BEANSTALK

An Overview of Lowering Australian Pork's Carbon Footprint

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foodagility

CRAIG MOSTYN GROUP
FOOD & AGRIBUSINESS

GOVERNMENT OF WESTERN AUSTRALIA
Department of Primary Industries and Regional Development

PIWA Pork Innovation WA

Curtin University

AN OVERVIEW OF LOWERING AUSTRALIAN PORK'S CARBON FOOTPRINT

Purpose of Report

This report was developed as part of Food Agility program FA136: ESG Credentials for Australian Pork in the Pork Industry. Overall, this report aims to give Australian pork producers a baseline understanding to proactive make progress towards producing pork with a lower carbon footprint.

The information contained in this publication is intended for general use to increase knowledge and discussion, and the long-term prosperity of the Australian Pork Industry.

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Contents

1. Report Purpose and Overview

The sustainability and reporting landscape for Australian pork producers is shifting rapidly, driven by numerous factors, including the phased introduction of mandatory climate disclosure requirements from January 1, 2025. Under this new reporting regime, large businesses[1], including major retailers, banks, and agribusinesses, and their supply chains must annually disclose climate-related risks, opportunities, and greenhouse gas (GHG) emissions in accordance with international standards. While these obligations initially fall on the biggest market players, their influence extends deep into the supply chain. Pork producers supplying retailers such as Coles and Woolworths may soon face stronger demands to provide robust, verifiable emissions data.

Much of the industry's recent focus has been on developing reliable systems for measuring and reporting emissions, especially Scope 3 emissions. Leading retailers, such as Coles, Woolworths and ALDI have set net zero and Environmental, Social and Governance (ESG) goals and will prioritise suppliers who not only measure but can also demonstrate real reductions in their emissions footprint. As expectations shift from simple reporting to achieving measurable improvement, pork producers who invest in GHG reduction strategies should remain preferred partners, while those lagging in measurement or action risk losing contracts and market relevance.

For pork producers, this evolving landscape brings both obligations to help downstream organisations meet reporting obligations and market opportunity. Meeting evolving standards is quickly becoming the baseline, not just for regulatory purposes, but as a fundamental condition to retain supply contracts and secure future growth. Progressive producers are now focusing beyond just accurate measurement and reporting, and towards routine benchmarking and active collaboration with partners across the value chain to speed up emissions reduction.

Purpose of This Report

This report aims to provide a practical, actionable roadmap for Australian pork producers and industry stakeholders, enabling them to credibly reduce and remove GHG emissions, and move confidently toward carbon neutral pork production. It will:

- **Explain key concepts** such as net zero, decarbonisation, carbon credits, and related terminology
- **Examine the main drivers** for decarbonisation in the pork sector
- **Map out the sources of emissions** in pork production
- **Explore and analyse options** for decarbonising pork operations at the farm level

[1] The first group of businesses that are affected by the mandatory climate disclosures reporting regime from January 2025 include entities that meet at least two of the following criteria: 1) $500 million or more in consolidated revenue 2) $1 billion or more in consolidated gross assets 3) 500 or more employees. By 1 July 2027, groups that meet any two of the three criteria will also be required to report: 1) $50 million or more in consolidated revenue 2) $25 million or more in consolidated gross assets 3) 100 or more employees.

- **Present a structured framework** to guide effective decision-making for decarbonisation
- **Demonstrate through a worked example** what level of emissions reduction can realistically be achieved.

Overall, this report aims to give the Australian pork supply chain ranging from producers to downstream partners a baseline understanding to proactively make progress towards producing pork with a lower carbon footprint.

Executive Summary

As seen in Figure 1 Australian pork producers can progress toward decarbonisation through four levels of approach:

1. **Measure:** Establish robust systems for tracking greenhouse gas (GHG) emissions across all sources. Accurate, auditable data is now essential, driven by mandatory climate disclosures and market expectations.
2. Measure and **Reduce:** Go beyond measurement and implement on-farm actions to cut emissions, such as improving feed efficiency, reducing waste, upgrading to energy-efficient technologies, installing solar, and adopting biogas systems. Early adopters will secure and expand market opportunities.
3. Measure, Reduce and **Inset:** Implement specific projects focusing on reducing or removing emissions within farm operations or the direct supply chain (e.g., tree planting, product circularity). This strengthens supply relationships and enhances credibility.
4. Measure, Reduce, Inset and **Offset:** Offset any remaining emissions with high-quality carbon credits as a last resort, and if carbon neutral certification is required. Typically, only retail products with a carbon neutral claim require offsets to receive certification. Landowners or pork producers need to make decisions on the role of offsetting within their business if applicable.

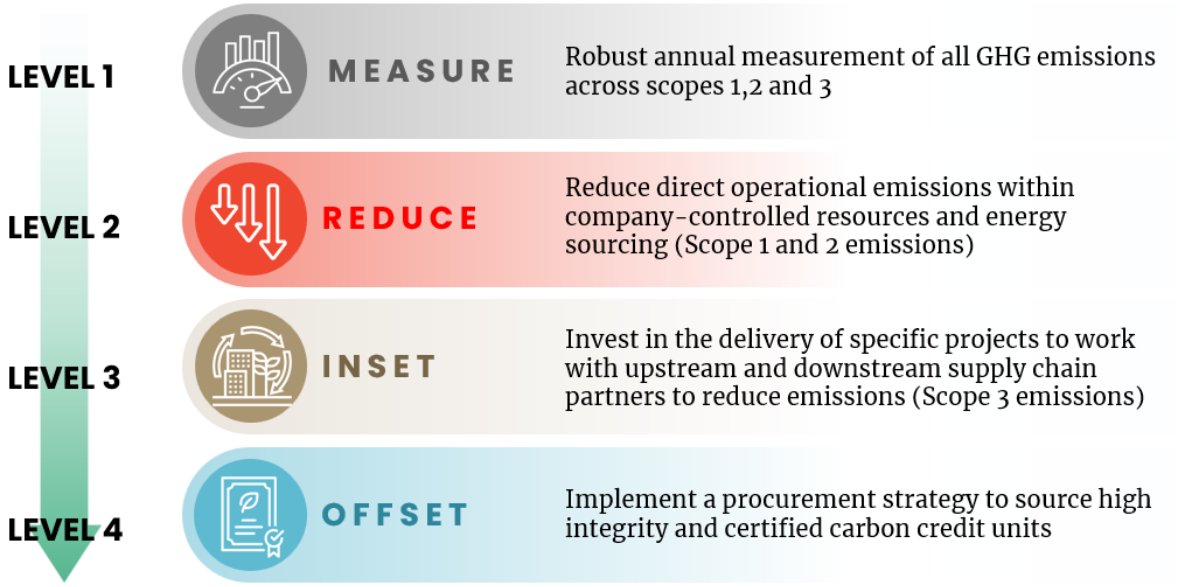

Figure 1. Four approaches of Decarbonising Pork Production

Options for Decarbonisation On-farm

Today, the primary sources of greenhouse gas (GHG) emissions in Australian pork production continue to be methane from manure management processes and the embedded emissions of feed production, particularly those linked to high-impact ingredients such as imported soymeal. Turning these challenges into opportunities, this report examines a selection of both proven practices and innovative solutions to decarbonise pork farming, including:

- **Precision feed and herd management** to optimise efficiency and minimise resource use
- **Advanced manure and biogas systems** to capture methane and generate renewable energy
- **Effluent pond additives** to suppress methane emissions cost-effectively
- **Renewable energy deployment** (solar, wind) to further decrease reliance on fossil fuels
- **On-farm carbon sequestration** through targeted tree planting and soil health initiatives
- **Collaborative supply chain action** to drive emissions reduction and leverage shared value.

