

Wine  
Australia

# Safeguarding the future for Australian Wine

An Emissions Reduction Guide





## About Wine Australia

Wine Australia is an Australian Commonwealth Government statutory authority, established under the Wine Australia Act 2013. We're funded by winegrape growers and winemakers through levies and user-pays charges and the Australian Government, which provides matching funding for research and innovation investments.

Wine Australia supports a competitive wine sector by investing in research and innovation, growing domestic and international markets and protecting the reputation of Australian wine.

## Acknowledgements

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How to use this document

# This Guide is to be read in conjunction with **Wine Australia's Emissions Reduction Roadmap.**

It's intended to increase understanding of how greenhouse gas (GHG) emissions are generated in the vineyard and in the winery and provide options for the most effective ways to reduce those emissions. The Guide covers key impact areas across the vineyard, winery and the broader supply chain, with a focus on minimising costs and providing practical and achievable solutions.

In this Guide, we provide you with:

- 1 information on how you can deliver against the ambition set in Wine Australia's Roadmap whilst reducing emissions in your own business
- 2 the most impactful methods of reducing emissions at the vineyard and winery level
- 3 the potential carbon abatement of key GHG emissions reduction initiatives
- 4 tailored advice relating to emissions reduction opportunities within the wine supply chain
- 5 a review and recommendation of freely available tools individuals and businesses can use to calculate emissions arising from their business operations.

This document is designed to focus on the most important, immediate actions growers and winemakers can take to start reducing their emissions from today. We acknowledge the importance of longer-term planning, and this will be addressed throughout the document.



# Contents

<b>Credits</b>	<b>02</b>
About Wine Australia	02
Acknowledgements	03
How to use this document	04
<b>Part I: Introduction</b>	<b>08</b>
How can the Guide help the grape and wine sector?	10
Making our actions count	12
<b>Part II: The job to be done by 2030</b>	<b>14</b>
Why the urgent need to reduce emissions?	16
What do we need to do and how are we going to do it	20
2030 emissions reduction initiatives	22
<b>Part III: Master the essentials</b>	<b>24</b>
Greenhouse gas emissions	26
What do we mean by biogenic carbon emissions?	28
What one tonne of CO <sub>2</sub> -e looks like	30
Carbon accounting	32
What is in each scope calculation?	33
What is meant by carbon offsetting?	34
What is meant by carbon sequestration and insetting?	36
<b>Part IV: Reducing your emissions</b>	<b>38</b>
Where do I start?	39
For growers: vineyard emissions	42
For winemakers: winery emissions	50
For growers and winemakers: how to address supply chain emissions	58
<b>Part V: Conclusion &amp; next steps</b>	<b>62</b>
<b>Appendix A</b>	<b>64</b>
Information to get you started	66
Certification schemes	67
<b>Glossary</b>	<b>68</b>





# At Wine Australia, we're committed to supporting a prosperous grape and wine sector.

This extends to our commitment to supporting you, our community of grapegrowers and winemakers, in how to decarbonise.

Climate change poses a serious threat to our sector – we're already seeing the effects of this through changing grape phenology and earlier harvest dates, plus an increase in extreme weather events.

To ensure continued access to both domestic and international markets and limit the impacts of climate change, we must all take action to reduce our emissions so that together we can safeguard the future of Australian wine.

In the 2020-21 financial year period, the Australian wine sector contributed 1,770,997 tonnes of carbon dioxide equivalent (t CO<sub>2</sub>-e) to the atmosphere (excluding soil emissions and fermentation emissions). This is roughly equivalent to the emissions produced by a fully-laden jet plane flying 609 laps around the world<sup>1</sup>.

The Emissions Reduction Roadmap identifies the sector's current emissions footprint as well as the pathways to reduce our collective GHG emissions. It allows you to understand the full impact of grape and wine production, identify hot spots within the supply chain and the initiatives to achieve greater emissions reductions including cost savings.

To help reduce your business's GHG emissions, we have developed this practical guide to equip you with the information you need to take action, from today. As an Australian Government statutory authority, we take our role seriously in providing clear, science-based, data-driven advice and information that can support both vineyard and winery businesses in saving money and reducing emissions. That's why this Guide, like the Roadmap, has been informed through data-driven modelling and engagement with over 300 sector stakeholders.

We know through a sector survey<sup>2</sup> that 40 per cent of respondents are already taking action to quantify and reduce the GHG emissions generated through their business. So, whether you are just starting out or looking to build on existing efforts, this Guide offers insights into the basics of emissions reduction and how they can be applied to the unique challenges and opportunities of grape and wine production.

No matter where you are on your sustainability journey, the road ahead will be complex. Whilst it's important to plan for the mid-and long-term, efforts should be focused on the most immediate priorities to start or continue reducing your emissions. As with many challenges, the journey may not be clear, or the immediate solution may not be perfect. But it's important to focus on what you can control now, make the important first steps and continue to expand efforts over time.

<sup>1</sup> \* Greenhouse Gas Equivalencies Calculator | US EPA available at: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results>  
<sup>2</sup> Survey Monkey Australian Wine Industry Stakeholder Survey, Running from July 2022 to January 2023.



# How can the Guide help the grape and wine sector?



**Sector-wide collaboration is essential to create a united approach towards reducing emissions. By taking action together, we can achieve a gradual and systematic transition to a lower carbon economy.**

That's why this Guide is developed to be a reliable and informative resource for growers and winemakers. It provides you with the knowledge, tools, and best practices to reduce your carbon footprint and operate more sustainably. It's designed to stimulate changes and improvements to the production of grapes and wine, and to assist the Australian wine and grape community to better understand the benefits of reducing emissions and the risks of not acting.



### Making our actions count

To ensure that our community of growers and winemakers have a shared understanding and a consistent approach towards emissions reduction, we have identified key behaviours to adopt when implementing initiatives to reduce emissions.

By embodying these behaviours, winegrape growers and winemakers can demonstrate their commitment to sustainability, increase their knowledge and capabilities, and reduce avoidable emissions whilst improving operational and cost efficiencies as we transition to a lower carbon future.



#### Behaviours

## Educate

It's important to understand what emissions are, how they can be avoided and how to calculate the emissions from your business. It can be complex, but it's the first step we must all take so we can take further action.

#### Action

Use this Guide and links provided in Appendix A to better understand how emissions are generated, the data required to calculate emissions and how to identify your main sources of emissions.

#### Behaviours

## Commit

Don't shy away from committing to or taking accountability for your emissions reduction actions. This is an important step for genuine, impactful change. Commitment can be in the form of a public commitment or internal reporting.

#### Action

Capturing data required for the annual reporting of your business emissions can be time consuming, requiring additional labour and where required, externally sourced guidance. Develop systems to capture key emissions data associated with the supply chain and business operations. If you are a member of a sustainability program like Sustainable Winegrowing Australia, you'll already be doing this.

#### Behaviours

## Explore

Once you have understood your emissions, start considering your options and look at the various tools available to help you on your journey.

#### Action

There are a range of online calculators and tools that can help you to calculate the emissions footprint of your business. Use the accompanying footprinting Tools Document to better understand and explore the right tool for you, considering your current emissions knowledge, skills and the maturity of your business.

#### Behaviours

## Value progress over perfection

Commencing your emissions reduction journey can seem overwhelming. Don't be afraid to share your learnings, challenges and wins along the way. We're all in it together.

#### Action

Start with understanding the direct and indirect emissions (Scope 1 and 2) from your business operations and build up to reporting indirect supply chain emissions (Scope 3) over multiple years. Over time, note the data gaps you have in your business and seek to reduce these gaps over multiple reporting years.

#### Behaviours

## Strategise

While it's important to act on immediate initiatives to reduce emissions, it's just as important to start planning for mid-term and long-term goals. Consider what is realistic based on your footprint and business objectives.

#### Action

Develop a plan, linked to your business strategy, that clearly articulates the reasons you are calculating your business footprint and understand the differing requirements, considering the variety of reporting and certification schemes available. See the information included within this document related to recommended certification schemes, Appendix A.

#### Behaviours

## Embrace partnerships

Indirect emissions are a large part of the sector's footprint. That's why partnerships are important. We'll never reach our goals on our own. It's best done together.

#### Action

Work with your suppliers to better understand the actions they are taking and how these actions will benefit your business. Ask questions of your suppliers and seek to work with those suppliers taking action to reduce their emissions.



# Part II: The job to be done by 2030





Why the urgent need to reduce emissions?

**Globally, we're moving towards a lower carbon future and it's becoming increasingly clear that sustainability will be a key factor in the long-term success of businesses.**

In 2015, many countries – including Australia, pledged to limit global warming to 1.5°C in a legally binding treaty called *The Paris Agreement*. This means that businesses in all industries, including the wine sector, will need to take action to reduce their carbon footprint and help achieve this goal.

There is an urgent need to reduce emissions in the Australian grape and wine sector, not only to mitigate the impacts of climate change but also to capture economic and social benefits and retain market access.





## There are four benefits to reducing emissions

### Market access

Mature international wine markets are increasingly requiring GHG emissions data, emissions reduction targets and commitments from their suppliers. Failure to communicate transparent targets and strategies, supported by strong evidence, poses a significant business growth and continuity risk to all Australian grape and wine producers.

### Protecting reputation on the world stage

Australia is known globally as a producer of quality wines. We know that climate change not only affects grapegrowing, but may also affect the attributes of the wine produced. To maintain our reputation as a leading wine region globally and domestically, we must minimise the effects of climate change by collectively reducing our emissions.

### Cost savings

The wine sector has many examples of businesses which have significantly reduced their emissions and reduced their ongoing operating costs by understanding their footprint and then targeting key emissions sources. Being sustainable is efficient and being efficient and prudent with your business costs is being sustainable.

### Show your commitment to sustainability

Through capturing the emissions from your business and then setting ambitious, yet realistic emissions reduction targets, you are establishing yourself as a leader in the sector and ensuring your business is ready for a transition to a low emissions economy.

## Reducing emissions and costs - the case of Tahbilk Winery

**In 2021, Tahbilk installed 100 KW of solar panels, providing the business with an average annual saving of \$17,000, rising to \$23,000 as the price of electricity increased over 2022 and early 2023. This represents a 46 per cent financial saving every year, with an expected lifetime of 20 years.**

The supply and installation costs of the solar panels was \$145,000. With the assistance of state government rebates, the business is on track to receive a return on investment within 5 years, reducing the costs of electricity for the business for a period of 15 years post payback.

Tahbilk converted wine refrigerant systems to ammonia in 2018, replacing an aging glycol refrigeration system. Whilst the upfront replacement costs were considerable, at \$318,200, the total annual savings of \$58,000, allow for a return of investment well within a 6 year period.





# What do we need to do and how are we going to do it?

Achieving a 42 per cent reduction in emissions by 2030

As set out in the Roadmap, we have identified an opportunity to reduce emissions by 42 per cent by 2030, compared to a 2021-22 financial year baseline.

There are five key themes of opportunity for emissions reduction in the grape and wine sector.

Within these key themes we've defined 11 emissions reduction initiatives which were identified and modelled during development of the Roadmap. These initiatives can be adopted now to reduce your emissions, and if implemented collectively as a sector, will enable us to achieve a 42 per cent emissions reduction by 2030.

The key emissions reduction opportunity themes are:



Using data to inform emissions reducing business decisions



Reducing and eventually eliminating the use of fossil fuel vehicles, both in vineyards and wineries and through supply chains



Operating efficient grape and wine production sites powered by renewable electricity



Optimising low emissions transport and distribution networks now (and increasingly in the future)



Collaborating with the wine supply chain to reduce emissions from high emitting materials and services.





2030 emissions reduction initiatives

# The 11 emissions reduction initiatives fall into **three** of the five emissions reduction themes.

The fourth theme is *Reducing and in time eliminating the use of fossil fuel vehicles*, which is likely to be more viable after 2030, and the fifth theme of *Using emissions data to inform decarbonisation business decisions* is a cross-cutting theme that is important to incorporate into all future actions.

In addition to these initiatives, reducing and eliminating emissions from electricity through use of on-property

renewable electricity generation aligns cost savings with emissions reductions. Likewise, any operation that reduces the electricity demand will assist in reducing use and therefore costs associated with electricity purchase.

