates in, they will need to adapt in order to negotiate the risks and benefit from the opportunities. Gaining an understanding of the impact that a business has on the environment places it in a better position to decide on a strategy to create a competitive advantage.

Conducting a life cycle assessment (LCA) is one way for a business to gain such an understanding, however, to complete a full LCA is a complex process that requires a great deal of resources. For a business like Pebblebed conducting a high level LCA provides an understanding of its supply chain and identifies where effort to reduce emissions should be targeted. Based on the interview with the business owner and the results of the LCA it is suggested that the best strategy for Pebblebed to adopt would be to use its environmental qualities to differentiate their product in the market. The use of the estimated value of the carbon dioxide emissions per bottle on a consumer label is questionable. Without information on competing wine producers carbon emissions it would be difficult for consumers to evaluate Pebblebed's declaration. To ensure that declaring this information would prove to be positive attribute to consumers would require investigation into consumers understanding of a carbon label as proposed by the carbon trust. An alternative use of the information gathered in the LCA would be to declare that Pebblebed is actively looking to measure and reduce its carbon footprint.

7 Appendix

7.1 Appendix A

Interview conducted with owner of Pebblebed wine

Who do you see as your target market?

The majority of sales are with the local area. An estimated 90% of sales are within 50 miles. There is a lot of local support. This includes word of mouth sales to individual consumers. It can be difficult to persuade local pubs and restaurants to stock the wine as a number of local places are owned by larger companies who have a specified wine selection. Some wine is sold in London via specialised organic suppliers such as Abel and Cole. The wine is also targeted as a present or gift. It can be an interesting conversation topic when taken to a dinner party for example. Pebblebed wine at £9 per bottle is priced at the higher end of the market.

Who do you see as you main competition?

The wine is not competing with the £4 bottles in the supermarkets which are bought as 'every day' wine. Some New Zealand wine is being priced at the medium price level.

How does your supply chain work?

Local volunteers pick the grapes at harvest time and it's seen as a day out. The grapes are then taken to the winery in Bickleigh where they are turned into wine and bottled. The wine is then brought back to the cellar in Topsham. The wine is sold from the cellar and delivered to local retailers and restaurants. Geoff currently does this. Couriers can be unreliable and the wine needs extra packaging to reduce damages. One issue is the logistics of supplying the wine around the area. Geoff tries to combine as many deliveries as possible without keeping customers waiting. Using intermediaries would solve the logistic issues but their charges are too high to make that a viable option.

Are there any pressures in your supply chain?

There aren't any pressures perceived within the supply chain. Geoff chooses who he supplies and would not consider supplying a large supermarket. This is due to Geoff's beliefs about the ethics of supermarkets.

Do you see the business changing?

The business is looking to expand from current production of 12,000 bottles to 100,000 bottles per annum. Geoff is currently looking for suitable areas to start vineyards and this is often done in partnership with local farmers and their unused land.

Geoff would like to start his own winery when the production volumes make it viable.

What do you see as the risks to your business?

The main risk to the business comes from the uncertainty of the yield from the vineyards. A bad summer can severely affect the business. This risk is reduced as more vineyards are introduced and could be further reduced by partnering other vineyards

What do you see as the opportunities for your business?

The attitudes of consumers to English wine are changing. A number of English wines have won awards while competing against established wine producing companies. The effects of global warming are not only making people consider the products they are buying but also support the concept of being able to produce wine in the UK.

Do you currently have any environmental certification such as ISO 14000? The Soil Association is currently certifying Pebblebed for organic status. Not interested in an Environmental Management System (EMS) as there is too much paper work. He thinks that EMS are suitable for a B2B company but not for a B2C company like Pebblebed. He does have a number of environmental initiatives that he is working on including bottle re-usage.

7.2 Appendix B

Activities

Pre Production

Task	Description	Activity	Amount/Distance	Fuel per km	Factor	Total kg CO2	Reference	Comments
Ploughing of land	Ploughing of land	Use of 100 litres of diesel	100		2.63	263	Defra	
Ground cover	Installation of plastic groundcover on 5ha	Install plastic 100 litres of diesel	100		2.63	263	Defra	
Vines	50% from local source – 6000 vines from nursery in France	500 miles travel by land - lorry	800	0.414	2.63	871	Defra	Articulated lorry 75% laden. Assume one full load
Posts	Wooden posts from sustainable forests in UK	500 miles travel by land - lorry	800	0.414	2.63	871	Defra	Articulated lorry 75% laden. Assume one full load
Wire	Wire for trellis	1000 miles travel by land - lorry	1600	0.414	2.63	174	Defra	Articulated lorry 75% laden. Assume 10% of load
Sundries	Variety of nails, ties etc	50 miles distributed by land - lorry	80	0.414	2.63	9	Defra	Articulated lorry 75% laden. Assume 10% of load
Looking after vineyard	3 yrs work - General maintenance – travel to vineyard grass cutting	1000 Car miles	1000		0.31	310	Defra	

