Assessing the environmental credentials of Australian wine

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Life cycle analysis (LCA) is a method for assessing the environmental impact of a product or process, taking into account all of the steps from 'cradle to grave'. While LCA has been used to assess specific Australian wine products in the past, this is the first time the method has been used to examine the environmental impact of the Australian wine industry as a whole. An indicative carbon footprint of Australian wine was calculated and found to be relatively low, but the analysis also identified particular 'hot spots' where improvements could be realised.

INTRODUCTION

As a product of agriculture that is marketed in terms of its place of origin, wine has an important connection to the land and the environment. The Australian wine industry has a strong image of being clean and green, which is essential to its reputation in many markets. Alongside this, many international markets are starting to include sustainability metrics for the products that they sell. A number of major retailers including Walmart, Tesco and Systembolaget (the Swedish liquor monopoly) have introduced sustainability criteria into their sourcing policies, or offer specific contracts for sustainably produced goods. As the world continues to grapple with the effects of climate change and strives to transition to a low carbon economy, these types of supply arrangements may become more common and require industry-wide solutions.

Entwine is the Australian wine industry's umbrella environmental assurance program and was developed by the Winemakers' Federation of Australia in 2009 to help wine producers communicate their commitment to environmental management and improve market access. Members of Entwine report environmental data such as electricity, fuel and water use from their grapegrowing and winemaking businesses on an annual basis. Applying the method of life cycle analysis to the aggregated Entwine data has allowed calculation of an indicative greenhouse gas emission profile of Australian wine, for both bottled and cask formats, as well as domestic and export sales in bulk and bottled formats.

AT A GLANCE

- Sustainability metrics are becoming increasingly important for wine retailers, particularly in international markets.
- Entwine, the Australian wine industry's environmental assurance program, provides a mechanism for Australian grapegrowers and winemakers to demonstrate their commitment to sustainability.
- Entwine collects environmental data from its vineyard and winery members annually and this data is used by members to benchmark their performance and identify opportunities for improvement.
- For the first time, the method of life cycle analysis (LCA) has been applied to the aggregated Entwine data to develop a picture of the overall carbon footprint of the Australian wine industry.

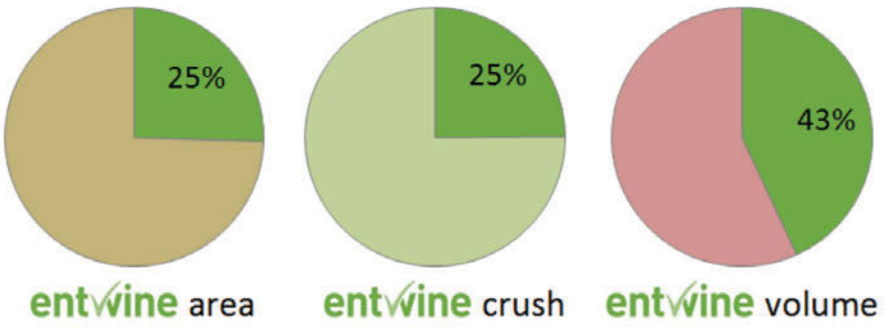

Figure 1. Entwine data coverage.

WHAT IS LIFE CYCLE ASSESSMENT?

Life cycle assessment (LCA) is a method for assessing the environmental impact and performance of processes and products. Life cycle assessments are typically said to be either 'cradle to grave' – considering all impacts from extraction and processing of raw materials, energy production, use, recycling and disposal – or 'cradle to gate' – considering all impacts until the product leaves the producer. An LCA on grapes may be performed up to the point of leaving the vineyard gate, ready for a winery to use the data in its own LCA. Likewise an LCA on a bottle of wine may be performed up to the winery gate, or to also include transport, sale and disposal of the packaging. Cradle to gate assessments are useful for intermediate products that will be further processed by another producer, like winegrapes. Cradle to grave assessments are usually used for finished products destined for the consumer, such as bottled wine.

When an environmental claim is made about a product, international

standards require this to be backed up by science-based methods like LCA. The methodology has evolved with the aim of minimising misleading claims by making sure that the whole story is always taken into account. A classic example is the introduction of the first hybrid electric cars. On one hand, these vehicles consumed far less fuel than conventional motors, but they were also criticised for needing a lot more energy to produce the lithium-ion batteries that powered them. These facts were traded back and forth in isolation until LCA was used to settle the matter by looking at the entire production, use and disposal cycle as one. The analysis eventually showed that the hybrid vehicle caused fewer carbon emissions over its life cycle than conventional vehicles (Burnham *et al.* 2006).

LCA can be used to investigate a number of different environmental impacts such as atmospheric acidification (leading to acid rain), eutrophication (leading to algal bloom in waterways), and ozone depletion. However, the most common assessment is global warming potential (GWP) or the carbon footprint. This category is arguably the most pressing environmental concern facing the world and, indeed, the wine industry, contributing to compressed vintages and impacting on grape and wine quality (Webb *et al.* 2010). GWP is measured in carbon dioxide equivalents (CO_2e), a unit which converts all greenhouse gases, like methane, nitrous oxide and refrigerants, to a single common basis.