Figure 2 presents an integrated overview of these decarbonisation options at the farm level

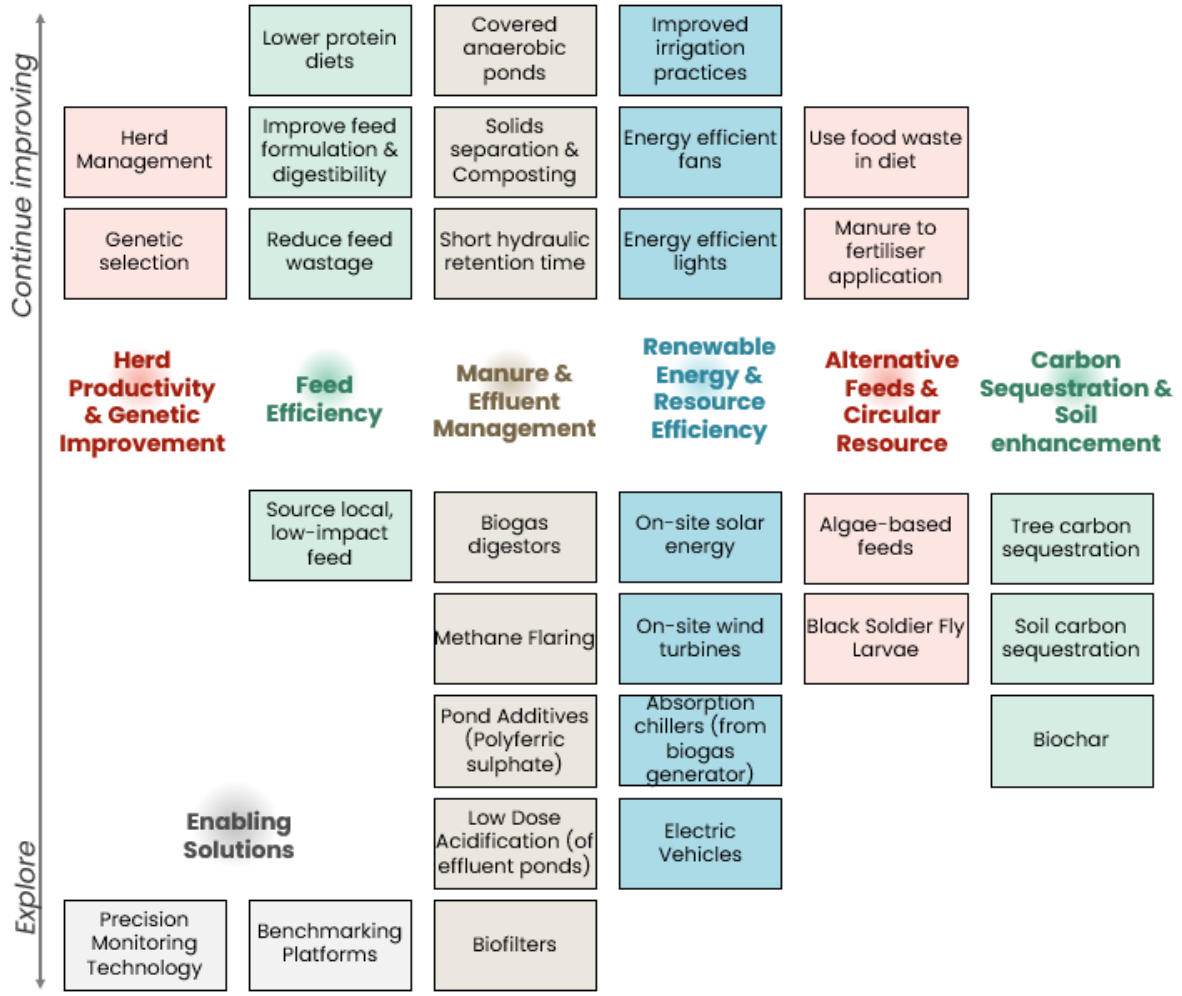

Figure 2. Overview of options to decarbonise pork production

Achievable Emissions Reduction: A Hypothetical Example

A hypothetical scenario analysis for a typical 500-sow conventional farm with uncovered ponds demonstrates what is achievable. By combining several decarbonisation approaches, total on-farm emissions can be reduced by up to 56%, starting from a baseline of 5.6 kg CO_2-e per kg liveweight. The most substantial emission savings come from methane capture via covered anaerobic ponds. Additional, meaningful reductions are realised through improved animal health, enhanced herd management, and more sustainable feed strategies. While reducing feed emissions and renewable energy provides important benefits, its share in the overall mitigation is comparatively smaller. Further abatement is possible through tree planting, which sequesters carbon over time contingent on land suitability and scale.

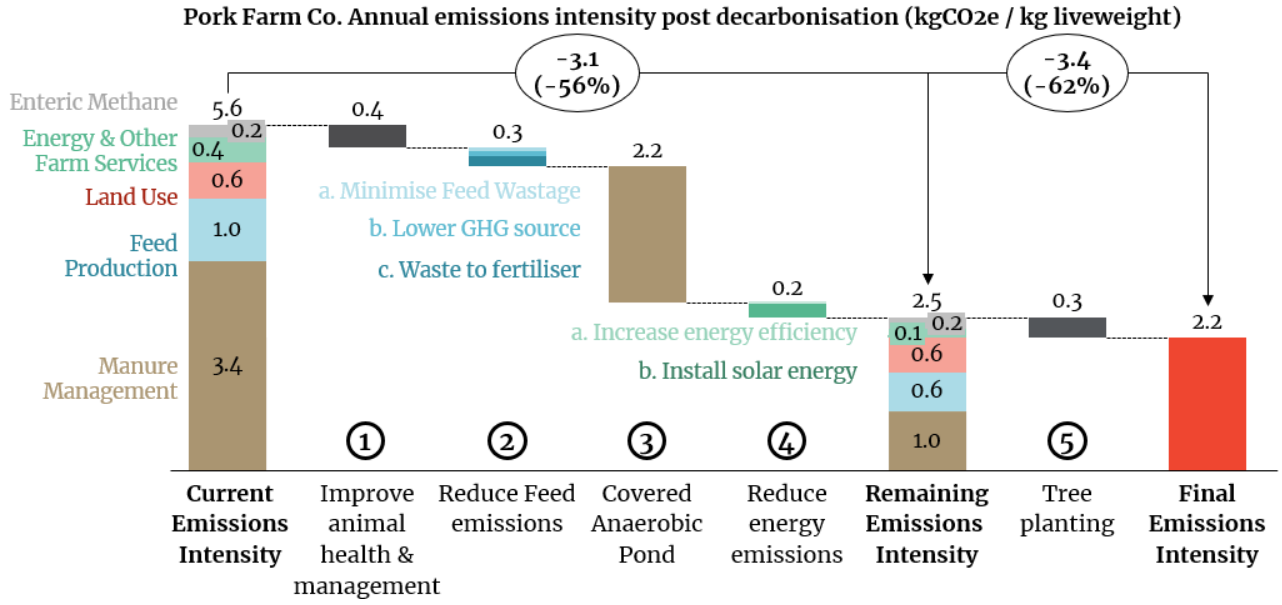

Figure 3. Hypothetical case scenario of what could be achieved through integration of decarbonisation strategies

By adopting a rigorous, transparent strategy focused on operational avoidance of emissions and targeted insetting, Australian pork producers can establish themselves as industry leaders. This proactive strategy not only builds long-term resilience and strengthens competitive advantage but also positions the sector at the forefront of the global transition to sustainable, low-carbon food systems.

2

Key Concepts

2. Key concepts

2.1. What are emissions?

Emissions are substances released into the atmosphere from both natural processes and human activities. In the context of climate change and agriculture, emissions typically refer to greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), which trap heat in the atmosphere and contribute to global warming. These gases are produced through activities like burning fossil fuels, industrial manufacturing, and farming practices including livestock management and fertiliser use.

Absolute Emissions and Emission Intensity

Absolute emissions and emission intensity are two key metrics used to assess greenhouse gas (GHG) impacts, but they serve different purposes.

Absolute emissions represent the total quantity of GHGs released into the atmosphere over a specific period, typically measured in metric tons of CO_2 equivalent (CO_2e). This metric reflects the overall environmental impact of an organisation, process, or country, regardless of its size or level of activity.

Emission intensity measures the amount of GHGs emitted per unit of output, activity, or economic value, such as per kilogram of liveweight pork produced at the farm level or per kilogram of pork consumed at the retail level. Emission intensity allows for comparisons of efficiency and performance across different organisations or time periods, especially when production levels fluctuate.

While absolute emissions provide a clear picture of the total greenhouse gases an activity contributes to climate change, this measure alone does not reflect how efficiently a process or business is operating, or whether improvements are being made over time. For pork producers seeking to show meaningful progress, emission intensity is a more relevant metric. It enables producers to benchmark efficiency, compare performance across operations of different sizes, and clearly communicate improvements in sustainability, even as production levels change.

2.2. What are Scope 1, 2 and 3 emissions?

A foundational principle of carbon accounting relates to classifying emissions into three distinct scopes. It is fast becoming a baseline expectation that all companies should consider Scope 1,2 and 3 emissions in any genuine net-zero or carbon neutral target.

- **Scope 1 emissions** are owned direct emissions from company owned and controlled resources. Examples include company owned facilities, vehicles and methane released from effluent.
- **Scope 2 emissions** are owned indirect emissions from purchased energy. Examples include electricity, steam, heating and cooling.