Grape and wine production businesses will also benefit from reducing emissions associated with the supply chain through procuring goods and services from companies and partners that can demonstrate emissions avoidance.

Operating efficient grape and wine production sites powered by renewable energy

### Grid decarbonisation



↓ **159,993** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

Grid decarbonisation is the emissions reduced through the conversion of the mains electricity grid to renewable energy sources

### 100 per cent renewable electricity purchase



↓ **85,967** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

### On-site solar generation



↓ **7,782** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

### Electrodialysis units for cold stabilisation



↓ **3,641** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

### Flotation for juice clarification



↓ **687** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

### Electrification of diesel-powered vineyard irrigation systems



↓ **946** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

Embracing low emissions transport and distribution

### Reduced emissions road transport



↓ **114,801** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

### Reduced emissions shipping



↓ **21,157** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

Collaborating with the wine supply chain to reduce emissions from high emitting materials and services

### Increased use of lightweight bottles



↓ **123,081** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

### Lower energy demand glass production



↓ **48,909** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

### Supply chain decarbonisation



↓ **14,384** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

Figure 1. Mitigation scenarios grouped into emissions reduction opportunity themes



# Part III: Master the essentials

No matter where you are in your sustainability journey, you'll need to master the essentials of GHG emissions. In fact, this is the first step for you to take towards reducing your business's environmental impact and demonstrating your commitment to decarbonisation.

Your deep understanding and knowledge will:

- 1 lead to a more effective reduction of emissions**
- 2 help you select which emissions reduction initiatives are a priority for your business**
- 3 identify opportunities for cost savings and improved efficiencies.**

This section covers some of the basic concepts and terms to help you on your way.



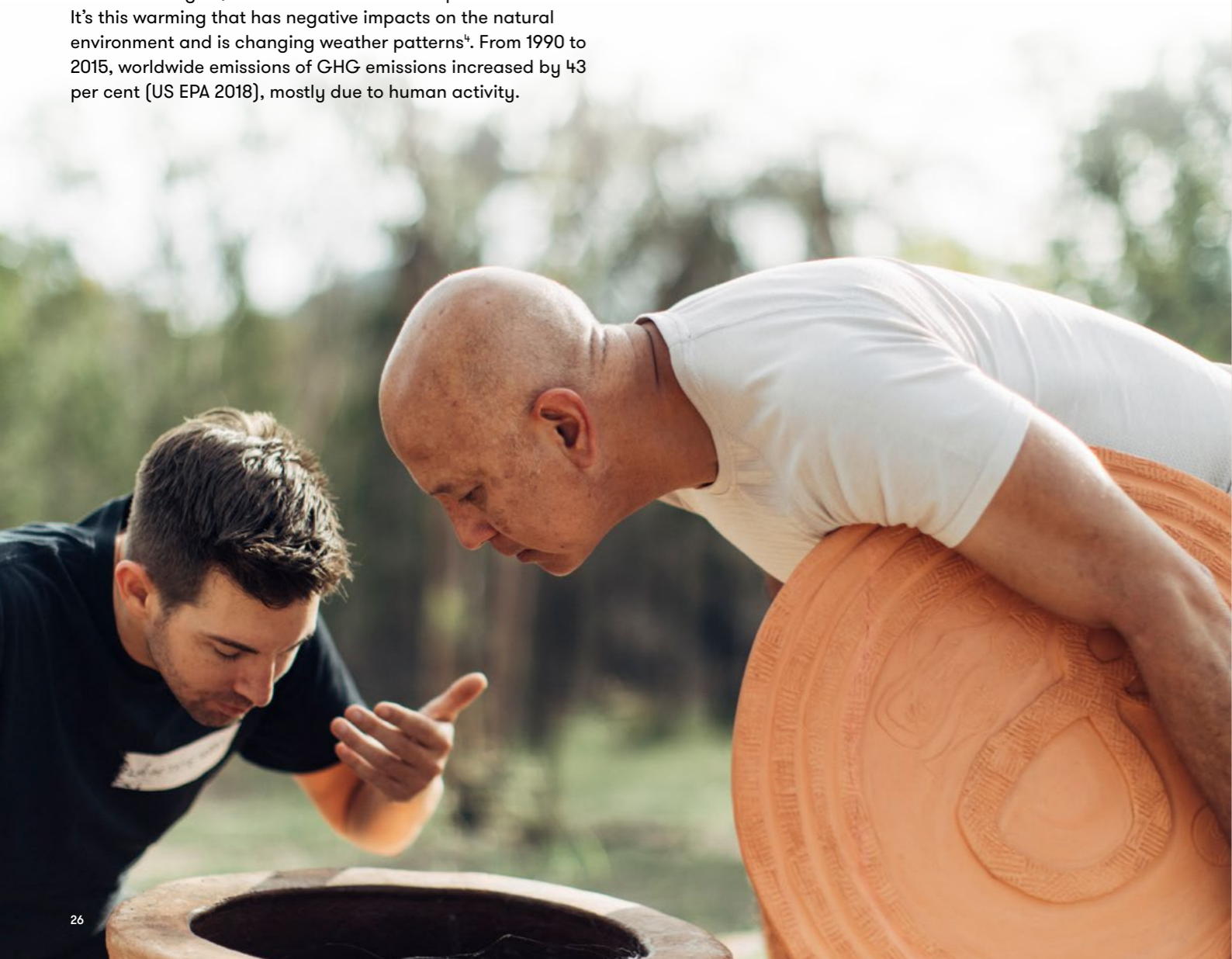


# Greenhouse gas emissions

What are greenhouse gas emissions?

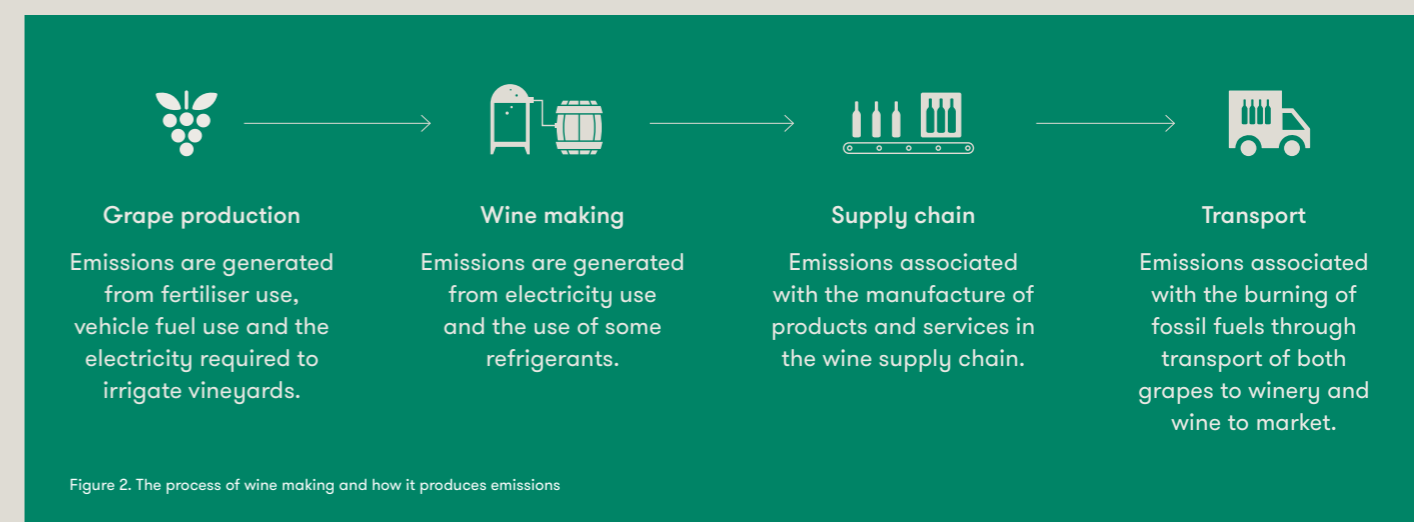
**GHG emissions are both natural and human-made gases that absorb and emit radiation, trapping heat in the earth's atmosphere.**

The primary GHG emissions in the earth's atmosphere are water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and ozone (O<sub>3</sub>)<sup>3</sup>. GHG emissions increase the greenhouse effect, trapping heat in the earth's atmosphere and increasing air, sea surface and land temperatures. It's this warming that has negative impacts on the natural environment and is changing weather patterns<sup>4</sup>. From 1990 to 2015, worldwide emissions of GHG emissions increased by 43 per cent (US EPA 2018), mostly due to human activity.



How does the production of grapes and wine produce GHG emissions?

The production of grapes and wine includes a range of operations that release emissions, for example: fuel burnt to power vehicles and machinery, fertiliser breakdown, electricity use and the consumption of goods, such as chemicals and packaging, which generate GHGs in their production.



You can find a more detailed breakdown of how wine production produces emissions on pages 32 and 33.

<sup>3</sup> IPCC, 2018  
<sup>4</sup> United Nations; <https://www.un.org/en/climatechange/science/causes-effects-climate-change>



# What do we mean by biogenic carbon emissions?

Most of the natural carbon on Earth is part of an existing long-term carbon cycle which takes place over thousands of years. It's this carbon that exists in fossil fuels, minerals, and rocks.

Short term or biogenic carbon naturally exists in plants, animals, the atmosphere and oceans. It cycles in time frames from months to centuries. These short-term cycles include the flow of carbon from plant material to the atmosphere, which is then recaptured by plants through the process of photosynthesis. We see the process of biogenic emissions in vineyards and wineries. In vineyards, carbon dioxide is absorbed

by grapevines and emitted during the breakdown of organic matter within soils and vine prunings. In wineries, biogenic emissions are generated by fermentation of grapes and breakdown of grape marc and lees; the biological waste products from winemaking. It's important to note that soils and vegetation both capture and store emissions and release these emissions to the atmosphere in a constant cycle.

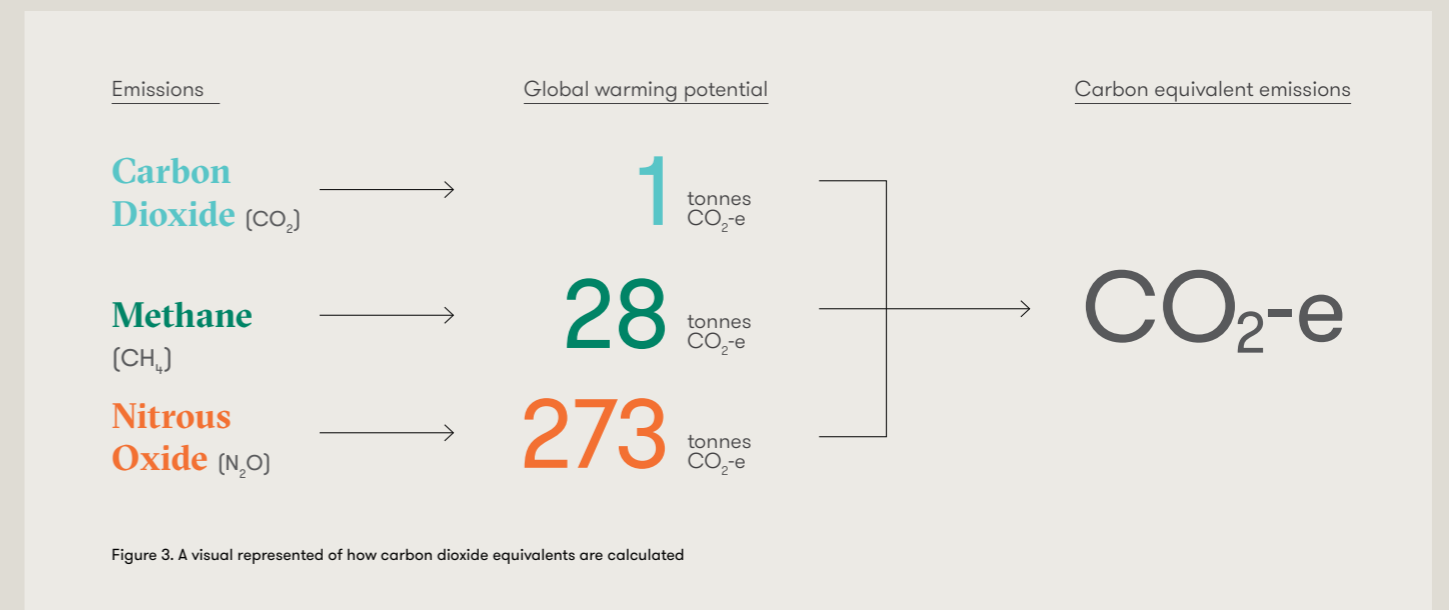


What are carbon dioxide equivalents?