THE ENTWINE DATABASE

The Entwine program collects comprehensive data from vineyards and wineries on their fuel and electricity use, water use, nitrogen input, and a range of other metrics that contribute to production efficiency and environmental performance. This year the data collection was expanded to enable onsite carbon footprint calculation and the ability for users to benchmark their operations against their peers.

The Entwine database currently covers a considerable proportion of Australia's grape and wine production, approximately 25% of the total vineyard area and tonnage harvested from vineyards, and 43% of the volume produced by wineries. This makes it a useful data source from which to draw a representative sample and model the industry as a whole. As more Australian grapegrowers and wineries commit to environmental management and become involved with the Entwine program, the accuracy of the data will increase, as will its usefulness as a communication tool. The Entwine database combined with data from other sources allowed an overall LCA of Australian wine to be performed. It is important to note that the data collected and the analysis conducted have not been independently verified, which means that the results of the LCA should be considered indicative only at this stage. The LCA analysis, however, provides a good example of how the data collected through Entwine can be applied.

THE LIFE CYCLE OF AUSTRALIAN WINE

Methods

The model used to calculate the average carbon footprint for Australian wine drew on primary production data from the Entwine database. Averages for small, medium and large sites were developed to capture scale effects. The model was weighted to represent the incidence of these sized sites throughout the industry. Additional data were taken from the Australian Bureau of Statistics, the National Water Commission, O-I Glass and previous wine industry LCA projects.

The model incorporated the proportion of wine sold domestically and exported to different markets, including the different formats in which they are delivered, according to Wine Australia export data. The breakdown of packaging formats by market type is given in Table 1. Standard 500g glass bottle weights were assumed, but the impact of lightweight glass was also assessed separately.

Table 1. Sales formats for Australian wine.

Domestic Sales	36%	Export Sales	64%
Cask	32%	**Bulk**	57%
Bottle	68%	**Bottle**	43%

Results

The indicative cradle to grave carbon footprint of Australian wine was calculated to be 1.16kg CO_2e/L. This is at the lower end of the range of results found for wine production in other LCA studies: 1.11-4.68 kg CO_2e/L (Amienyo *et al.* 2014), and is also lower than that seen in other AWRI studies performed for individual wineries. This result is probably a reflection of the fact that 65% of Australian wine is produced in large facilities with the benefit of high economies of scale, whereas most published LCA studies have been performed for small to medium-sized single producers.

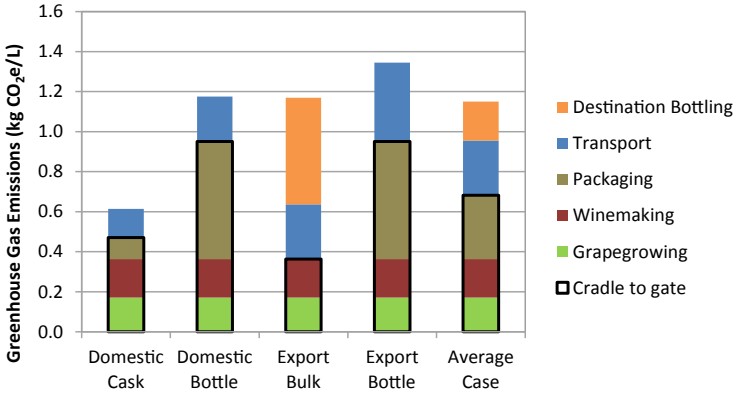

Figure 2. Greenhouse gas emissions of Australian wine delivered to domestic and export markets in different formats, showing both cradle to grave and cradle to gate emissions.

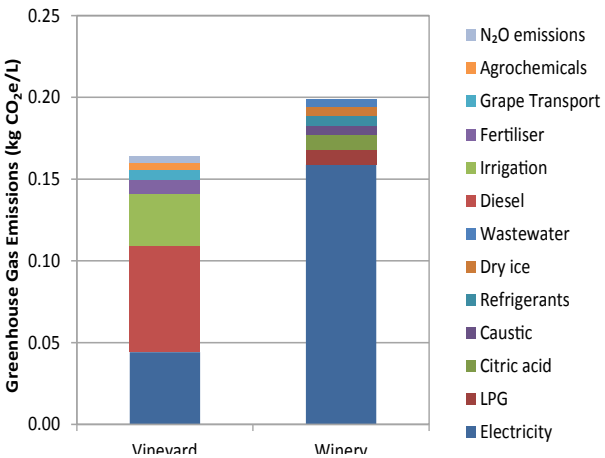

Figure 3. Vineyard and winery emission sources.