- **Scope 3 emissions** are not-owned indirect emissions from a company's upstream and downstream value chain. Examples include purchased goods and services, capital goods and usage of the company's products/services. These emissions are normally anything not accounted for in Scope 1 or Scope 2 emissions.

It's important to note that one organisation's Scope 1 and 2 emissions are counted as Scope 3 emissions for another entity further down the supply chain. In this way, Scope 3 emissions "accumulate" as products move from one stage to the next, and the definitions of Scope 1, 2, and 3 are always relative to the organisation being assessed.

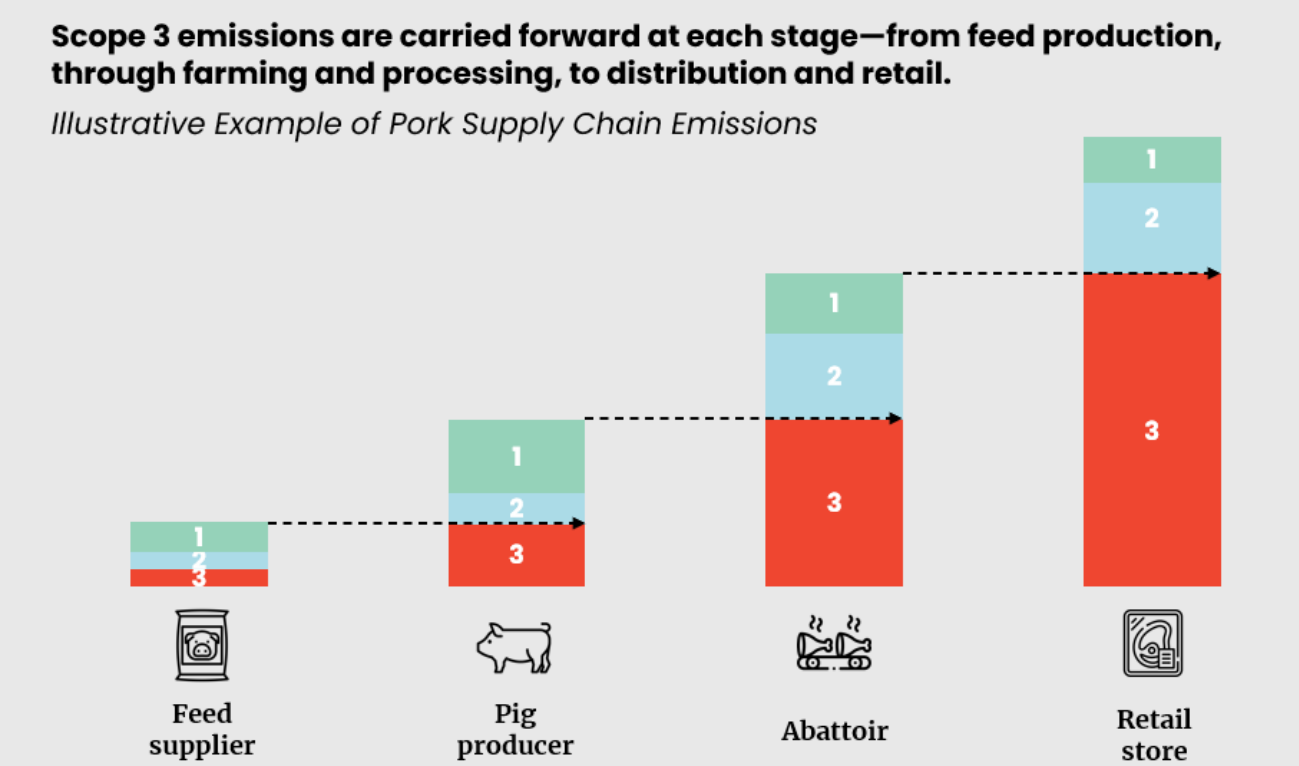

Figure 4. Visual representation of cumulative emissions across the supply chain

A critical implication of this, is the accumulative benefit of emissions reductions or removals at the farm level. When a farmer reduces their own carbon footprint, the emissions reduction is not just realised on-farm but also is reflected as a reduction for each downstream supply chain partner: the processor, the transport company, the retailer, and so on. This creates an opportunity for shared value and for downstream companies to contribute to helping those upstream to reduce their emissions.

2.3. What is Carbon Neutrality?

At the highest level, the concept of carbon neutrality means to achieve a total balance of zero tonnes carbon dioxide equivalent (CO2e) in your business's greenhouse gas emissions, either annually or at a set point in the future. As shown in the figure below this is typically achieved by measuring your baseline emissions at a given year, avoiding your emissions wherever possible, and then removing remaining emissions.

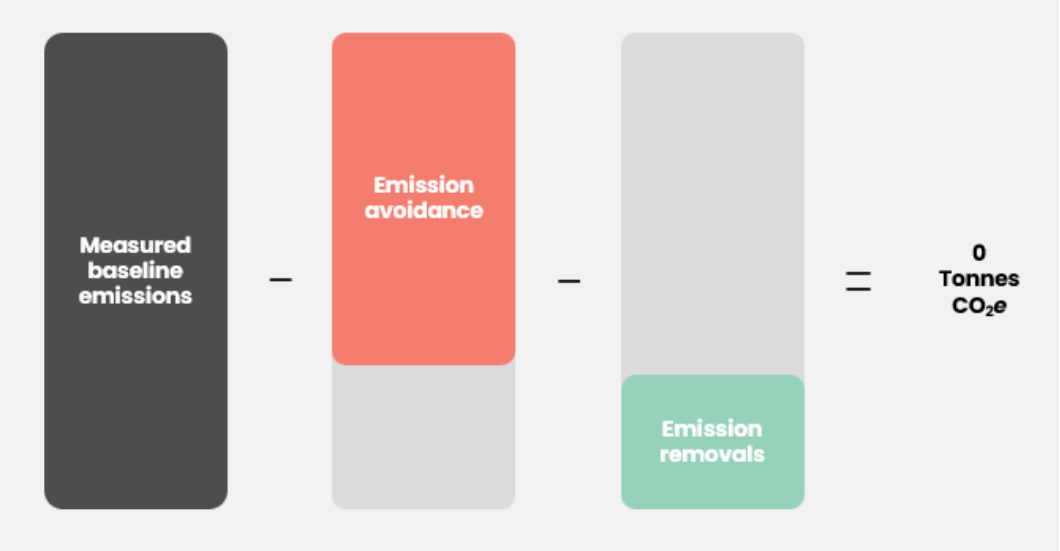

Figure 5. Carbon emissions pathways to achieve carbon neutrality

There is much nuance around terminology used by different companies or certification standards. The terms "net-zero", "climate positive", "carbon positive", "climate neutral" and other related expressions are often used interchangeably with "carbon neutral". However, it is important to note that these terms have distinct definitions and should not be considered synonymous. For carbon accounting purposes, all types of greenhouse gases are converted to carbon dioxide equivalent (CO2-*e*).

Without exploring every definition in detail, there are two key concepts to understand:

1. **Avoiding CO_2 emissions** is about changing practices to produce less CO_2.
2. **Removing CO_2 emissions** refers to pulling carbon dioxide out of the atmosphere and storing it in soils, oceans, trees, and rocks (nature-based or biogenic). It can also be done via direct air capture, or carbon capture and storage (technology-based).

Choosing between Carbon Neutrality or Net Zero

A net zero ambition relates to a long-term target (e.g. "Net Zero by 2050"), where the immediate focus is on avoiding emissions, with emission removal (to achieve carbon neutrality) only occurring at the end of the target period for unavoidable residual emissions.

Adopting a genuine carbon neutral stance, instead requires that all emissions are avoided or removed immediately on an annual basis. To be globally credible, a genuine carbon-neutral stance requires an aggressive emission avoidance approach, alongside carbon removal strategies.

Hybrid options exist in between these pathways. Companies can also take a leadership position by investing in catalytic climate action that goes beyond tonne-for-tonne neutralisation of emissions.