Every GHG has a different impact on the climate. Emissions are broken down at different rates within the Earth's atmosphere over differing time periods and make a greater or lesser contribution to the greenhouse effect.

Carbon dioxide equivalents, or CO<sub>2</sub>-e, is a measure used to compare emissions based on their potential to contribute to global warming. This is done by converting other gases to the equivalent amount of carbon dioxide. It's typically measured in metric tonnes. In Figure 3, methane has a global warming potential 28 times that of carbon dioxide, whilst nitrous oxide, often produced by the volatilisation of nitrogen-based fertilisers, has an even higher global warming potential, 273 times that of carbon dioxide.

Given different types of emissions are produced in the vineyard, in the winery and through the supply chain, CO<sub>2</sub>-e is utilised to combine all GHG emissions into a single unit of measurement. You'll see the term 'carbon dioxide equivalent' or abbreviation 'CO<sub>2</sub>-e' used throughout this document and the Roadmap.





# What one tonne of CO<sub>2</sub>-e looks like

When captured, a tonne of CO<sub>2</sub>-e would fill a balloon almost ten metres in diameter.

It's estimated that the Australian wine sector is releasing the equivalent of approximately 3.6 ten-metre diameter balloons of carbon dioxide every minute.



# 1 tonne of CO<sub>2</sub>-e represents...

1,961



Vegetarian meals

192



Cotton T-shirts

143,190<sup>hours</sup>



Usage of a 30w LED TV

138



Meat-based meals

1<sup>person</sup>



One way flight from Paris to New York

88<sup>days</sup>



Consumption of electricity in an average home in New South Wales

93<sup>days</sup>



Consumption of electricity in an average home in Victoria

250<sup>days</sup>



Consumption of electricity in an average Tasmanian home

Figure 4. Comparative examples of a tonne of CO<sub>2</sub>-e



# Carbon accounting

## What is a carbon footprint?

A carbon footprint is the amount of GHG emissions produced by your operations or business annually. An emissions baseline is the first carbon footprint conducted on your operations or business. Developing an emissions baseline is an important first step in emissions management. It helps you to understand your starting point, keep track of changes in emissions and identify ways to reduce them over time. In the Roadmap we estimated the carbon footprint of the entire Australian grape and wine sector.

## What does carbon neutral mean?

This is when human-produced GHG emissions associated with an activity or organisation are balanced by proactive GHG removals from the atmosphere. It's best practice for all organisations to reduce and avoid emissions prior to removing GHG from the atmosphere through the purchase of offsets. Carbon neutral is interchangeable with 'net zero'.

## What does carbon negative mean?

This means that an activity removes more GHG emissions from the atmosphere than it emits, to have a net environmental benefit. This is sometimes referred to as 'climate positive' however, it's best practice to use the term carbon negative.

## What are Scope 1, 2 and 3 emissions?

Emissions are grouped into three categories: Scope 1, 2 and 3. To meet the global warming targets agreed upon internationally, we must reduce emissions in all three scopes. In the context of the Australian grape and wine sector (Figure 5, below), the three scopes of emissions are:

- direct vineyard and winery emissions (Scope 1)
- indirect vineyard and winery electricity emissions (Scope 2)
- indirect vineyard, winery and supply chain emissions (Scope 3).

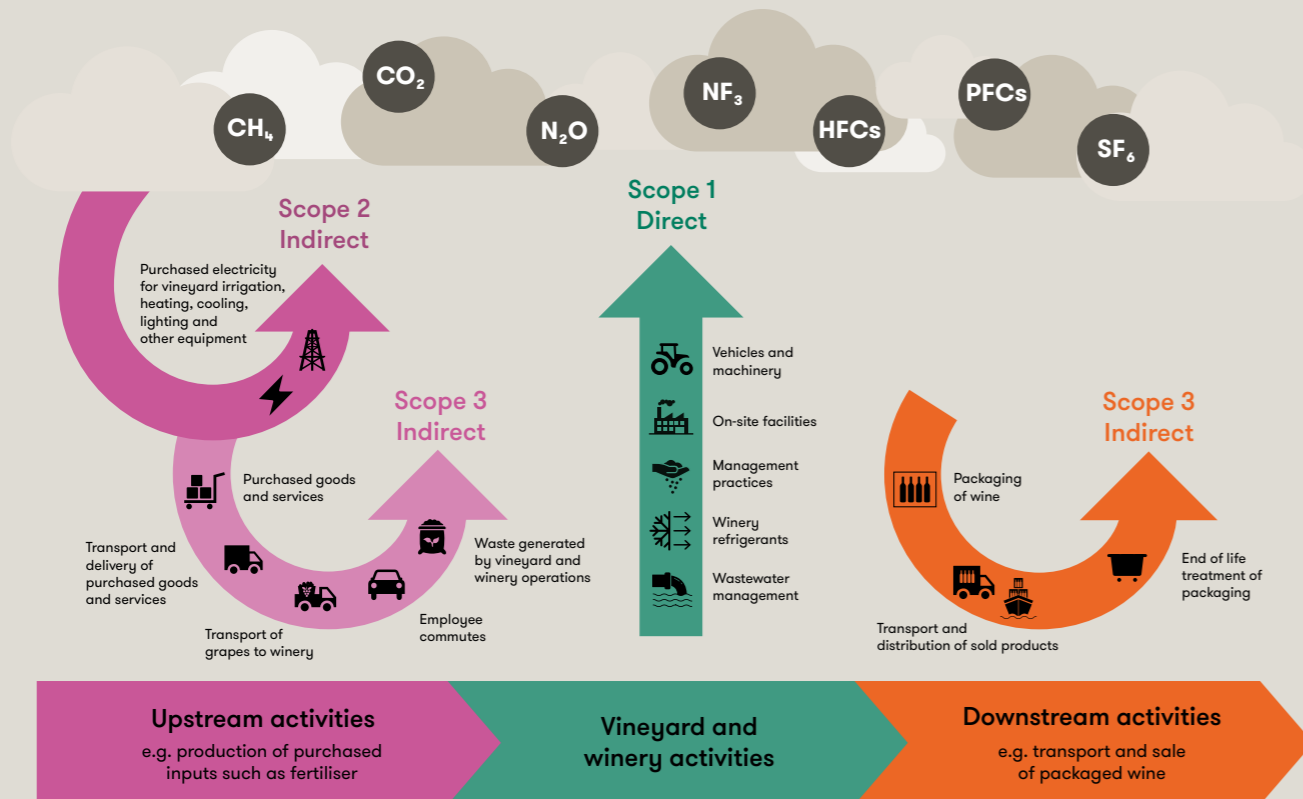


Figure 5. Emission scopes for the grape and wine sector

# What is in each scope calculation?

## Scope 1: Direct Vineyard & Winery Emissions



Machinery Fuel Use



Fertiliser Use



Refrigerant Use



Wastewater Management

\*Emissions arising from soils, the breakdown of organic matter within vineyards and wine fermentation emissions have been calculated but not included within the wine sector emissions baseline. Declaring emissions that are part of the biogenic carbon cycle, as described above, is not required under best GHG management practice.

## Scope 2: Indirect Vineyard & Winery Emissions



Purchased Electricity

Used for vineyard irrigation, lighting, cold stabilisation, refrigeration and similar equipment.

## Scope 3: Indirect Vineyard, Winery and Supply Chain Emissions



Transportation and Distribution

Includes the grapes and wine from vineyard to winery and winery to market.



Waste

Such as those generated in operation of Australian vineyards and wineries.



Common Goods and Services

Those that are typically purchased in the wine supply chain, including wine packaging materials, water and winery chemicals and inputs.



End-of-life Packaging

In Australia and overseas markets.



Indirect Emissions from Fossil Fuel Use

Fossil fuel emissions associated with the transport, refinement and processing of fossil fuels that are used in the vineyard and in the winery.



Employee Commutes

The commuting of Australian wine sector employees for work purposes.



# What is meant by carbon offsetting?

The Carbon Management Hierarchy identifies four ways to reduce your GHG emissions: **avoid, reduce, replace and then offset.**

The Climate Council defines carbon offsets as a measure 'used by a company or organisation to compensate for what they are emitting and thereby decrease their net emissions. Carbon offsets cancel out carbon emissions, specifically by purchasing carbon credits. Typically, one credit permits the emission of one tonne of CO<sub>2</sub>-e'<sup>15</sup>.



<sup>15</sup> Climate Council, <https://www.climatecouncil.org.au/resources/carbon-offsetting-worthwhile/>

Carbon offsets are a topic of much debate within the global sustainability community. They've been criticised for allowing companies to continue emitting GHG emissions while presenting a misleading image of environmental responsibility. However, as identified in the Carbon Management Hierarchy, offsets are an option to consider once all opportunities to avoid, reduce and replace high emitting sources have been explored.

Based on the information and technology available today, offsets are likely to be required for the sector to achieve net zero by 2050. However, there is a lot we don't know yet. Wine

Australia is dedicated to continuing to keep up to date with the latest technological advancements to ensure the sector first avoids, reduces and replaces before offsets are considered.

If you are using offsets, consider purchasing them from a reputable source and know the benefit that your payments are delivering. Offsets can be used to deliver co-benefits, such as increased biodiversity, conservation and habitat protection or avoided emissions from newly financed renewable energy projects. Be clear about your ambitions and goals and whether offsets are appropriate for your business's emissions reduction journey.

## Avoid

The most important measure is to avoid any unnecessary activity that causes emissions.

Avoid production practices with high energy consumption.

## Replace

Once reduced to a maximum allowable, replace with a lower impact alternative.

Use renewable energy to power equipment.

## Reduce

If it cannot be avoided, then identify the possibility of reducing its intensity.

Only operate machinery when needed.

## Offset

Last measure to consider.

Buy high-quality and certified carbon credits.

Figure 5. Carbon Management Hierarchy





# What is meant by carbon sequestration and insetting?

Carbon sequestration is the process of capturing and storing carbon dioxide from the atmosphere. Carbon stored stably in plants, soil, oceans and geological formations can't contribute to global warming. Carbon can be sequestered both naturally and through human activity<sup>6</sup>.

As described earlier, grapevines and vineyard soils both capture and release carbon. The amount of carbon stored and/or released by soil or vegetation is dependent on a range of factors, including soil health and management and local climatic conditions. For example, activities such as cultivation which disturb the soil release carbon. Soils can also release carbon as they dry and store more carbon as they absorb moisture. The carbon storage potential of each vineyard changes over time and from vineyard to vineyard. Assessing the carbon sequestration of Australian vineyard soils and vegetation has not been conducted as part of the Roadmap.

Insetting is a term used mainly within agriculture to describe growing and/or protecting vegetation on your land to sequester carbon. Climate Active, the Australian Government carbon neutral certification scheme, is seeking to incorporate insets into emissions calculations.

<sup>6</sup> CSIRO Draft September 2022 Common Language Document, A Common Approach to Sector-Level GHG Accounting for Australian Agriculture.



# Part IV: Reducing your emissions

**Commencing your business emissions reduction journey doesn't have to be complicated. There are a few things you'll need to know about your own business operations, prior to understanding where emissions are generated in your business and through your supply chain.**

The emissions figures quoted in the Roadmap and in this Guide document were generated based on the supply of sector-wide data. This information provides a great baseline for the average grape and wine production business, but there may be significant differences depending on your own circumstances. It's recommended that you use business specific-data where possible, especially for things like fuel use and electricity consumption, to understand the direct emissions generated through your business operations.

The following pages outline a recommended approach to understanding your business emissions, developing a baseline and communicating the success of your emissions reduction progress over time. More detailed information on each of the steps is provided further on in this Guide.