Production

Task	Description	Activity	Amount/Distance	Fuel per km	Factor	Total kg CO2	Reference	Comments
Picking	Done with local labour – day out no increase in travel							
Transport of grapes to winery	Grapes taken to Bickleigh winery	2000 Car miles	2000		0.31	620	Defra	
Pruning of vines	Vines pruned over winter months	100 Car miles	100		0.31	31	Defra	
Processing of Grapes	Diesel Generator for 50 batches. 3 litres per hour x 10 hours.	1500 litres diesel	1500		2.63	3945	Defra	

Packaging and Distribution

Task	Description	Activity	Amount/Distance	Fuel per km	Factor	Total kg CO2	Reference	Comments
Bottles	Bottles imported from central France by road	500 miles travel by land – lorry	800	0.414	2.63	871	Defra	Articulated lorry 75% laden. Assume one full load
PR	Marketing activity	200 Car miles	200		0.31	62	Defra	
Selling of Wine	60% sold very locally	300 Car miles	500		0.31	155	Defra	
	30 % sold in Devon							
	10% sold outside Devon (mainly Sussex/London)							

Materials

Pre-Production

Task	Description	Input	No of items	CO2 rating per item	Total kg CO2	Reference	Comments
Ploughing of land	Ploughing of land						
Ground cover	Installation of plastic groundcover on 5ha	20,000m2 of woven plastic	400	2.53	1012	ICE	20g per m2
Vines	50% from local source – 6000 vines from nursery in France						
Posts	Wooden posts from sustainable forests in UK	4000 wooden posts. 3kg per post gives 120 tonnes	12000	0.476	5712	ICE	
Wire	Wire for trellis	100km of wire	1000	2.83	2830	ICE	10g per metre
Sundries	Variety of nails, ties etc	10,000 nails	50	2.83	141.5	ICE	5g each
		20,000 ties	24	2.53	60.72	ICE	1.2g each

Packaging and Distribution

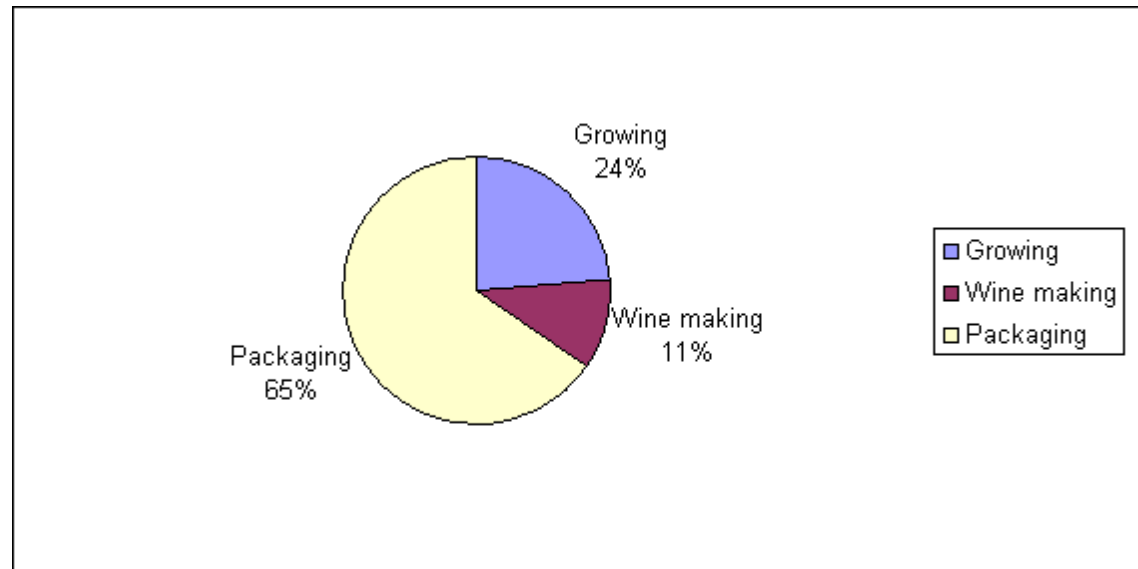
Task	Description	Input	No of items	CO2 rating per item	Total kg CO2	Reference	Comments
Bottle	Production of wine bottle		100000	0.343	34300		From Food Climate Research Network
Disposal	Bottles to Landfill		25	10	250	Defra	50% Landfill. Percentage taken from www.recyclenow.com
	Bottles recycled		25	-574	-14350	Defra	