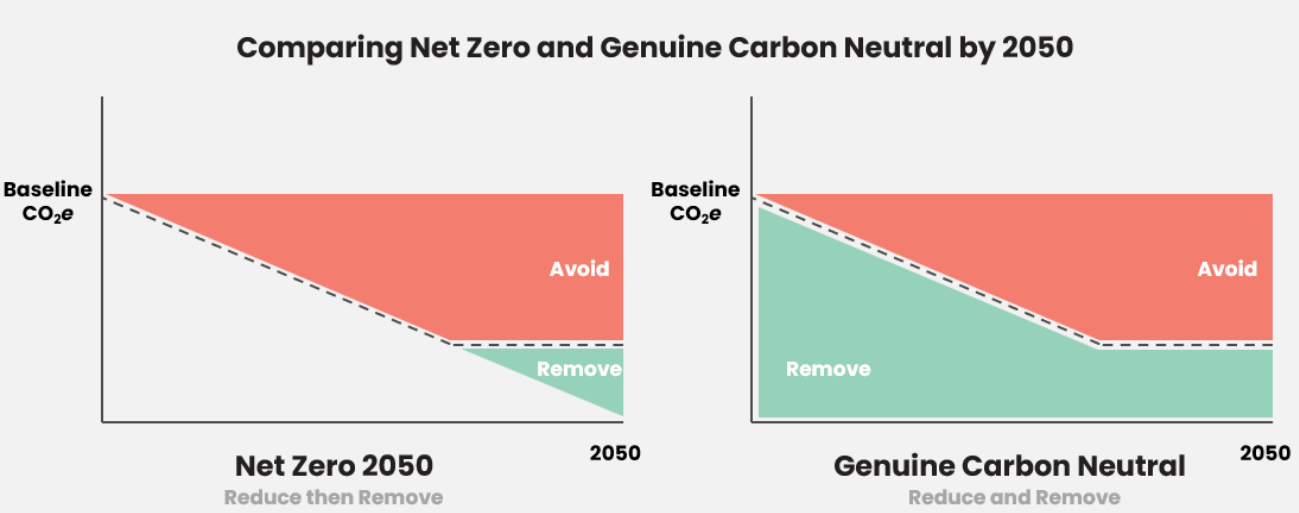

Figure 6. Comparing Net Zero (reduce then remove) and Genuine Carbon Neutral (reduce and removal) by 2050

2.4. Decarbonisation Strategies: A Clear Framework

All decarbonisation solutions fall into two fundamental categories: **avoiding emissions** (preventing greenhouse gases from being released) and **removing emissions** (capturing and storing existing CO_2, such as through carbon sequestration or removal technologies).

For any organisation, decarbonisation activities can take place **across three key areas**:

1. **Within direct business operations**
2. **Across the value chain** (upstream and downstream partners)
3. **Beyond the value chain** (external projects and initiatives)

By considering both the type of decarbonisation (avoid vs. remove) and where it occurs in the value chain, organisations can build a comprehensive framework to guide their climate action strategies.

Within this framework, there are **three core decarbonisation strategies:**

1. **Reduce:** Implement operational changes within your business to avoid CO_2 emissions, such as adopting more efficient processes or sourcing energy and materials with a lower carbon footprint.
2. **Inset:** Remove or avoid CO_2 emissions within company-owned land or infrastructure or collaborate with supply chain partners to achieve emissions reductions. This approach can include generating or using carbon credits within the value chain.

3. **Offset:** Support high-integrity projects outside your company's value chain that reduce or remove CO_2 emissions. This always involves the purchase of certified carbon credits.

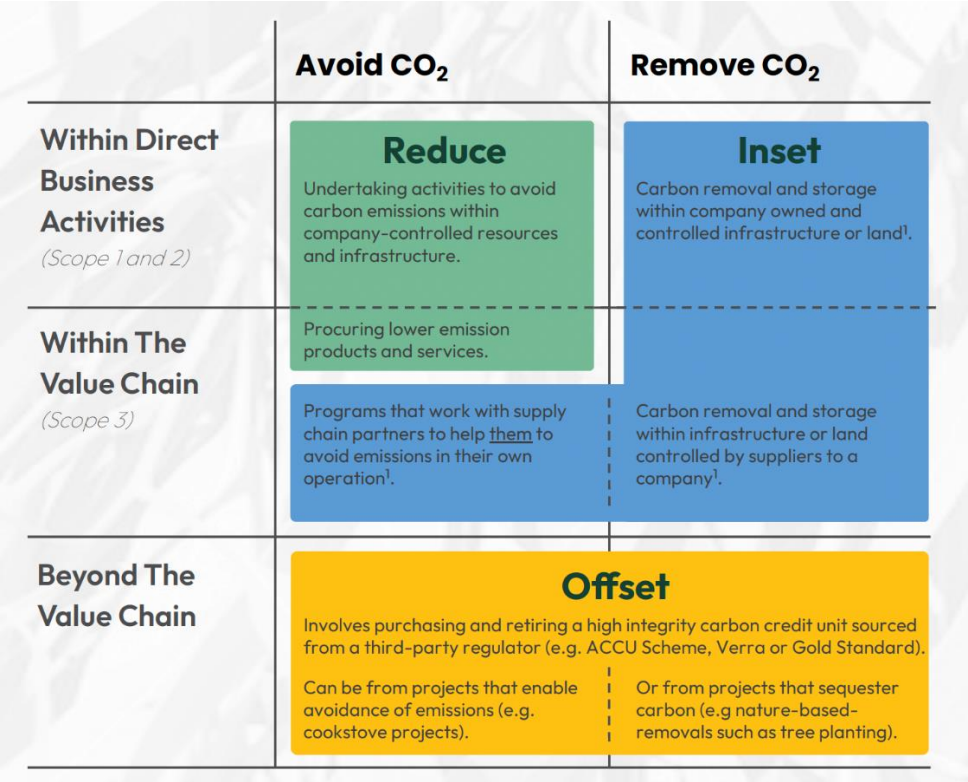

Figure 7. Lachy Ritchie (Kakariki Capital) on Tactics to decarbonise a company. Source: Carbon Markets 101 Guidebook - Kakariki Capital

2.5. What is a carbon credit?

A carbon credit is a certificate that represents one tonne of carbon dioxide equivalent (tCO_2-e) either avoided or removed from the atmosphere through specific projects.

One carbon credit unit = one metric tonne of CO2

Globally, there are many certification bodies that create tradable carbon credit units. At its most basic, the intention is that this carbon finance acts as an incentive to reduce or remove GHG emissions.

They are always subject to strict methodology rules, particularly around:

1. **Additionality** - that the activity is new, and would not happen without carbon finance *and*
2. **Permanence** - that the carbon avoidance or removal will have a lasting effect on the climate and will not be reversed

How do Carbon Credits work?[2]

[2] Australian Government Clean Energy Regulator. *Australian Carbon Credit Unit Scheme (2025).* https://cer.gov.au/schemes/australian-carbon-credit-unit-scheme

- **How are carbon credits earned?** Individuals, businesses, or organisations can earn carbon credits by running approved projects that either reduce GHG emissions (such as upgrading equipment or changing farming practices) or remove and store carbon (such as reforestation or soil carbon projects).
- **How are credits verified?** Credits are only issued after a project's emissions reductions or removals have been independently audited, verified, and reviewed by a regulator to ensure each credit represents a real, measurable, and permanent climate benefit.

What is "retiring" a carbon credit?

When companies purchase carbon offsets to compensate for their GHG emissions, they are required to retire those offsets to ensure the environmental benefit is real and cannot be claimed by anyone else.

Retirement of a carbon credit permanently removes it from circulation after it has been used to offset emissions. Once retired, the offset cannot be resold, traded, or used again by any other entity. This is recorded in an official public registry to prevent double counting and provide transparency and accountability for climate action.

Test your understanding:

Hypothetical Example:

A pork producer generates **1,000 tonnes of CO_2e emissions** per year. After installing a biogas facility, they are able to **avoid 1,000 tonnes of CO_2e being released into the atmosphere** each year. These avoided emissions are verified and converted into 1,000 carbon credit units, which the producer sells each year to a supermarket chain.

Q: For reporting purposes, what is the net emissions of the pork producer?

Misconception: *"0 tonnes of CO_2e. This pork producer is carbon neutral."*
This is incorrect.

Correct Answer: *"The net emissions are the same as their original emissions prior to biogas installation - 1,000 tonnes of CO_2e"*

When the farmer sells the 1,000 carbon credits, the right to claim the emissions reduction is transferred to the buyer, the supermarket chain. The pork producer can no longer claim those reductions for themselves. For reporting purposes, the net emissions of the pork producer revert to their gross emissions prior to the installation of the biogas facility, 1,000 tonnes of CO_2e for that period.

The table below outlines the three most well-established regulators with relevance in Australia.

Table 1. Established Carbon Credit Regulators in Australia

Carbon Credit Regulator	Carbon Credit	Description
Australian Government Clean Energy Regulator	Australian Carbon Credit Units (ACCUs)	- Developed the Australian Carbon Credit Units (ACCU) Scheme. - Multiple methodologies exist across a wide range of nature-based and technology-based emission avoidance or removal activities. - Credits are registered in the Australian National Registry of Emissions Units (ANREU).
Gold Standard	Certified Emission Reductions (CERs) Verified Emission Reductions (VERs)	- Global regulator with a wide range of methodologies. - Certified Emission Reductions (CERs) that are generated under the Clean Development Mechanism and Verified Emission Reductions (VERs) covered by voluntary standard.
VERRA	Verified Carbon Units (VCUs)	- Largest global regulator by volume of credits traded. - Wide range of methodologies. - Verified carbon standard program (VCS), drives finance towards activities that reduce and remove emissions, improve livelihoods and protect nature. Once certified, programs are issued Verified Carbon Units (VCUs).