**Where do I start?**

**Given the broad range of emissions associated with your business, we know it's difficult to understand where to start. We recommend focusing first on what you can control immediately – and that is your direct vineyard and winery emissions (Scope 1) and the electricity you use indirectly in the vineyard and winery (Scope 2).**

Typically, Scope 3 emissions can be the most challenging to address as they include emissions generated by your supply chain where you may have little immediate influence. We know that to avoid the worst effects of climate change, we must reduce emissions through the collective efforts of the entire production and supply chain. Markets are already requesting more information related to Scope 3 emissions. That's why we're including Scope 3 emissions within the Roadmap and seeking to reduce these over time.

Supply chain emissions include what you as a business can influence, such as the packaging you choose to purchase, and other areas of concern over which you have very little influence, such as emissions arising from land use and transport.

It's important to remember that your Scope 3 emissions are someone else's Scope 1 and 2 emissions. As market and other pressures come to bear on our supply chain partners, they will be required to report on and reduce their own Scope 1 and 2 emissions. In turn this will reduce the Scope 3 emissions of grape and wine businesses and drive decarbonisation of the entire supply chain.



Where do I start?

# Six steps to reduce your emissions from today

## Step 1

### Educate and define

1. We have provided a range of reputable information sources in the links in Appendix A. You can use them in combination with this Guide to help you understand the impact of your operations and the key sources of emissions.
2. Understand why you are reducing your emissions, and how those drivers fit with your business philosophy and operations.
3. Set your goals and targets for reducing your business emissions. Key considerations when setting your goals are:
  - goals are SMART - Specific, Measurable, Achievable, Realistic and Time bound
  - goals are inclusive - where possible, include staff in determining emissions reduction opportunities.
  - define the emissions boundary of your operations, based on the information that markets and your customers are requesting. For example, some businesses may choose to exclude certain emissions sources from their operations, as the data is not required or reducing emissions from such sources is considered unfeasible.

## Step 2

### Collect data

1. Using the key emission sources detailed within the Guide and the accompanying Carbon Accounting Tools for the Australian Grape and Wine Sector document, determine what data you require. Members of Sustainable Winegrowing Australia are already collecting some or all of the data required for Scopes 1 and 2.
2. Identify the most appropriate and accurate method to source and collect the data. When calculating emissions from business operations, it's essential to utilise relevant and up-to-date data related to key emissions sources, such as electricity, refrigerant and vehicle fuel use.
3. Utilise one of the tools recommended in the Tools document or engage a contractor to help you determine what data you need to collect and how to source it.

## Step 3

### Calculate your footprint

1. The key emissions sources of most vineyards and wineries are listed in Figure 6 and Figure 7.
2. For a more accurate picture of emissions generated through your business operations, you can conduct a carbon footprint assessment. The information in the Tools document will allow you to select a carbon accounting tool appropriate for your business and your familiarity with emissions management.
3. Once you've calculated your footprint, you've calculated your emissions baseline. Members of the Sustainable Winegrowing Australia program already have their Scope 1 and 2 emissions footprint calculated annually
4. For all future measurements, use this baseline (based on financial year) as your reference point for emissions reduction.

## Step 4

### Plan your reduction actions

1. Prepare an emissions reduction plan to identify the actions you'll take, matching them to your future budgets and labour requirements. It's important to determine the emissions reduction opportunities and the areas that allow for cost savings, whilst achieving emissions reductions. Use this Guide to understand the most effective actions for reducing emissions.
2. A cost-benefit analysis can be conducted to better understand the financial viability of initiatives and the up-front costs compared to the ongoing operational costs or savings relative to the benefits.
3. Re-evaluate your emissions reduction targets and goals set in Step 1, based on your footprint data and the plan you've outlined.

## Step 5

### Implement

1. For most businesses, an effective way to reduce emissions is through a staged approach, starting with low-cost, low-effort initiatives which can be implemented quickly and are under your direct control. However, these initiatives may not provide the greatest emissions reduction potential. That's why it's important to always review your plan and approaches to ensure it aligns with where others are within the sector and learn from the successes of peers.
2. Keep up to date with emerging technologies and opportunities for collaboration and how you can leverage these in your emissions reduction plan, through Wine Australia<sup>9</sup>.

## Step 6

### Declare, promote, monitor and evaluate

1. Now, with a sound understanding of your emissions footprint and a plan in place, it's important to declare your footprint and plans for reducing emissions. Declarations can be made through publicly available systems, such as the Carbon Disclosure Project or through your business website. In addition, you might want to consider joining one of the organisations in Appendix A, to participate in an international community of grape and wine businesses committed to climate action. This is important because declaring your emissions stimulates other businesses to do the same, promoting collective action, and allows future customers to evaluate your commitment to decarbonise.
2. Calculating emissions from your business is an annual process that can be utilised to identify data gaps, track progress and identify opportunities to continue to reduce emissions.
3. Assess whether carbon offsets, insets and reporting and certification schemes are right for your ambitions and business operations.



# For growers: vineyard emissions

How are GHG emissions produced in winegrape growing?

In agricultural production, GHG emissions are produced through natural processes and human activities. Examples include the breakdown of organic matter within the soil and on top of the soil, the burning of fossil fuels during tractor use and the application of fertiliser, which has high embodied emissions associated with its production and also releases emissions as it breaks down.

We know it can be challenging to make changes to established management practices. That's why we've outlined some practical initiatives including a check list in the following section to help you further reduce emissions - no matter where you are in your sustainability journey.

## Vineyard direct emissions and electricity emissions sources

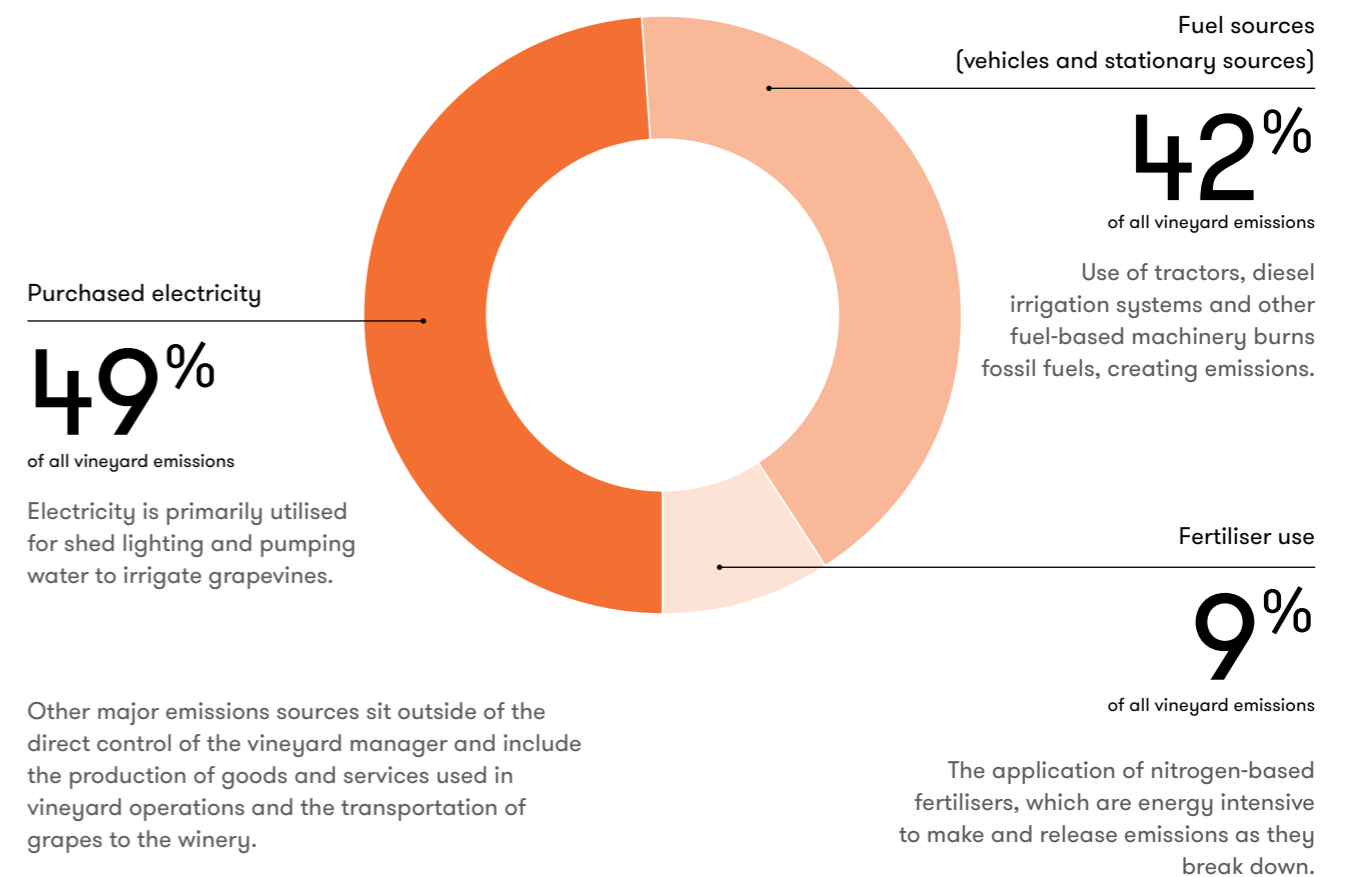


Figure 6. Vineyard direct emissions and electricity emissions sources





Emissions reduction initiatives

There are several ways to reduce the emissions generated by growing winegrapes.

Two of those initiatives were modelled as part of the Roadmap. They address the largest contributors of vineyard emissions and can be implemented from today.

1

Vineyard emissions reduction initiative



Staged grape and wine sector uptake of 100 per cent renewable electricity from 2023 to 2028

↓ **85,967** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

Key implementation details

Includes the following actions, and takes into account transition of state electricity grids to renewable energy sources

- Installation of solar panels for on-site electricity generation, to replace purchased electricity and diesel-powered generators.
- Purchase of 100 per cent renewable electricity through an electricity provider.

In addition to the above two initiatives, emissions from fertiliser can be reduced by optimising their application, and reducing overall use as much as possible, especially of nitrogen.

2

Vineyard emissions reduction initiative



Electrification of all diesel-powered vineyard infrastructure

↓ **946** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

Key implementation details

The use of water pumps and frost fans powered by diesel produces greater emissions than electric equivalents. Growers should aim to eliminate inefficient diesel-powered infrastructure in favour of electric systems which operate at higher efficiency and lower cost. Combined with the initiative above, these will soon become carbon-neutral.

i

It may feel like there are not many options for emissions reduction in the vineyard.

That's mainly because a large proportion of vineyard emissions arise from diesel use, and low-emissions diesel alternatives for tractors and other vehicles are not yet readily available. This will improve with time as the technology and supporting infrastructure develop to meet market requirements and growers have options for diesel replacement.

In the meantime, addressing the other key emissions sources is a great first step. It's also worth noting that producing grapes as efficiently as possible will minimise inputs, and improve productivity and profitability.







### Getting clear on your plan

**To reduce emissions across your vineyard operations, it's important to develop a plan that is aligned to your broader sustainability goals and business values.**

Short-term, medium-term and long-term goals and targets should be established to ensure emissions are reduced over time and budget is assigned to your actions, such as collection and reporting of sustainability metrics and changes to infrastructure and practices. Everyone in your business can be involved in planning and be encouraged to take ownership of emissions reduction efforts.

For example, initial plans (Phase 1), should aim to drive down operational emissions, whilst medium (Phase 2) and

longer-term (Phase 3) plans should target higher expense upgrades and emissions associated with your supply chain. We have outlined the recommended short-term or immediate actions you can take now to reduce your emissions and plan for your goals.

Remember that a roadmap is never a set and forget. You'll need to continue updating it as your reporting matures, more actions are undertaken, and more data is available. That's why phases two and three will require updates over time.