The cradle to grave impacts of Australian wine sold domestically in cask and bottle formats, as well as exported in bulk and in bottle are shown in Figure 2. The cradle to gate impacts are shown on the same chart by the thick black line. This chart indicates the importance of performing assessments over the whole life cycle. The cradle to gate impacts of wine shipped in bulk are far lower than that for exporting in bottle however, the impacts of glass production have only been shifted outside the wine producer's gate and do not necessarily represent a real reduction in emissions over the product life cycle. Overall, wine exported in bulk is less emission intensive due to lower emissions in shipping as the glass weight is not transported over large distances. Glass production in the destination market may be more or less carbon intensive than production in Australia. Factory specific data would be required to make such an assessment.

Transport and glass packaging were obvious 'hot spots' in the study, together representing approximately 68% of the average life cycle. Grapegrowing and winemaking gave similar contributions at 15% and 17%, respectively. In grapegrowing, diesel use, electricity used onsite, and electricity used by irrigation providers were the main contributors to emissions. On the winemaking side, electricity was by far the biggest contributor, accounting for 82% of emissions. The use of renewable energy like solar power is captured within the Entwine database and has been included in the models. As more producers in the industry take up alternative energy sources, the emissions from electricity will fall, but currently this represents the biggest opportunity for improvement. Refrigeration is often the largest user of winery electricity and there are many steps that can be taken to improve refrigeration efficiency, from zero cost changes like increasing brine temperature, to investing in greater insulation across the site. More information can be found on this topic in the Improving Winery Refrigeration Efficiency handbook, available from the AWRI website.

PACKAGING FORMAT

Packaging innovation is one of the strengths of the Australian wine industry. From the invention of the cask to the early adoption of the screwcap, winemakers have been keen to give their products an edge, whether that is aesthetically on the shelf, in terms of technical performance, by minimising production costs, or lowering emissions. Packaging manufacturers are continuing to innovate giving winemakers a wealth of choice for finished wines. Figure 4 shows the large difference in greenhouse gas emissions between wine packaged in cask compared with glass. Glass bottles require a large amount of energy to produce due to the high melting temperatures of the materials. Cask packaging is much lighter and easier to produce. Cask wine is also a larger volume format, further contributing to lower emissions on a per litre basis. A four-litre cask was assumed for this analysis, but the results are still favourable regardless of the package size, as shown in Figure 4.

Another packaging alternative is the use of lightweight glass. Advances in glass production have enabled 750mL bottles as light as 330g to be produced. A standard bottle weight of 500g was used for the main LCA, however, premium glass bottles can weigh up to 750g. Figure 4 shows an analysis of the impact of packaging format in the domestic market. Using 330g bottles reduced the domestic life cycle impacts by 18%, while using a 750g bottle increased the life cycle impacts by 26%. Packaging in cask reduced the life cycle impacts over packaging in 500g glass by 48%, or 37% over packaging in 330g glass.

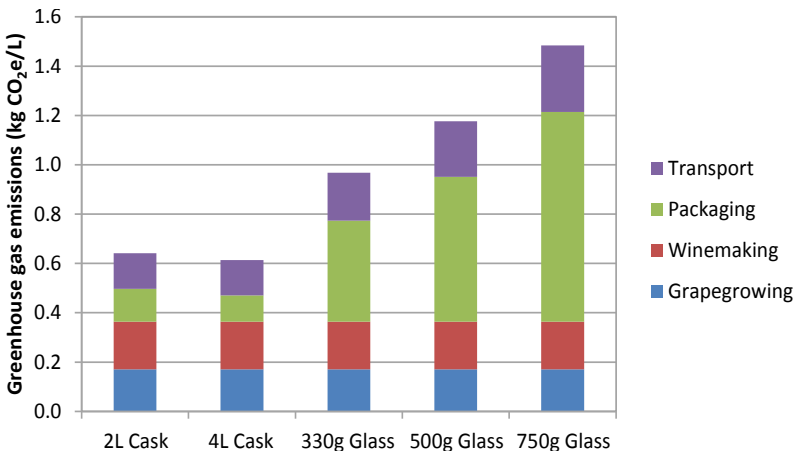

Figure 4. Effect of different packaging formats on greenhouse gas emissions.

SUMMARY

A number of 'hot spots' were identified in the carbon life cycle of Australian wine production. These were glass packaging, transport and winery electricity use. Exporting wine in bulk reduces the life cycle impact by about 13%, however, glass production emissions still occur in the destination market. The indicative impact of Australian wine production was at the low end of the range generally found in wine LCAs at 1.16kg CO_2e/L.

The Entwine database was the primary data source for this assessment, providing a significant sample size to assess the industry's production. As this database continues to grow, the coverage and accuracy of the data will improve, providing valuable information to producers as well as international markets. To find out more about participating in the Entwine program, visit the AWRI website or contact Dr Mardi Longbottom (mardi.longbottom@awri.com.au)

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