2.5.1. How to manage farm-level carbon credits

There are three main options for handling carbon credits generated at the farm level:

1. **Hold carbon credits:** Carbon credits can be kept as assets on the balance sheet
2. **Sell carbon credits:** Producers can sell credits on the open market to generate additional revenue, either to buyers seeking offsets or as part of carbon trading schemes.
3. **Retire carbon credits:** Credits may be retired to offset the producer's own emissions or used within insetting programs to benefit the supply chain or meet partnership requirements. (See Section 2.6 for What is Carbon Insetting?)

Table 2. Options and considerations for managing farm-level carbon credits

Option		Who buys / uses the credit	Considerations
1. Hold carbon credits		The farm (landowner / producer holds the credit)	Carbon credits kept as asset on the balance sheet, providing potential for increased value over time and strengthening the farm's sustainability credentials
2. Sell carbon credits	**a. Outside value chain**	External buyers (e.g., corporates, brokers, voluntary carbon market, government)	Access to a wide range of buyers (corporates, brokers, government, etc.) however not linked back to supporting own supply chain to decarbonise.
	b. Within value chain	Downstream partners (e.g., processors, retailers, supply chain collaborators)	Supports downstream partners who intend to accumulate carbon credits for future use. If intention is for downstream partner to retire the credit, paying for a landowner to retire the credits themselves (Option 3) offers greater value.
3. Retire them yourself		The farm (producer retains and retires credits)	Enables the farm to claim carbon neutrality or reduced emissions. When a farm retires its own carbon credits, the emissions reduction benefits extend through the entire downstream supply chain, making this an attractive approach for the supply chain to collaborate to reduce emissions at the farm level.

How do the three options impact reportable emissions?

Out of all three options, the option that benefits the whole of industry most is retiring the credit at the farm level. Building upon the concept covered in Figure 4, where emissions accumulate down the value chain and become another organisation's scope 3 emissions, by retiring the credit at the farm level, all downstream organisations are able to report lower scope 3 emissions, creating a multiplier effect. If the credit is sold outside the value chain, emissions reductions cannot be claimed within the value chain. This is illustrated in Figure 8 below.

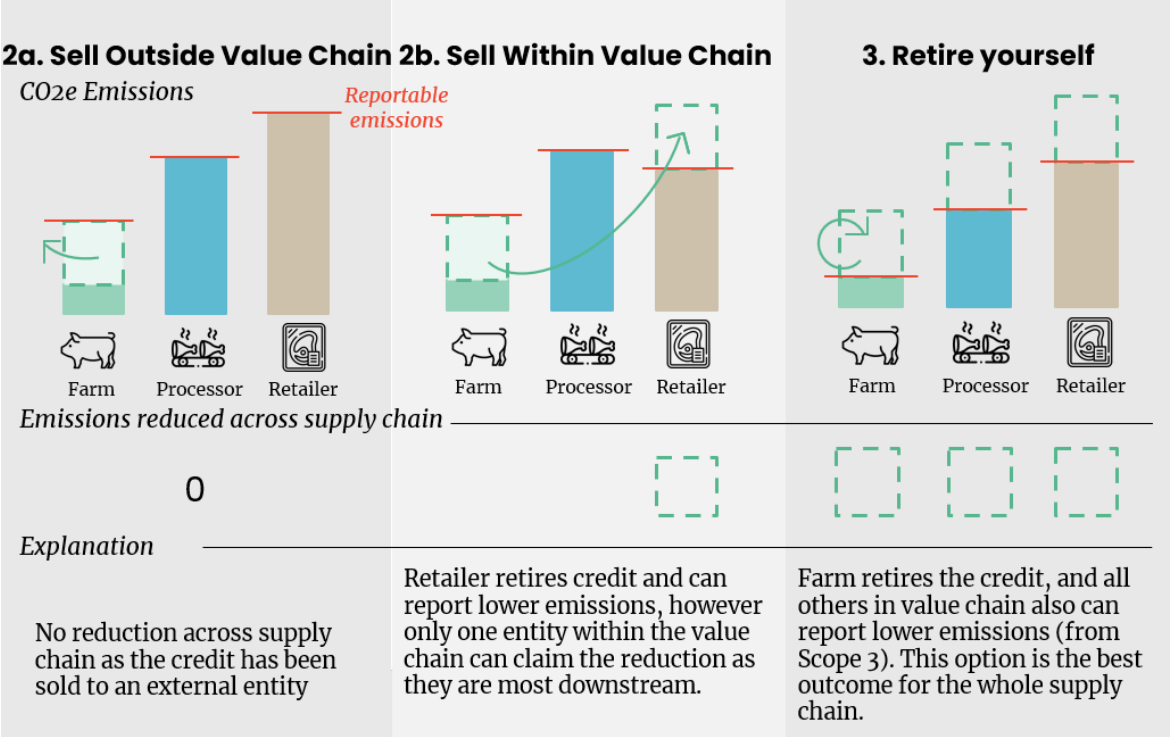

Figure 8. Visualisation of impact of selling credits outside/inside value chain and retiring at the farm level

What does this mean for industry?

The pork supply industry should strive to support upstream entities particularly at the farm-level to decarbonise and collaborate, so decarbonisation occurs at the farm level. This ensures many more organisations will stand to benefit from decarbonisation activities carried out on farm.

Downstream entities can collaborate across the value chain through insetting programs that financially incentivise farmers to choose to retire the carbon credits themselves. If multiple supply chain partners, such as processors and retailers, each contribute to paying the farmer for the same ton of emissions reduction, their individual payments can be lower, but the combined total will often deliver a higher net return for the farmer than selling credits outside the value chain.

For example, instead of selling a carbon credit externally for $50, a farmer could receive $15 from each of five supply chain partners, totalling $75. This makes decarbonisation financially attractive for farmers and cost-effective for supply chain entities, while ensuring that carbon reduction benefits are shared across the industry. This collaborative insetting model represents a future-focused approach to building resilient, sustainable supply chains.

2.6. What is Carbon Insetting?

Carbon insetting is the avoidance or removal of CO2e from within an entities' value chain. It may involve a formal carbon credit unit (e.g. from the Australian Carbon Credit Unit (ACCU) Scheme), or it could be a non-accredited program from an internal measurement approach with no tradable carbon credit unit (these approaches will usually follow carbon accounting standards such as the

GHG Protocol). This process requires investing in or managing specific projects that are usually in partnership with supply chain companies.

There is no universally accepted definition of carbon insetting. The key is to adopt a clear internal definition of the three categories of direct reductions, insetting and offsetting.

Test your understanding:

A farm installs solar panels on their roof through funding provided by a retail customer, is this considered insetting?

Insetting is relative to the entity in question.

1) For the farm - installing rooftop solar helps to avoid the emissions that would have been generated from using electricity. This is considered **emission avoidance, not insetting.**

2) For the retailer - funding the farm, an entity downstream within the retailer's value chain, to avoid their emissions is considered **carbon insetting**.

2.6.1. Accredited vs unaccredited insetting

Accredited insetting (with carbon credits)

Accredited insetting involves projects that generate formal carbon credits such as Australian Carbon Credit Units (ACCUs) or internationally recognised credits like those from Verra or Gold Standard (For more information see 2.5 What is a carbon credit?). These projects follow rigorous, third-party approved methodologies for monitoring, reporting, and verification. The credits created are registered, may be independently traded or retired, and are widely accepted for claims in both voluntary and compliance markets. Accredited insetting requires strict standards for additionality, permanence, and transparency, ensuring that reductions are both genuine and exclusive to the claimant.

An example would be a farm registering a tree planting project under the ACCU scheme: the carbon removals are verified by a regulator, registered, and ultimately retired to make a formal emissions claim. This approach gives the business or supply chain partner the confidence that the claimed reduction is robust, unique, and supported by detailed documentation.

Unaccredited insetting (no carbon credits)

Unaccredited insetting includes emissions reduction or removal activities that are not registered as tradable credits but are still measured according to recognised protocols. Programs such as the Science Based Targets initiative (SBTi), specifically the Forest, Land and Agriculture Guidance (FLAG), and the forthcoming GHG Protocol Land Sector and Removals Guidance provide frameworks for robust measurement without formal crediting. See Section 2.10 Target Setting Initiatives for more information on these programs.