## What your roadmap could look like (2023-2050)

2023

Phase 1: 2023 - 2025

### Set up for Success

1. Calculate the emissions footprint of your vineyard operations over at least one year period to establish a baseline from which to track your performance over time. Most agricultural businesses will need to calculate the emissions of their business over more than one year to gain an accurate reflection of the impact of their operations, due to seasonal weather variations.
2. Utilise the emissions footprint to identify the key sources of direct emissions and emissions from electricity use within your business operations.
3. Target the lower cost and easier to implement initiatives that are within your control, such as energy efficiency and monitoring and evaluation.
4. Reducing tractor passes will assist you to save fuel. Consider tractor use reduction methods, such as the use of sheep instead of slashing or herbicide application, and the use of multi-row spraying.
5. Determine the baseline carbon measurements of your soils and above ground vegetation.
6. Monitor the use of emerging technologies, such as the rollout of electric/ alternative fuel tractors, and the use of drones for spraying and hyperspectral imagery to identify disease.
7. Plan and budget for future emissions reduction actions.

2025

Phase 2: 2025 - 2035

### Drive Progress

1. Implement initiatives that require planned budget and labour expenses, such as converting existing fleet or tractors to electric equivalents.
2. Aim to have all electricity supplied from renewable energy sources, removing the need for on-farm fossil fuel sources.
3. Investigate options to store and sequester carbon on-farm, including the use of insetting methodologies to reduce the operational emissions of your business.
4. Conduct cost-benefit analysis for implementing carbon reduction and capture methods. This can be completed in-house or with the assistance of contractors.
5. Ensure you are able to communicate and provide climate related data and plans to those requiring this information (customers, banks, insurers, industry bodies).
6. Source suppliers offering reduced emissions products and services.

2035

Phase 3: 2035 - 2050

### The Road to Success

1. Update your business emissions reduction plan over time to reflect current business operations, progress and updated targets.
2. Collaborate with your supply chain. With a particular focus on suppliers of goods and services with high associated emissions (packaging and transport), gather the information you need to determine if they are undertaking activities to support your emissions reduction goals.
3. In time, exclusively utilise suppliers offering reduced or zero emissions products and services
4. Allow your business to respond to customer requests for information.
5. It is impossible to predict the long term future and the new technologies and actions that will assist your business to decarbonise. Ensure your emissions reduction plan is adaptable and can set up your business for success.

2050



Checklist: immediate actions to reduce emissions in your vineyard

# We know that each vineyard is different - grape variety, climatic and seasonal conditions, farming approach, topography and other factors all influence your management methods.

It makes it hard to know which to manage first and how to start implementing. That's why we've created this checklist to make it easy for you to use resources efficiently and to align cost reduction opportunities to reducing emissions from winegrape production.

For now, we've focused on the four most important and priority areas, which are low-cost and easy to implement actions – electricity, diesel use, irrigation efficiency and land management. By using this checklist, you can start reducing your emissions, operate more efficiently and save money on energy and input costs. To identify which are the best actions for you, it's recommended that you use the information outlined above and in the Tools document to determine your carbon footprint and identify the emissions sources in your own business.

## Electricity

- Know your energy usage. Many businesses have benefited from an energy audit aligned to the national standard (AS/NZS 3598.2:2014).
- Install an energy wattmeter, an inexpensive but useful electricity measurement tool, that can assist in determining the appliances and infrastructure using the most power.
- Take time to improve your understanding of your energy bills, usage and costs. Your energy provider charges for electricity use based on a range of factors including consumption, time of use, your meter type and the size of your business, which is determined by your network demand (kVA) and consumption (kWh).
- Visit the independent [Australian Government Energy Made Easy](#) website to find the right energy provider and plan for you.
- Implement low-cost and low-labour initiatives. Energy-efficient lighting, insulation and equipment sensors are all low-cost options to limit emissions.
- Explore opportunities to access funding for energy audits, renewable energy and energy efficiency retrofit grants and incentives. Look for schemes such as the South Australian Resource Efficiency and Productivity grants, the NSW Energy Savings Scheme or the Victorian Energy Up-grades program (VEU) and the Small-scale Renewable Energy Scheme.
- Investigate opportunities to reduce costs through the implementation of on-site solar. Return on investment (ROI) for most vineyards is within a four to seven year period. There are also opportunities to utilise solar with battery systems, including electric vehicles to store electricity for use at times of peak costs.

## Diesel Use

- Reduce tractor passes by using multiple row spray units, improving spray efficiency, using minimum or no-till practices and combining operations into one pass over a block, together with seasonal planning.
- Explore the use of sheep in place of herbicides and slashing, to control the undervine and midrow areas.
- Convert all diesel- and petrol-powered machinery, such as pumps, frost fans and generators, to electric equivalents which can be powered by mains electricity or on-site solar.

## Irrigation

- Schedule irrigation timing and volume based on monitoring devices
- Utilise 100 per cent renewable electricity or solar powered irrigation
- Perform regular system tests to ensure flow rates match expected outputs
- Consider installing variable speed drives onto pumps to match flows to requirements
- Consider replacing old or retiring assets with electric/solar powered pumps, to reduce diesel consumption and improve water flow rates.
- Transition all diesel- and petrol-powered pumps to electric alternatives which can be powered by mains electricity or on-site solar.
- Establish business contingency strategies, aligned to emissions and cost savings.

## Land Management

- Minimise nitrous oxide emissions, save money and boost grapevine production by remembering to apply the Four R's to fertiliser application - Right time, Right place, Right rate, Right product. Over-application or incorrect timing of fertiliser application can result in nitrogen losses to the atmosphere and to waterways in run-off. Explore options to optimise fertiliser use using the Four R's with these resources from Agriculture Victoria and the AWRI.  
Agriculture Victoria hyperlink: <https://agriculture.vic.gov.au/climate-and-weather/understanding-carbon-and-emissions/nitrogen-fertilisers-improving-efficiency-and-saving-money>  
AWRI hyperlink: [https://www.awri.com.au/industry\\_support/viticulture/soil-and-grapevine-nutrition/](https://www.awri.com.au/industry_support/viticulture/soil-and-grapevine-nutrition/)
- Quantify your soil carbon storage and sequestration to determine future opportunities for storage and the viability of accessing alternative income sources through increasing soil carbon. There are multiple methods used to quantify soil carbon, with the most common metric applied by the Australian Government called FullCAM. It's detailed further on the Department of Climate Change, Energy, the Environment and Water website.
- Quantify and baseline the carbon storage and sequestration of non-grapevine vegetation growing on your property. There may be opportunities to inset business operational emissions through voluntary and Australian Government Carbon Neutral schemes, such as Climate Active.
- Understand longer-term climate projections for your region and the impacts for grapevine management through the Wine Climate Atlas and the Climate Analogues Tool.



# For winemakers: winery emissions

What are the main sources of emissions from wine production?

Winery emissions sources are defined as the emissions generated from the point where grapes are received from the vineyard, to storage of the final product at the winery prior to bottling or other packaging. This means the primary sources of emissions arising from direct wine production are electricity use, fossil fuel use (gas and diesel for forklifts and heating), fermentation emissions, and the use of inputs, such as citric acid and caustic soda.

Tackling electricity use will be key to mitigating winery emissions. This will include reducing electricity use, increasing energy efficiency and sourcing or generating renewable energy. However, we recognise that understanding how to reduce costs and emissions associated with electricity use is complex because the timing of electricity use (peak usage and off-peak usage), as well as demand, influences the cost of electricity. Outlined in the next few sections are practical initiatives and actions you can take to reduce winery emissions.

## Common winery emissions sources

### ⚡ Electricity use

**87%**

Purchased electricity (87 per cent of all winery emissions) - mostly from the use of refrigeration for winemaking and wine storage, with other sources including lighting, processing of wine and air-conditioning systems.

### 🛢 Fuel use

**11%**

Mobile and stationary fuel sources (11 per cent of all winery emissions) - winery-owned vehicles and diesel-powered forklifts, and stationary emissions sources such as heating and cooling systems.

### ❄️ Emissions from refrigerant leakage

**1.5%**

Refrigerant use (1.5 per cent of all winery emissions) - many wineries still utilise refrigerants in wine cooling and storage systems that produce emissions.

\*Wastewater treatment represents 0.5% of all winemaking emissions

Figure 7. Common winery emissions sources



## There are many ways to reduce your emissions when considering wine production and storage.

A key consideration is the source of your emissions - in particular electricity. There is a strong business case for reducing electricity emissions due to the financial savings associated with efficient energy use, on-site electricity generation and the conversion of mobile and stationary fuel sources to electricity.

The modelling in the Roadmap included four key initiatives you can implement to reduce emissions in the winery.

1

Direct winery emissions reduction initiatives



### On-site solar generation

↓ **7,782** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

#### Key implementation details

Uptake of 100 kilowatt systems across 100 percent of wineries across all wine producing Australian states.

2

Direct winery emissions reduction initiatives



### 100 per cent renewable electricity purchase

↓ **85,967** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

#### Key implementation details

A staged grape and wine sector uptake of 100 percent renewable electricity from 2023 to 2028, through purchase of renewable energy and decarbonisation of state electricity grids.

3

Direct winery emissions reduction initiatives



### Flotation for juice clarification

↓ **687** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

#### Key implementation details

Flotation for juice clarification was modelled as an example of how using an alternative technology in the winery can reduce emissions and be cost-effective. Flotation is more energy-efficient than the traditional method which requires chilling. The modelling assumes a maximum uptake of 40 per cent of wineries.

4

Direct winery emissions reduction initiatives



### Electro dialysis units for cold stabilisation

↓ **3,641** Modelled total emissions reduced by 2030 (t CO<sub>2</sub>-e)

#### Key implementation details

Electro dialysis units are an energy-efficient alternative to cold stabilisation, requiring on average 90 per cent less energy than cold stabilisation. The potential cost savings resulting from electro dialysis are more significant for medium-large producers than for smaller wineries.

## In addition to the primary emissions reduction initiatives, we have identified other high-level emissions reduction actions to consider.

- Seek to reduce business costs through minimising electricity consumption, by understanding key sources of winery electricity demand, replacing energy-intensive equipment and infrastructure while generating on-site electricity.
- Replace gas-powered hot water systems with electric heat pumps or solar hot water systems.
- Switch to using ammonia, a common emissions-free and cost-effective alternative to many other refrigerants.
- As availability and feasibility increase, upgrade and electrify passenger vehicles and forklifts to eliminate direct emissions from combustion engines. Some electric vehicles can and are utilised in the wine sector as mobile electricity storage.

We know from the Roadmap that fermentation emissions contribute to our GHG emissions footprint as a sector. But fermentation emissions are also a product of the natural carbon cycle. We believe the priority is to avoid and reduce emissions arising from fossil fuel sources before exploring cost-effective options to reduce fermentation emissions. However, we also recognise that capturing emissions from fermentation has the potential to provide financial and emissions insetting opportunities.



## Getting clear on your plan

To reduce emissions across your winery operations, it's important to develop a plan that is aligned to your sustainability goals and business values.

Short-term, medium-term and long-term goals and targets should be established to ensure emissions are reduced over time and budget is assigned to your actions, such as collection and reporting of sustainability metrics and changes to infrastructure and practices. Everyone in your business can be involved in planning and be encouraged to take ownership of emissions reduction efforts.

For example, initial plans (Phase 1), should aim to drive down business operational emissions, whilst medium (Phase 2) and longer-term (Phase 3) goals should target higher expense upgrades and emissions associated with your supply chain. We've outlined the recommended short-term or immediate actions you can take now to reduce your emissions and plan for your goals.

Remember that a roadmap is never a set and forget. You'll need to continue updating it as your reporting matures, more actions are undertaken, and more data is available. That's why phases two and three will require updates over time.

## What your roadmap could look like (2023-2050)

2023

Phase 1: 2023 – 2025

### Set up for Success

1. Calculate the emissions footprint of your business over at least a one year period to establish a baseline from which to track your performance over time.
2. Utilise the emissions footprint to identify the key sources of direct emissions and emissions from electricity use within your business operations.
3. Target the lower cost and easier to implement initiatives that are within your control, such as energy efficiency and monitoring and evaluation.
4. Take note of what other wineries are doing to address emissions. Initiatives, such as insulation installations, LED upgrades, and improvements to Heating Ventilation Air Conditioning (HVAC) systems are low cost and provide a quick return on investment.
5. Replacement of winery equipment can be expensive. High capital costs of equipment need to be balanced against operational cost savings and efficiencies gained through upgrades. Plan for future upgrades over time and factor in potential emissions savings through cost-benefit analysis.