Totals

Excluding Recycling factor

	Total	Activities	Materials
Growing	125	2761	9758.22
Wine making	57	5684	0
Packaging	343	0	34300
Total	525	8445	44058

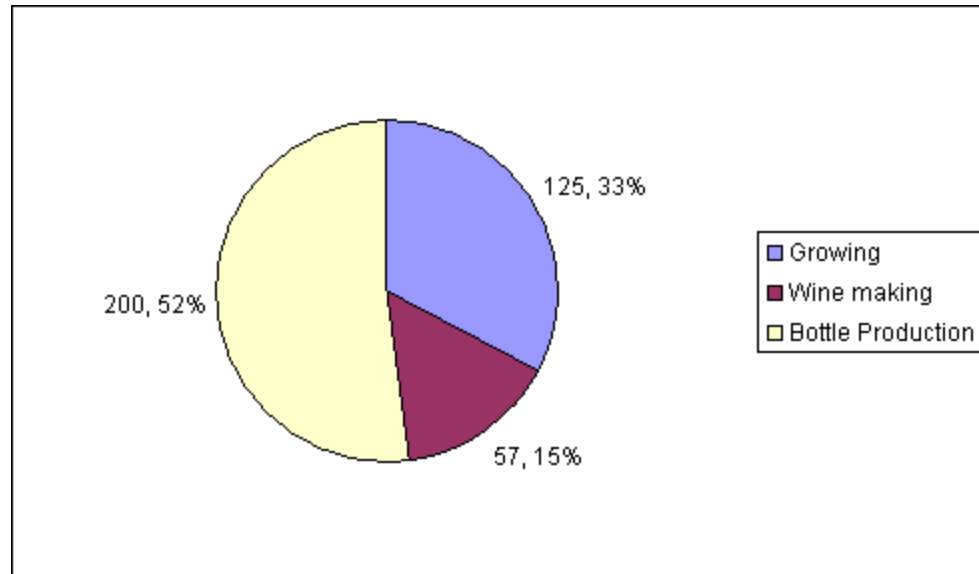
Per bottle 0.525 Kg
 525 g



Including Recycling Factor

	Total	Activities	Materials
Growing	125	2761	9758
Wine making	57	5684	0
Packaging	56	0	19950
Total	238	8445	29708

Per bottle 0.238 kg
 238 g



8 References

Aranda, A., Scarpellini, S. & Zabalza, I. (2005). 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 Tertiary Sector.

BBC (2006). UK Planning law on climate change.

[www Document]. URL

http://news.bbc.co.uk/1/hi/uk_politics/6045680.stm

(accessed on 12/06/2007)

Blair, T. (2004). Speech by the Prime Minister at the launch of the Climate Group.

[www Document]. URL

<http://www.number-10.gov.uk/output/page5716.asp>

(accessed on 05/06/2007)

Bjorner, T., Hansen, L. and Russell, C. (2004). Environmental labelling and consumers' choice—an empirical analysis of the effect of the Nordic Swan. *Journal of Environmental Economics and Management* Volume 47, Number 3, 2004

Carbon Footprint LTD (2007). Carbon definition

[www Document]. URL

<http://www.carbonfootprint.com/>

(accessed on 07/05/2007)

Case, S. (2004). Eco labels: Making Environmental Purchasing easier? *Government Procurement*. Jun-04

Collins-Chobanian, S. 2001. A Proposal for Environmental Labels: Informing Consumers of the Real Costs of Consumption. *The Journal of Social Philosophy*. Volume 32, Number 3

Carbon Trust (2006) Solutions

[www Document]. URL

<http://www.carbontrust.co.uk/solutions>

(accessed on 12/06/2007)

Carbon Trust (2007) Carbon Trust Labelling Scheme rolls out across country

[www Document]. URL

http://www.carbontrust.co.uk/about/presscentre/260707_CT_label.htm

(accessed on 12/06/2007)

DEFRA (2006). Food Industry Sustainability Strategy. *Department for Environment, Food and Rural Affairs*. 2006

Gulbrandsen, L. (2006). Creating markets for eco-labelling: are consumers insignificant? *International Journal of Consumer Studies*. 5, September 2006, pp477–489

GTS (2004). Carbon Trust study proves the benefit of using recycled glass.