While no tradable credits are created or sold in these cases, reductions are still calculated, documented, and can be reported toward internal and supply chain climate targets. For example, if a pork producer and a retailer jointly invest in soil carbon improvements on-farm, the reduction is measured and reported but not certified or listed on a carbon registry. This approach is particularly

valuable for supply chain collaboration but requires clear agreements and robust internal or third-party verification to avoid double counting.

Key differences between accredited and unaccredited insetting

The key distinction lies in verification and market acceptance. Accredited insetting produces credits that are independently verified, traceable, and accepted in compliance and some high-stakes voluntary frameworks. It minimises risks of double counting or ambiguity over claims, critical to both regulatory and reputational integrity.

Unaccredited insetting, while often faster and more flexible, carries higher risks if tracking and verification are inconsistent or if multiple parties accidentally claim the same reductions. The absence of a central registry can lead to unclear ownership, and claims could be challenged by customers, investors, or regulators, especially as expectations and standards tighten in line with ASIC greenwashing guidance and evolving global protocols.

Unaccredited approaches do have evolving guidance, such as from SBTi and GHG Protocol Land Sector and Removals Guidance, and the now-stalled Climate Active draft insetting policy. However it is important to note that for programs aiming to deliver credible insetting, both the SBTi and GHG Protocol Land Sector and Removals Guidance require compliance standards that are nearly as rigorous as formal carbon credit schemes. This is especially true around the issue of permanence where landowners must ensure that any carbon removals are secured for periods ranging from 25 to 100 years, with clear systems to monitor and verify ongoing storage.

Therefore, if an insetting program is not accredited through a carbon credit scheme, it must establish its own robust methodology for monitoring, reporting, and demonstrating permanence over these long durations. In practice, building and maintaining such a credible approach can prove to be more onerous than simply adopting a formal carbon credit program.

Risks of unaccredited insetting programs

Unaccredited insetting programs present distinct risks for both landowners and downstream partners, especially concerning the long-term continuity of carbon removal initiatives. If such a program is altered or discontinued, landowners are generally prevented from enrolling removal activities initiated under the unaccredited scheme in accredited carbon credit programs, due to strict requirements around additionality and project newness. This constraint can block landowners from accessing the full value potential of their carbon removal investments over the 25 to 100-year permanence period and poses reputational risks for downstream partners by limiting landowner opportunity in the broader carbon market.

In contrast, accredited insetting programs generate carbon credits that can be held as tradable assets on the balance sheet, providing flexibility. Landowners may choose to retire credits for insetting, benefiting all supply chain participants, or sell credits independently if circumstances change. This optionality is vital for removal-based projects with long-term commitments, but less critical for short-term, avoidance-focused activities.

Overall, accredited programs offer landowners greater strategic choice and protect all parties by ensuring ongoing access to the carbon market, regardless of changes in insetting arrangements. Unaccredited approaches, by comparison, tend to make landowners fully dependent on downstream partners for market participation, increasing both business and reputational risk if the underlying program fails.

2.6.2. The Rise of Insetting Companies and Collaboration

In recent years, a new ecosystem of specialist insetting companies and collaborative initiatives has accelerated the adoption and scale of insetting across global agriculture and food sectors.

Leading food brands such as General Mills and Mars are increasingly backing insetting projects to generate verifiable Scope 3 emissions reductions within their own value chains. These projects enable large corporates to meet sustainability targets and investor expectations for genuine, supply chain-based climate action.

A key pioneer in this field is SustainCERT, which approved its first value-chain intervention in 2019[3]. SustainCERT went on to co-found the Value Change Initiative (VCI), a forum now involving over 100 corporate and non-profit members across the apparel and agri-food industries, dedicated to codifying best practice, sharing knowledge, and scaling credible emission reductions within supply chains. SustainCERT's collaboration has enabled companies to rigorously account for and accelerate Scope 3 decarbonisation, with guidance and verified solutions now being widely disseminated among industry leaders[4].

Meanwhile, new insetting finance and market models are expanding. Athian, launched in 2022, has created the first carbon insetting marketplace dedicated to livestock. By verifying farms, issuing inset credits, and enabling third-party credit sales, Athian directs value from food brands and processors directly back to producers, with contracts already distributing millions in incentives for on-farm practices that reduce emissions[5,6]. Amsterdam-based Proba is another notable entrant, recently raising €1 million in 2025 to scale its platform that creates verifiable insetting certificates for agri-food supply chains[7]. Proba's approach links financial rewards directly to on-farm emission reductions, turning shared climate goals into economic opportunity for farmers and their supply chain partners.

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[3] SustainCERT. *Value Chain Initiative*. https://www.sustain-cert.com/value-change-initiative

[4] Value Change Initiative. *On SustainCERT and the Value Change Initiative*. https://valuechangeinitiative.com/on-sustaincert-and-the-value-change-initiative/

[5] Carbon Credits. *Athian's New Carbon Insetting Marketplace Revolutionizes Livestock Farming (2024).* https://carboncredits.com/athians-new-carbon-insetting-marketplace-revolutionizes-livestock-farming/

[6] Business Wire. *Athian and Elanco Team Up to Transform Food Production through Methane Reduction (2023).* https://www.businesswire.com/news/home/20231102251225/en/Athian-and-Elanco-Animal-Health-Team-Up-to-Transform-Food-Production-through-Methane-Reduction

[7] Know ESG. *Proba Raises €1M for Carbon Insetting, Agri-Food Decarbonisation (2025).* https://www.knowesg.com/sustainable-finance/proba-expands-agri-food-decarbonisation-with-eur1m-14022025

2.6.3. A Case Study of a Collaborative Insetting Approach

Revisiting the concept covered in Figure 4, emissions accumulate across the supply chain. This means an upstream organisation's emissions become a downstream organisation's Scope 3 emissions. The case study below explores an example of downstream organisations collaborating to inset emissions within their own supply chain to reduce their scope 3 emissions.

Case Study 1: A collaborative insetting approach to reduce emissions in UK[8,9,10]

SOIL ASSOCIATION EXCHANGE

A group of major UK supermarkets, Tesco, Lidl, and Co-op, alongside landowners and financial partners such as the Church Commissioners for England and Lloyds Banking Group, have established a collaborative managed by Soil Association Exchange. This fund directly incentivises farmers to avoid or remove greenhouse gas emissions on their farms, allowing supply chain companies to invest directly in their own supply chain.

How does it Work?

- The fund pools £1 million from participating companies to support verified on-farm emission reductions
- Farmers are paid £60 for every tonne of carbon dioxide (CO_2e) they reduce, with half the payment given upfront to support transition to lower emission practices (e.g., less fertiliser, improving fuel efficiency, installing solar panels)
- Emission reductions are counted towards downstream contributors' Scope 3 emissions
- Farmers who already operate below average emissions (benchmarked using the Farm Carbon Toolkit) are eligible for maintenance payments, supporting sustained good practice.

Learnings for Industry: *A collaborative insetting program allows supply chain contributors to count the farm's emission reductions towards their own Scope 3 goals. Because costs are shared, each contributor pays less per-tonne of emissions reduced whilst farmers receive a stronger aggregate incentive. By pooling resources, these programs make farm-level decarbonisation more cost-effective and rewarding for all supply chain partners.*

Learnings for Pork Producers: *Processors and retailers in Australia are likely to show growing interest in collaborating with pork producers to achieve Scope 3 emission reductions across the supply chain. Pork producers who invest in accurate data collection and robust verification of their emissions will be best positioned to take advantage of these emerging partnerships and access new opportunities for financial incentives, long-term supply agreements, and recognition as sustainability leaders within the industry.*

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[8] Social Association Exchange website. https://www.soilassociationexchange.com/exchangemarket

[9] Foodbev Media. *New £1m fund aims to incentivise farmers for emission reductions (2025).* https://www.foodbev.com/news/new-1m-fund-aims-to-incentivise-farmers-for-emission-reductions

[10] The Grocer UK. *Supermarket-backed £1m carbon insetting fund for farmers unveiled (2025).* https://www.thegrocer.co.uk/news/supermarket-backed-1m-carbon-insetting-fund-for-farmers-unveiled/699631.article

2.7. What is Carbon Offsetting?

Carbon offsetting is avoiding or removing CO_2e from outside a company's value chain. This process requires the purchase and retirement of a formal carbon credit unit (See Section 2.5 What is a carbon credit? for more information). The recommended approach for companies is to measure their total baseline emissions, followed by reducing any direct carbon emissions from within the business, then inset carbon emissions from within the value chain, and lastly, offset any remaining emissions outside of the value chain.