2025

Phase 2: 2025 – 2035

### Drive Progress

1. Develop an emissions reduction plan aligned with your broader business strategy.
2. Implement initiatives that require planned budget and labour expenses, such as converting your existing fleet of vehicles and machinery to electric equivalents.
3. Aim to have all electricity supplied from renewable energy sources, by purchasing renewable electricity or generating your own on-site.
4. Investigate options to sequester and store carbon on-site - consider tree plantings and native vegetation around the winery. Keep an eye on developments in fermentation capture and reuse.
5. Ensure you are able to communicate and provide climate related data and plans to those requiring this information (customers, banks, insurers, industry bodies).
6. Eliminate refrigerants with high global warming potential. Optimise the use of ammonia as a refrigerant.
7. Source suppliers offering reduced emissions products and services.

2035

Phase 3: 2035 – 2050

### The Road to Success

1. Update the business emissions reduction plan over time to reflect current business operations, progress and updated targets.
2. Collaborate with your supply chain. With a particular focus on suppliers of goods and services with high associated emissions (packaging and transport), gather the information you need to determine if they are undertaking activities to support your emissions reduction goals.
3. In time, exclusively utilise suppliers offering reduced or zero emissions products and services
4. Allow your business to respond to customer requests for information.
5. It is impossible to predict the long term future and the new technologies and actions that will assist your business to decarbonise. Ensure your emissions reduction plan is adaptable and can set up your business for success.

2050



Checklist: immediate actions to reduce emissions in your winery

# We know that each winery is different, and the age and functionality of current infrastructure varies, meaning ongoing operational and upgrade costs will differ.

We recognise that it can be challenging to identify what to tackle first. That's why we've created this checklist to make it easy for you to reduce your emissions, no matter where you are on the journey.

For now, we've focused on the four most impactful and easy to implement priority areas – electricity, refrigerant use and energy efficiency. By using this checklist, you can use resources efficiently, whilst aligning cost savings to reduced emissions from wine production.

<sup>9</sup> Martinez-Perez et al. 2020, Evaluating Alternatives to Cold Stabilization in Wineries: The Use of Carboxymethyl Cellulose, Potassium Polyaspartate, Electrodialysis and Ion Exchange Resins, Foods 11:9(9):1275.



## Electricity

- Take time to improve your understanding of your energy bills, usage and costs. Your energy provider charges for electricity use based on a range of factors including consumption, timing of use, your meter type and the size of your business, which is determined by your network demand (kVA) and consumption (kWh).
- Visit the independent [Australian Government Energy Made Easy](#) website to find the right energy provider and plan for you.
- Implement low-cost and low-labour initiatives. Energy efficient lighting, insulation and equipment sensors are low-cost options to limit emissions.
- Explore options to access funding for energy audits, renewable energy and energy efficiency retrofit grants and incentives. Look for schemes such as the South Australian Resource Efficiency and Productivity grants, the NSW Energy Savings Scheme or the Victorian Energy Up-grades program (VEU) and the Small-scale Renewable Energy Scheme.

## Energy Efficiency

- Smaller wineries will benefit from freely available tools, such as the NatHERS rating tools, designed to predict the temperature inside a building on an hour-by-hour basis for a whole year, based on a range of building elements including size, insulation type and quantity and building materials.
- An alternative to NatHERS is the Greenstar Design and As Built Tool, established by the Green Building Council Australia. The tool allows users to rate different buildings according to a range of sustainability metrics, including GHG emissions. This tool can be utilised to increase your knowledge of building efficiency.
- The Australian Government 'Your Home' website provides advice related to the repair and maintenance of houses in

## Refrigerant Use

- Eliminate the use of refrigerants with high levels of CO<sub>2</sub>-e that are contributing to global warming, such as Freon. Refrigerant gases leak from air-conditioning units and other refrigerant systems, and many have a greater global warming potential than other GHGs. The most effective methods of reducing emissions from refrigerant use are to:
  - Reduce the need to utilise refrigerants through increasing the efficiency of cold storage of wine.
  - Adopt alternative methods to cold stabilisation such as the use of carboxymethyl cellulose (CMCs) and potassium polyaspartate<sup>9</sup>, which prevent the formation of crystals forming in juice, or utilising electro dialysis.
  - Switch to using ammonia, a common-emissions free and cost-effective alternative to many other refrigerants.

Australia. The information is relevant to all small buildings and can be applied to small wineries.

- Remember to use the energy hierarchy – avoid and reduce energy use by insulation, gap fillers, paint and audits, before seeking to generate or purchase renewable electricity.
- Consider the location of wine storage and how shade structures, reflectivity of surfaces, insulation and sealants can create an environment that optimise heat reflection and cold storage.
- Use resources such as this [2XE Report](#) and the [SAWIA Wine Energy Saver Toolkit](#) to help you identify opportunities for your own winery operations.



# For growers and winemakers: how to address supply chain emissions

Recap: understanding the scale of impact

Currently, 78 per cent of the sector's emissions come from indirect vineyard, winery and supply chain emissions. These emissions are generated from the extraction of resources, manufacture, processing and transportation of goods and services that you rely on and use in your business. Even though these emissions are generated outside of your business, as a purchaser of goods and services, the associated emissions are attributed to your operations.

Like most other sectors, a majority of the Australian grape and wine sector's emissions come from its supply chain, primarily within transport and packaging. That's why supply chain decarbonisation is crucial to assist us as a sector to produce, package and transport reduced emissions wine, as outlined in the Roadmap.

Breakdown of emissions by source

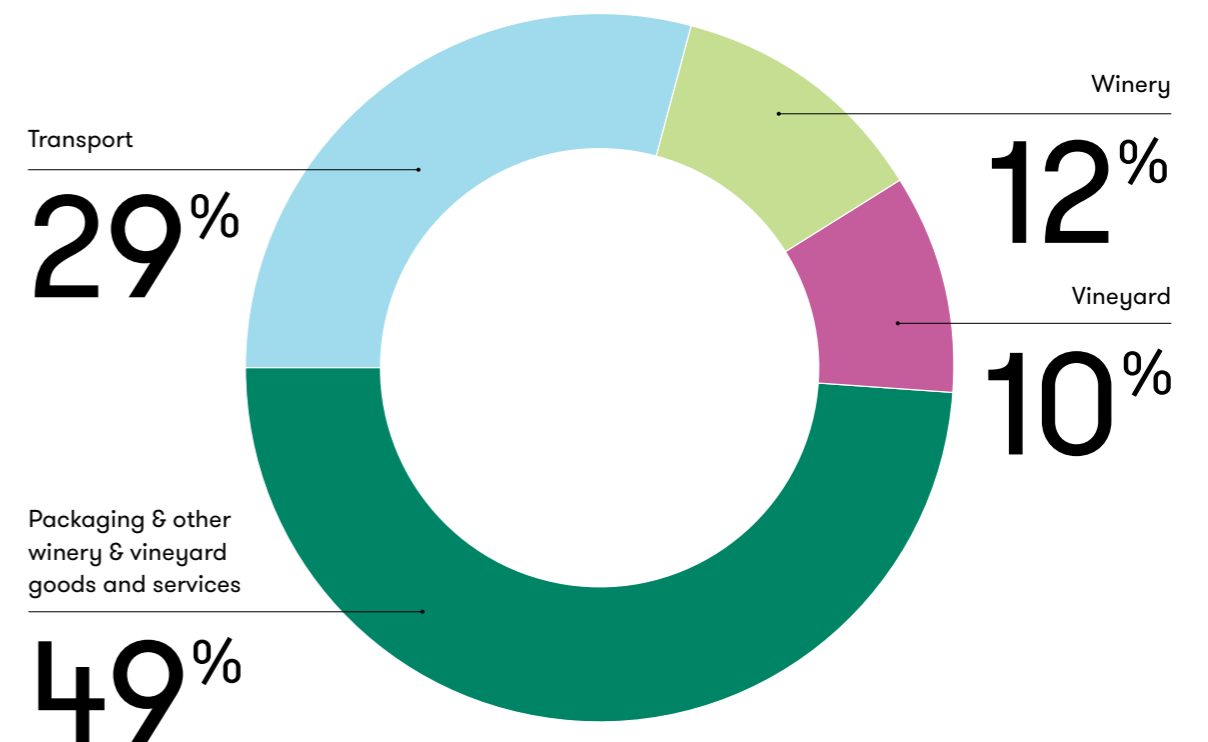


Figure 8 Breakdown of emissions by source



# Emissions related to the transportation of wine to market are high due to two key reasons.



## Transportation of large quantities of wine

Transportation emissions include the transportation of goods and services to vineyards and wineries, the transportation of grapes from vineyard to winery and the transportation of wine to market.

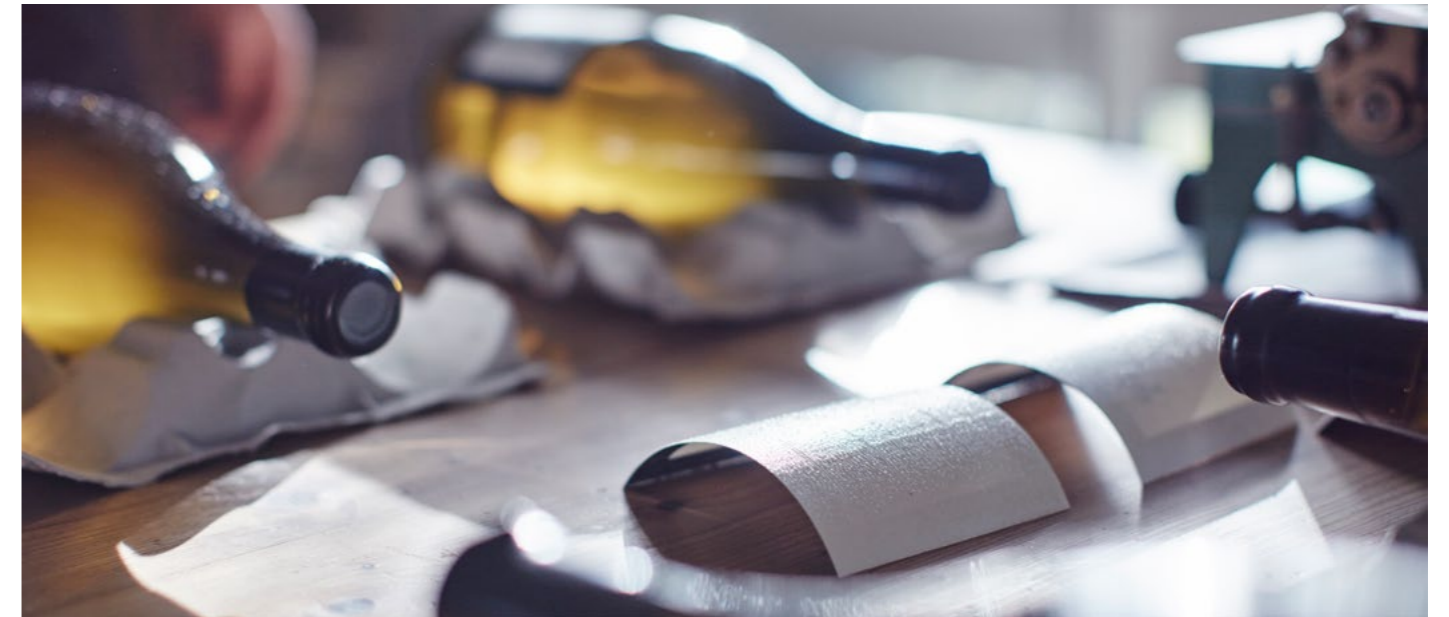
We know that the proposed future uptake of electric and hydrogen on-road transport is already commercially available and that use of alternative non-fossil fuel energy sources within shipping can further reduce transport emissions. Emissions from both sea and road transport are projected to decrease over time, as transport sectors progress towards their own emissions reduction targets.



## Packaging inefficiencies of the glass wine bottle

Glass production is an energy-intensive process, producing GHG emissions through the use of fossil fuels and chemical changes occurring during the manufacture process. Furthermore, due to the traditional round shape of wine bottles, there are space inefficiencies when packaging and distributing wine.