[www Document]. URL

<http://www.glass-ts.com/News/PressArchive/PressReleases6.html>

(accessed on 01/05/2007)

Gunningham, N. (1995) Environment, Self-regulation and the Chemical Industry: Assessing Responsible care. *Australian Centre for Environmental Law: Environmental and Policy Papers*. 1995

Horsham District Council (2005) Festival toasts English wines.

[www Document]. URL

http://www.horsham.gov.uk/your_area/News/news_5425.asp

(accessed on 22/06/2007)

HM Treasury (2005) Background to Stern Review on the Economics of Climate Change. [www Document]. URL
http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_backgroundtoreview.cfm#terms
(accessed on 13/05/2007)

IPCC (2007) Working group 1: Scientific Basis.
[www Document]. URL
http://www.grida.no/climate/ipcc_tar/wg1/518.htm
(accessed on 12/06/2007)

Jaffe, A.B. and Palmer, K. (1997): “Environmental regulation and innovation: A panel data study”, *Review of Economics and Statistics*, Vol. 79, No. 4, pp.610-619.

Leveque, F. (1996) Environmental Policy in Europe – Industry, Competition and the Policy Process. Cheltenham: Edward Elgar

Matthews H., Lave L., MacLean H. (2002). Life Cycle Impact Assessment: A Challenge for Risk Analyst. *Risk Analysis* Vol. 22, No.5, 2002

Met Office (2005) Climate change and the greenhouse effect. Hadley Centre. Dec 2005
[www Document]. URL
http://www.metoffice.gov.uk/research/hadleycentre/models/climate_system.html
(accessed on 01/05/2007)

Met Office (2007) Climate Systems [www Document]. URL
http://www.metoffice.gov.uk/research/hadleycentre/models/climate_system.html
(accessed on 23/05/2007)

Mendelsohn,R. (2006) A Critique of the Stern Report. *Regulation*. Winter 2006-2007

New Scientist (2007). Climate myths: CO2 isn't the most important greenhouse gas.
[www Document]. URL
<http://environment.newscientist.com/channel/earth/climate-change/dn11652>
(accessed on 12/06/2007)

Orsato, R.(2006) Competitive Environmental Strategies: When does it pay to be green?
California Management Review. Vol. 48, No.2 Winter 2006.

Oxfam (2007). Weather disasters getting worse.

[www Document]. URL

<http://news.bbc.co.uk/1/hi/world/7111623.stm>

(accessed on 3/7/2007)

Porter, M. (1991) America's green strategy, *Scientific American*, April, p. 96.

Porter, M. and Van de Linde, C. Green and Competitive: Ending the Stalemate.

Harvard Business Review. September-October 1995.

Reinhardt, F.(1998). Environmental Product Differentiation: Implications for Corporate Strategy. *California Management Review*, 40/4 Summer 1998: 43-73.

Reinhardt, F.(1999). Market Failure and the Environmental Policies of Firms: Economic Rationales for 'Beyond Compliance' Behaviour," *Journal of Industrial Ecology*, 3/1 (1999): 9-21

The Times Online (2005). Shrink your carbon footprint.

[www Document]. URL

http://women.timesonline.co.uk/tol/life_and_style/women/body_and_soul/article1679066.ece

Tyler, R. 2007. Carbon Trust hits back over small firms.

[www Document]. URL

<http://www.telegraph.co.uk/money/main.jhtml?xml=/money/2007/07/02/ybnenvironment102.xml>

(accessed on 12/06/2007)

UKERC (2007) Carbon Labelling Roundtable Report. *Environmental Change Institute*. May 2007

UNFCCC (2007). Article 2 of the Convention definitions.

[www Document]. URL

http://unfccc.int/essential_background/convention/background/items/1353.php

(accessed on 04/05/2007)

University of Surrey (2005). UK Carbon Attribution Model. *Centre for Environmental Strategy*. 2005

Waddock, S. and Bodwell, C. (2004) Managing Responsibility: What Can Be Learned from the Quality Movement? *California Management Review*. Vol. 47, No. 1 Fall 2004

Watkiss, P (2005) The Validity of Food Miles as an Indicator of Sustainable Development: Final report. *AEA Technology*. July 2005

White, R. (2007) Carbon governance from a systems perspective: an investigation of food production and consumption in the UK. *ECEEE 2007*

Winefacts (2007). Australian Wine and Brandy Company

[www Document]. URL

<https://www.awbc.com.au/winefacts/data/default.asp>

(accessed on 23/07/2007)