Figure 9 summarises the role reducing, insetting and offsetting plays across, within and outside of the value chain. There is no special term needed to describe emission reductions within Scope 1 or 2 areas. This overlaps slightly into Scope 3, because changing purchasing choices to reduce Scope 3 emissions would not be considered "insetting" (for example, choosing recycled packaging).

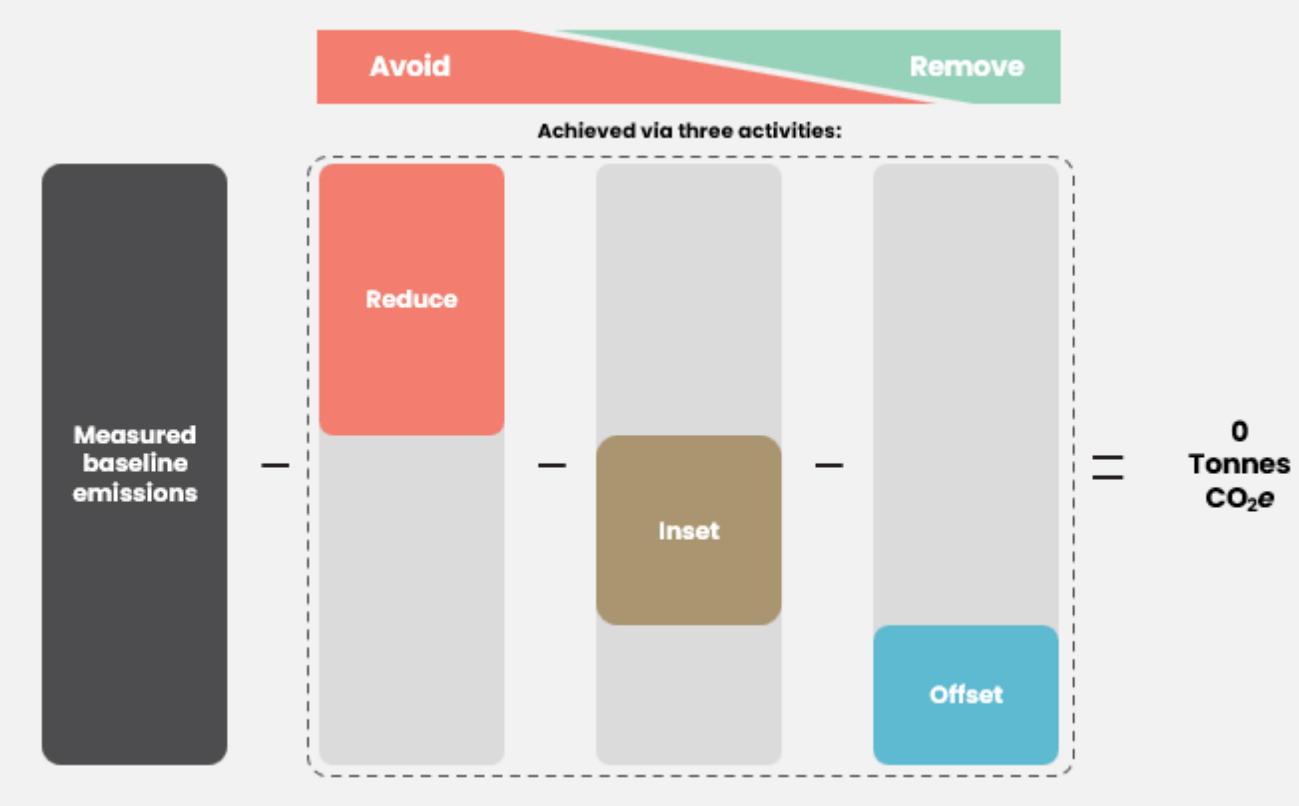


Figure 9. Measured baseline emissions can be removed by a combination of direct emission reductions, carbon insetting and offsetting.

2.8. Life Cycle Assessment

A Life Cycle Assessment (LCA) is a systematic method used to measure the environmental impacts associated with every stage of a product's life, from raw material extraction through production, use, and disposal. In the pork life cycle this includes from growing animal feed and raising pigs to processing, distribution, consumption, and waste. By evaluating the full "cradle-to-grave" process, LCA reveals where carbon emissions, water use, and land occupation are most significant within the supply chain.

For pork, LCA typically highlights feed production as a major contributor to greenhouse gas emissions, followed by farm energy use, manure management, and processing. Using this approach, producers can identify environmental "hotspots," benchmark sustainability improvements, and make informed decisions, such as using local grains instead of imported soy, to reduce their footprint.

LCA provides transparent, data-driven insights, supporting environmental claims and compliance with sustainability standards. In Australia, LCA has enabled the pork industry to track and achieve significant emission reductions, making it a critical tool for sustainable pork production and communication with regulators, consumers, and investors.

2.9. Certifications and Standards

Certifications and standards play a central role in the decarbonisation journey by providing credible, recognised frameworks for measuring, verifying, and communicating emissions reduction and carbon neutrality progress. As market, investor, and regulatory expectations grow, achieving certification or meeting leading standards can help producers demonstrate genuine action, gain access to new markets, enhance brand value, and reduce business risk. This section highlights the key global and Australian organisations and standards shaping the carbon neutral and decarbonisation process.

The list below is not exhaustive however focuses on the main global and Australian players relevant to the carbon neutral and decarbonisation process. However, it does not extend to broader nature related certifications and standards (such as biodiversity).

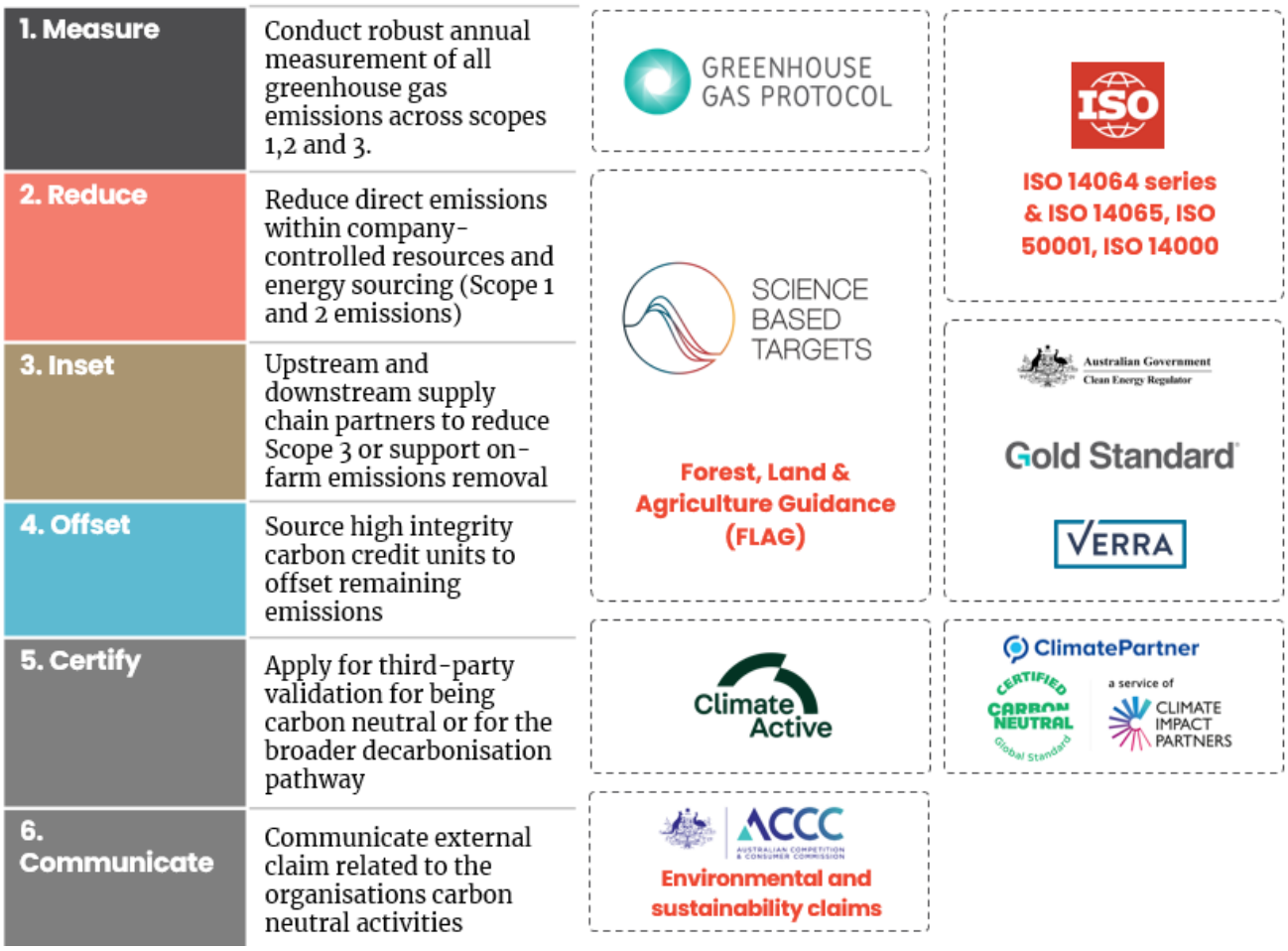


Figure 10. Landscape map of organisations and standards involved across various stages of decarbonisation