However, by using lighter glass bottles, more efficient glass manufacturing processes and exploring more efficient packaging design solutions, there is an opportunity to reduce emissions.



### What you can do about it

**Whilst supply chain emissions may not be a priority for some growers and winemakers, they are increasingly becoming more important as markets are requesting greater transparency in emissions data. So, whilst your focus is on Scope 1 and 2 emissions, it's just as important to start thinking about Scope 3 emissions and how to report them. Actions you can take now are to:**

1. Start the conversation: talk to your suppliers to understand their emissions and the actions they are taking to reduce their emissions.
2. Build relationships: it's important for meaningful and purposeful relationships to be built between growers, winemakers, suppliers and partners. This will allow for greater collaboration and transparency in the supply chain.
3. Understand the data: we've already identified the hot spots within our sector's supply chain, with the majority of emissions from packaging and transport. Take the time to investigate what your suppliers are doing to address these.
4. Choose lower carbon suppliers: you can take the power into your own hands by choosing to work with and source products from suppliers who are actively reducing their emissions.
5. Keep the conversation going: emissions reduction is a challenging topic, so it's important for this conversation to unfold naturally over multiple times. Keep asking questions of suppliers to show your commitment to reducing emissions.

### Checklist: having the conversation with your suppliers

**To help you start the conversations with your suppliers or to further conversations you're already having, we've developed a checklist you can use from today.**

- Understand the total emissions arising from your supply chain. This sounds difficult, but there are tools available to help you calculate your Scope 3 emissions - see the accompanying Tools document to choose the right tool for your business. It's important to note that the accuracy of information on Scope 3 emissions will improve as organisations get better at measuring the emissions associated with their product or service. Ask your key suppliers if they can provide specific emissions factors for their products. This will help you to accurately quantify the total emissions arising from the key products you buy. These emissions are likely to reduce over time as our supply partners address their own Scope 1 and 2 emissions.
- Identify what percentage of your business emissions are attributed to your top five suppliers. Focus your supply chain emissions reduction conversations and efforts on your largest supplier groups. Share your learnings of supply chain interactions and emissions reduction with others in your region and across the sector. We all need to understand how to best reduce emissions, and a collective industry approach will help fill gaps in data and address emissions in our supply chain.



# Part V: Conclusion & next steps

We hope this Guide helps you to understand the general principles of emissions management and empowers you to take action in your own vineyard or winery.

At Wine Australia we believe that, with collective action, we can achieve a 42 per cent reduction in total Australian wine sector emissions by 2030 and establish our industry as a global leader. A united approach is required and those who move first are likely to receive the greatest benefits.

The emissions reduction opportunities for grape and wine production businesses are considerable - and are key to accessing future wine markets in an increasingly competitive global landscape. Establishing a baseline and focusing on emissions reduction activities that are within your control will reap significant benefits - such as improved production efficiencies, reduced costs and decreased reliance on expensive inputs. Many of the initiatives outlined in this Guide will improve both efficiency and profitability - if emissions reduction isn't your primary driver for change, it can still be a side-benefit of sound production practices.

Even though supply chain emissions remain a challenge for many businesses, we believe that a united sector approach in communication with key suppliers can incentivise them to share data, take further and more ambitious action on emissions reduction and share their successes. As our supply partners decarbonise, and strive to meet emissions reduction targets in their own organisations and industries, the overall carbon footprint of growing grapes and making wine will diminish.

For Wine Australia, the Roadmap is not just a plan for reducing emissions, it is a call to action. It will help transition the grape and wine sector to a lower carbon future and minimise the effects of climate change, while protecting market access and securing the livelihoods of the grape and wine community. Wine Australia will continue to support Australia's grapegrowers and winemakers in their efforts to build business resilience and reduce emissions to 2030 and beyond. We'll promote collective action through investment in regional initiatives, communication and sharing of success, and take a lead role in delivery and implementation of the Emissions Reduction Roadmap and the Emissions Reduction Guide.

Join the [Australian wine emissions reduction network](#) to hear from other producers and our supply chain partners on their emissions reduction activities, share the challenges and wins you have experienced, and hear about helpful resources, tools, projects and funding opportunities.

**Because together, we believe we can safeguard the future of Australian wine.**



# Information to get you started

## Sources of reputable information

One of the key issues identified by growers and winemakers through stakeholder engagement is the need for trustworthy information that is practical, relevant and helpful. The following information sources are designed to assist individuals, organisations and businesses to build their knowledge and understanding of climate change, emissions footprint assessment and emissions reduction modelling.



### Greenhouse Gas Protocol

**Description:** The GHG Protocol supplies the world's most widely used standards to measure and manage GHG emissions. GHG Protocol frameworks and standards are utilised by ISO14067; Science based targets; Climate Active; PAS2060. The calculation of Australian Wine Sector emissions has utilised the GHG Protocol framework.

**Information available:**

- calculation tools
- guidance related to Scopes 1, 2 & 3
- FAQ documents
- online training courses.

**Link to website:** [ghgprotocol.org/](https://ghgprotocol.org/)



### Science-Based Targets Initiative (SBTi)

**Description:** Science-Based Targets Initiative (SBTi) has been established by WWF, The World Resources Institute, Carbon Disclosure Project and the UN Global Compact to call to action businesses to reduce emissions in alignment to a well below 2°C or 1.5°C warming scenario. More than 4,000 companies representing more than a third of global market capitalisation have approved SBTi targets or commitments. Wine companies, such as Concha y Toro and Taylors have SBTi-aligned emissions reduction targets.

**Information available:**

- sector specific guidance for forest, land and agriculture organisations
- a suite of learning resources, including e-learning modules, progress reports and net-zero commitments.

**Link to website:** [sciencebasedtargets.org/](https://sciencebasedtargets.org/)



### Climate Active

**Description:** Climate Active is a partnership between the Australian Government and Australian businesses to drive voluntary climate action. Climate Active offers carbon neutral certification for organisations, products, events and more. Many Australian wineries, including Hither and Yon, Ross Hill Wines, Keith Tulloch Wine, have Climate Active certification.

**Information available:**

- case studies from Australian businesses
- technical, certification and carbon neutral information
- FAQ document

**Link to website:** [climateactive.org.au/](https://climateactive.org.au/)



### Climate Kelpie

**Description:** Climate Kelpie is an agriculture specific website housing a range of tools related to both climate mitigation and climate adaptation. Many links within the site lead the user to external websites.

**Information available:**

- links to peer reviewed climate literature
- links to tools to help guide on-farm decision making (most tools are grazing or broadacre cropping focused)
- climate and weather systems information

**Link to website:** [www.climatekelpie.com.au/](https://www.climatekelpie.com.au/)



## Certification schemes

Many agricultural businesses are seeking to promote their progress and successes in reducing and/or offsetting emissions arising from business operations.

Below are four recommended certification programs. Three of the programs utilise the Greenhouse Gas Protocol as a framework, whilst the PAS 2060 program utilises a separate although very similar framework. Carbon neutral certification is offered through ISO, PAS and Climate Active. The Science-Based Targets Initiative (SBTi) is the only program that does not allow offsetting and instead requires reductions in emissions aligned to a well below 2°C or 1.5°C warming scenario. There are many more lesser recognised certification bodies.



### ISO

**Description:** ISO14067:2018 is an internationally recognised standard for the carbon footprint and carbon neutrality of products.

#### Advantages:

- Internationally recognised standards organisation, with standards extending beyond environmental compliance.
- Recognition that the standards process is a robust system.
- ISO is a trusted brand

#### Disadvantages:

- Only applicable to individual products.
- Like almost all carbon neutral certification schemes, offsetting to achieve neutrality is required.



### Science-Based Targets Initiative (SBTi)

Science-Based Targets Initiative (SBTi) has been established by WWF, The World Resources Institute, Carbon Disclosure Project and the UN Global Compact to call to action businesses to reduce emissions in alignment to a well below 2°C or 1.5°C warming scenario. More than 4,000 companies representing more than a third of global market capitalisation have approved SBTi targets or commitments. Wine companies, such as Concha y Toro and Taylors have SBTi-aligned emissions reduction targets.

#### Advantages:

- Internationally renowned.
- Used by over 4000 multinational and SME businesses and over 80 Australian organisations.
- The focus of SBTi is to encourage business to disclose and report emissions reductions. Offsetting within SBTi is not permitted.

#### Disadvantages:

- Some businesses want to advertise their product as carbon neutral. Science based target certification does not support such claims.
- Not well understood or recognised by Australian consumers.



### Climate Active

**Description:** Climate Active is a partnership between the Australian Government and Australian businesses to drive voluntary climate action. Climate Active offers carbon neutral certification for organisations, products, events and more. Wineries including Hither and Yon, Ross Hill Wines, Keith Tulloch Wine have Climate Active certification.

#### Advantages:

- Australian Government backed.
- Well recognised within Australia.
- Robust and well trusted certification program that can be used to certify as 'carbon neutral' a product, organisation, event, service or building.

#### Disadvantages:

- Not well recognised or understood within non-Australian environments, i.e., overseas based retailers.
- Like almost all carbon neutral certification schemes, offsetting to achieve neutrality is required.

Carbon Neutrality in accordance with PAS 2060

### PAS 2060 Carbon Neutrality

**Description:** PAS 2060 Carbon Neutrality is a carbon neutrality standard offered by British Standards Initiative (BSI). PAS 2060 is an updated version of PAS 2050, first developed in 2008.

#### Advantages:

- A rigorous carbon neutrality footprinting process.

#### Disadvantages:

- Not well understood or recognised by consumers, suppliers or customers outside of the UK.
- Product focused.

## Leading wine climate bodies

There are two peak bodies leading emissions reduction in the international wine community, International Wineries for Climate Action (IWCA) and the Porto Protocol.



### International Wineries for Climate Action (IWCA)

**Description:** IWCA is a working group of wineries committed to climate action. The focus of the group is squarely on winery emissions reduction.

The group produces a range of useful resources and tools and aims to address the 'how' in addressing emissions production at the winery level.

IWCA was founded in 2019 by Familia Torres and Jackson Family Wines. The goal of the organisation is to decarbonise the wine industry.

#### Membership requirements:

IWCA offers a three-tiered membership system – Applicant Members, Silver Members and Gold Members. Minimum standards are outlined for each membership group.

#### Membership fees:

Application fee (on time): 1,000 €

Annual fixed fee: 4,000 € prorated based on the date of joining IWCA

Variable fee: 0.01 € / 9L case (capped at 6,000 €)

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Application fee (on time): 1,000 €

Annual fixed fee: 4,000 € prorated based on the date of joining IWCA

Variable fee: 0.01 € / 9L case (capped at 6,000 €)



### The Porto Protocol

**Description:** The Porto Protocol is an international non-profit institution committed to climate mitigation. The aim of the organisation is to create a network of wineries working towards reducing emissions from wine production. To this end, the group shares and promotes experiences and solutions, collaborates and offers training courses, tools and resources to assist winery managers and staff to decarbonise operations.

#### Membership requirements:

The Porto Protocol aims to decarbonise all aspects of the wine supply chain. As such, grape growers and wine supply chain organisations are included as membership organisations.

#### Membership fees:

Membership to the Porto Protocol is free of charge. Membership is open to anyone within the wine industry and its ancillary industries who is willing to commit to and share knowledge of emissions avoidance, reduction and mitigation.

#### Membership fees:

Over 150 organisations, with membership across Europe, North America, Africa, South America, Oceania and Australia are represented. Representation from Australian operations include Treasury Wine Estates, Keith Tulloch Wine and Pernod Ricard Winemakers.



# Glossary

## Abatement

GHG removals by sinks and/or reduction in GHG emissions by sources of emissions.

## Activity data

Quantitative measure of the level of a human activity, taking place during a given time period, that results in GHG emissions or GHG removals. Example: litres of fuel used; tonnes of urea applied; numbers of livestock and their liveweight gain Activity data are multiplied by the relevant emissions factor to quantify the GHG emissions or GHG removals generated by a company or country.

## Baseline

A reference that provides the basis for comparison. The baseline can be performance in a specified past year or time period, or a projection of future performance under “business as usual”. The latter is also referred to as a dynamic or forward baseline, or counterfactual. A baseline can be a benchmark, such as industry average or best practice, such as in a baseline-and-credit emissions trading scheme, or the Safeguard Mechanism. Australia has used 2005 as the baseline year for its National Determined Contribution. Under the ERF some methods, such as soil carbon methods, use a historical baseline, determined by the performance prior to project commencement. In contrast, the beef herd management method uses a counterfactual baseline to estimate GHG emissions in the absence of the project activities.

## Biogenic emissions / carbon

Carbon released as carbon dioxide or methane from combustion or decomposition of biomass or biobased products. Biogenic carbon emitted as CO<sub>2</sub> from non-woody biomass, and removals by non-woody vegetation, are excluded from national inventory reporting, and are commonly excluded in company-level inventories, emissions trading and carbon neutrality schemes. Biogenic carbon emissions from woody biomass are included in national inventory reporting, but are sometimes excluded in LCA, such as when supplied from a sustainably managed plantation, on the basis that if forest carbon stocks are stable there is no net A Common Approach to Sector-Level Greenhouse-Gas Accounting for Australian Agriculture | 7 Term Definition Source See also Comments emission. Biogenic carbon emissions may be reported separately, and several standards (ISO 14067, GHG Protocol) require this for woody biomass. In national inventory reporting, emissions from burning peat are classed as fossil fuel emissions due to the slow formation rate of peat compared with other biomass materials.

## Carbon

A chemical element with the symbol C. In the context of climate change, carbon often refers to carbon dioxide, or to all greenhouse gases.

## Carbon credit

Tradeable certificate representing one tonne of carbon dioxide equivalents (CO<sub>2</sub>e) in GHG emission reductions or GHG removals Carbon credits are generated by abatement projects, and quantified relative to a baseline. In Australia, ERF projects generate carbon credits, called ACCUs. Carbon credit schemes commonly apply integrity criteria to ensure that the abatement is genuine, for example, ensuring additionality and permanence, avoiding double-counting and leakage. Carbon credits are commonly purchased to offset GHG emission of the purchasing entity.

## Carbon dioxide equivalent (CO<sub>2</sub>-e)

Unit for comparing the radiative forcing of a GHG to that of carbon dioxide The carbon dioxide equivalent is calculated as the mass of a given GHG multiplied by its global warming potential.

## Carbon footprint

Sum of GHG emissions minus GHG removals of the subject expressed as carbon dioxide equivalents (CO<sub>2</sub>e). The subject could be a product or an organisation. Where the subject is an organisation, such as a company, the carbon footprint often includes indirect emissions also known as scope 2 and scope 3 emissions. Where the subject is a product, the carbon footprint includes the emissions and removals across the product life cycle.

## Carbon neutrality

IPCC definition: Condition in which anthropogenic carbon dioxide (CO<sub>2</sub>) emissions associated with a subject are balanced by anthropogenic CO<sub>2</sub> removals. Common usage e.g. Climate Active, ISO Carbon neutrality standard: Condition in which anthropogenic GHG emissions associated with a subject are balanced by anthropogenic GHG removals. Achieving carbon neutrality commonly involves offsetting residual emissions through the purchase of carbon credits to counterbalance residual emissions. The subject can be an entity such as a country, an organisation, a district or a commodity, or an activity such as a service or an event. For a company: Carbon neutrality assessment includes the emissions and removals, over a specified period, for which the company has direct control, and may also include “scope 3” emissions and other indirect emissions, as specified by the relevant scheme. For a product: Carbon neutrality is assessed over the life cycle

of the product, although the use phase and disposal are sometimes excluded. For a country, state or local government: Carbon neutrality is assessed on a territorial basis, including direct emissions and removals occurring within the territory, over a specified period. The term net zero (CO<sub>2</sub> or GHG) is more commonly applied to the territorial perspective.

## Carbon sequestration

The process of removing carbon from the atmosphere and transferring it to a carbon pool such as vegetation, soil, ocean or geological formation. Carbon can be sequestered through natural and anthropogenic processes. In national inventory reporting and many other contexts the carbon uptake by annual plants and herbaceous perennial plants , such as grasses, is excluded because it is usually returned to atmosphere within a short period.

## Decarbonisation

The process of stopping or reducing carbon gases, especially carbon dioxide, being released into the atmosphere as the result of a process, for example the burning of fossil fuels<sup>10</sup>.

## Direct emissions

GHG emissions from sources owned or controlled by the reporting entity. Agricultural examples include GHG emissions from burning diesel in farm machinery, the release of N<sub>2</sub>O from bacteria breaking down crop residues or N fertilisers. Also called Scope 1 emissions.

## Emissions intensity

The quantity of emissions per unit of production. Example: the kg CO<sub>2</sub>-e emitted per tonne of grapes at farm gate.

## GHG management hierarchy

Priority order of actions to achieve carbon neutrality: 1. Reduce GHG emissions 2. Remove CO<sub>2</sub> by implementing carbon dioxide removal methods 3. Offset residual emissions through purchase of carbon credits.

## Global warming potential

An index measuring the radiative forcing following an emission of a unit mass of a GHG, accumulated over a chosen time horizon, relative to that of the reference substance, car-bon dioxide (CO<sub>2</sub>). The GWP represents the combined effect of the differing times that GHGs remain in the atmosphere and their different effectiveness in causing radiative forc-ing, that is, in heating the Earth’s atmosphere. GWP is measured in units of carbon diox-ide equivalents (CO<sub>2</sub>e). The most common time horizon is 100 years (GWP100). Parties to the UNFCCC have agreed to use GWP100 values from the IPCC’s Fifth Assessment Re-port (AR5) or GWP100 values from a subsequent IPCC Assessment Report to

report ag-gregate emissions and removals of GHGs under the Paris Agreement. In addition, parties may use other metrics to report supplemental information on aggregate emissions and removals of GHGs.

## Greenhouse gas (GHG)

Gaseous constituent of the atmosphere, either natural or anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of radiation emitted by the Earth’s surface, by the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and ozone (O<sub>3</sub>) are the primary GHGs in the Earth’s atmosphere. Human-made GHGs include sulphur hexafluoride (SF<sub>6</sub>), hydrofluorocarbons (HFCs), chlorofluorocarbons (CFCs) and perfluorocarbons (PFCs). Emissions of CO<sub>2</sub>, methane, nitrous oxide, HFCs, nitrogen trifluoride, PFCs and sulphur hexafluoride are reported under the UNFCCC and aggregated into carbon dioxide equivalents (CO<sub>2</sub>e) using global warming potentials (GWPs). Water vapour and ozone, which are anthropogenic as well as natural greenhouse gases, are not included in reporting under the UNFCCC. GHGs differ in their radiative efficiency (potency as a GHG) and their atmospheric lifetime.

## Greenhouse gas emission

Release of a GHG into the atmosphere. GHG emissions result from a GHG source.

## Greenhouse gas Protocol / GHG Protocol

An initiative of the World Resources Institute and the World Business Council on Sustaina-ble Development that provides standards, guidance and tools for quantifying organisa-tion-level GHG inventories.

## Indirect emissions

GHG emissions that are a consequence of the organisation’s activities, but that arise from GHG sources that are not owned or controlled by the organisation. Indirect emissions occur upstream and/ or downstream of the farm, across the value chain, and include emissions from manufacture of inputs such as fertiliser, and from processing of products, such as abattoir operations or milling. Indirect emissions also include emissions outside the value chain that are induced by change in demand for (or supply of) products produced or sourced by the organisation.

## Insetting

Emissions reduction or carbon sequestration through management of GHG sources and GHG sinks within the value chain the reporting entity. Insetting occurs when a company offsets its emissions using abatement occurring within its own value chain. The definition of insetting varies between schemes. Under Climate Active, insetting refers to manage-ment of GHG sources and GHG sinks within the emission

boundary, that reduce the net GHG emissions of that enterprise.

## Inventory boundary

(for reporting or accounting) Boundary specifying which emissions and removals are accounted and reported by the company. GHG accounting and reporting boundaries can have several dimensions, i.e. organizational, operational, geographic, business unit, and target boundaries.

## Mitigation

GHG removals by sinks and/or reduction in GHG emissions by sources

Nationally determined contribution (NDC) (Under the UNFCCC) National plans that specify a party’s self-determined target for GHG emissions reduction under the Paris Agreement, and describe how it intends to meet the target, and to assess progress. Australia has committed to reduce emissions by 43 per cent below 2005 levels by 2030, and to reach net zero GHG emissions by 2050.

## Net zero GHG emissions

Condition in which GHG emissions are balanced by GHG removals over a specified period. For a company: Net zero GHG assessment includes the GHG emissions and removals, over a specified period, for which the company has direct control, and may also include indirect emissions (“scope 3” emissions), as determined by the relevant scheme. The term GHG neutrality is also applied to the company perspective, with the same meaning. For a country, state or local government: Net zero GHG is assessed on a territorial basis, including GHG emissions and removals occurring within the territory, over a specified period. The quantification of net zero GHG emissions depends on the GHG emission metric chosen to compare emissions and removals of different gases, as well as the time horizon chosen for that metric. GHG neutrality and net zero GHG emissions are overlapping concepts. See GHG neutrality for explanation of the differences.

## Offset

The reduction, avoidance or removal of a unit of greenhouse gas (GHG) emissions by one entity, purchased by another entity to counterbalance a unit of GHG emissions by that other entity. Offsets are calculated relative to a baseline. Offsets are commonly subject to rules and environmental integrity criteria intended to ensure that offsets achieve their stated mitigation outcome. Relevant criteria include the avoidance of double counting and leakage, use of appropriate baselines, additionality, and permanence or measures to address impermanence. Offsets are usually represented by a carbon credit that has been retired or cancelled in a register by or on behalf of the entity that counterbalances unabated GHG emissions or residual GHG emissions ACCUs are sold as offsets on the voluntary emissions trading market.Paris Agreement Legally binding international treaty on

climate change made under the UNFCCC. It was adopted by 196 Parties at UNFCCC COP 21 in Paris, in 2015 and entered into force in 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. Under the Paris Agreement (2021-2030), Australia has pledged to cut emissions by 43 per cent compared with 2005 emissions. Based on a 43 per cent reduction by 2030, Australia’s emissions budget for this period is 4,381 Mt CO<sub>2</sub>-e.

## Science-based targets initiative SBTi

Initiative that supports companies to set emission reduction and net zero targets in line with climate science and Paris Agreement goals.

The SBTi is a partnership between CDP, the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF).

## Scope 1, 2, 3 emissions

Terminology developed by the Greenhouse Gas Protocol and now adopted broadly, including in National Greenhouse and Energy Reporting (NGER) documentation.

Scope 1 emissions: direct emissions arising from sources within the control of the reporting organisation.

Scope 2 emissions: indirect emissions from the generation of purchased or acquired electricity, steam, heating or cooling consumed by the reporting organisation. For farms, this is predominantly electricity use.

Scope 3 emissions: indirect emissions other than scope 2 emissions that occur within the value chain as a consequence of the organisation’s activities. For farms, scope 3 emissions are the pre-farm and post-farm emissions, such as from manufacture of urea and herbicides, processing in abattoirs, and refrigerated transport of produce. Scope 3 emissions are not reported under the NGER scheme. Scope 3 emissions that occur outside Australia are not reported in Australia’s national inventory report. Scope 3 emissions are included in consumption-based accounting, that seeks to capture the climate impacts of the manufacture of imported goods.

## Sink

A process, activity or mechanism that removes a GHG, an aerosol or a precursor to a GHG from the atmosphere. A pool (reservoir) is a sink for atmospheric carbon if, during a given period, more carbon is moving into it than is flowing out. Forests and agricultural lands are reservoirs: they can be either a source or a sink. A forest is a sink if there is net flow of greenhouse gases into the aggregated forest pools (sum of living biomass, litter and soil pools), and it is a source if there is a net flow of GHG to the atmosphere from the aggregated pools.



**For more information and  
to download the Emissions  
Reduction Roadmap, visit:**

[wineaustralia.com/sustainability/  
emissions-reduction-roadmap](https://wineaustralia.com/sustainability/emissions-reduction-roadmap)