2.9.1. Standards for Emissions Measurement

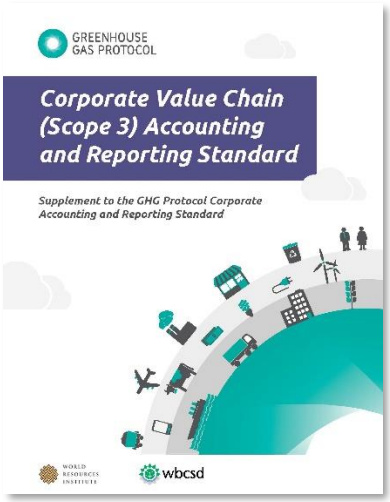
There are two main standards for emissions measurement: The Greenhouse Gas (GHG) Protocol and various frameworks by the International Standardization Organization (ISO).

1. The GHG Protocol[11]

The global GHG protocol is an internationally accepted "accounting standard" for emissions. It provides comprehensive frameworks for organisations to measure, manage, and report their emissions across all sectors and activities.

Outlined below are the standards frameworks and frameworks most relevant to the agricultural supply chain covering value chain Scope 3, agriculture, and land-based emissions and removals.

Figure 11. List of relevant GHG Protocol Standards and Guidance resources for agricultural supply chain



Corporate Value Chain (Scope 3)

GHG Protocol Agricultural Guidance

Land Sector and Removals Guidance (Draft)

The **Land Sector and Removals Guidance (LSR)** will be a new addition to the GHG Protocol, providing a global standard for accounting and reporting emissions and removals from land management, land use change, and carbon removal activities. The complete guidance will be published in towards the end of 2025.

[11] Greenhouse Gas Protocol. Standards & Guidance. https://ghgprotocol.org/standards-guidance

How the GHG Protocol Land Sector and Removals Guidance will enable credible carbon insetting

This guidance will align carbon accounting to the SBTi FLAG (See Section 2.10), and similarly will mandate organisations to keep two separate carbon accounts, one for land-related activities (like farming, forestry, and soil carbon) and one for the rest of their business operations. This separation is important to avoid overlap between land-sector removals and operation emissions, ensuring each tonne of carbon avoided or removed is only counted once and attributed correctly.

These new rules pave the way for credible carbon insetting (removals) where organisations can directly account for land-based removals such as improved soil management or reforestation in their own carbon inventories without the need to generate and sell a third-party carbon credit. unit.

2. Alternative accounting standard – ISO[12],[13]

The International Standards Organisation (ISO) offers a globally recognised alternative for measuring greenhouse gas emissions and verifying emission reduction or removal activities.

ISO is an independent body comprising 170 national standard organisations, each representing a single country. Through its internationally harmonised standards, ISO provides a unified framework for carbon accounting.

Adopting an ISO standard ensures consistency and comparability of emissions data across borders and industries, creating a reliable baseline for ongoing tracking and transparent reporting. Certification to an ISO standard requires independent third-party verification by an accredited provider, ensuring credibility and integrity in environmental claims.

[12] U.S. Environmental Protection Agency. *ISO 14064, International Standard for GHG Emissions Inventories and Verification*. https://www3.epa.gov/ttnchie1/conference/ei16/session13/wintergreen.pdf

[13] ISO. ISO 14064 – 1:2018. *Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.* https://www.iso.org/standard/66453.html

2.10. Target Setting Initiatives

Setting credible, science-based targets is now widely recognised as essential for addressing climate change and maintaining trust with stakeholders. The Science Based Targets initiative (SBTi) provides a robust, globally respected framework to align greenhouse gas reduction efforts with scientific pathways for limiting global warming. For land-intensive sectors like agriculture and forestry, the SBTi's Forest, Land and Agriculture (FLAG) guidance delivers sector-specific tools to account for land-related emissions and removals. Adopting these targets helps businesses demonstrate climate leadership, manage risk, and unlock new opportunities in an increasingly sustainability-driven market

2.10.1. The Science Based Targets Initiative

The Science Based Targets initiative (SBTi) is a globally recognised partnership that helps businesses set credible, science-based decarbonisation targets aligned with limiting global warming to 1.5°C.[14]

Established in 2014 through collaboration between the United Nations, CDP, World Wide Fund for Nature (WWF), World Resources Institute, and the We Mean Business Coalition, SBTi provides sector-specific guidance and practical support for companies to set and monitor progress toward rigorous emissions reduction goals.

A science-based decarbonisation target, endorsed by the SBTi, is fast becoming a global benchmark for credibility. By the end of 2023, companies with science-based targets represented 39% of the global economy by market capitalisation.

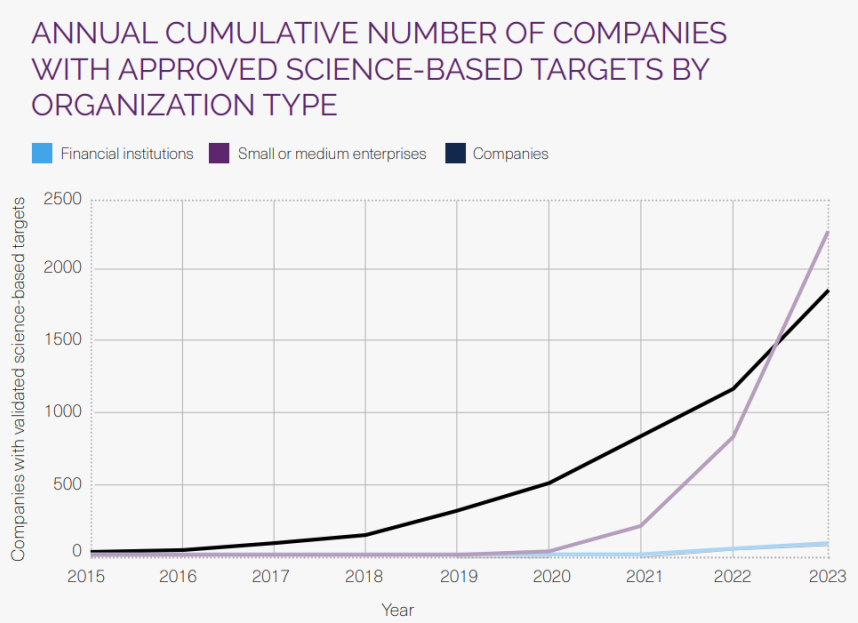


Figure 12. Science Based Targets initiative Monitoring Report 2023 (July 2024) - Source

Achieving an SBTi-approved target enhances brand credibility by offering third-party validation of a company's net-zero ambitions. Importantly, SBTi focuses on a net-zero pathway rather than carbon

[14] Science Based Targets. https://sciencebasedtargets.org/about-us

neutral certification and does not allow carbon offsets to count toward core target achievement; offsets are only recognised for "Beyond Value Chain Mitigation," meaning they are used to support climate action outside a company's own value chain, rather than as a substitute for direct emissions reductions.

2.10.2. SBTi's Forest Land and Agriculture Guidance (FLAG)[15]

The Science Based Targets initiative (SBTi) has introduced the Forest, Land and Agriculture Guidance (FLAG) to provide a robust, science-based framework for companies with supply chains that involve agriculture, forestry, or other land uses (collectively known as AFOLU). FLAG is now a mandatory component for any business whose operations or sourcing touch these sectors, ensuring that climate targets and reporting reflect the unique emissions and removals associated with land-based activities.

Under FLAG, companies are required to maintain a distinct set of greenhouse gas (GHG) accounts for their land sector activities, in compliance with the Greenhouse Gas Protocol. This is in addition to the energy and industry GHG targets set for the rest of the business. The FLAG framework enables organisations to quantify emissions from land use change (such as deforestation or conversion of grasslands), ongoing land management practices (like soil management or fertiliser use), and carbon removals (including reforestation or soil carbon sequestration). Importantly, carbon removals can only be used to reduce the GHG inventory within the FLAG carbon account, ensuring transparent and credible reporting.

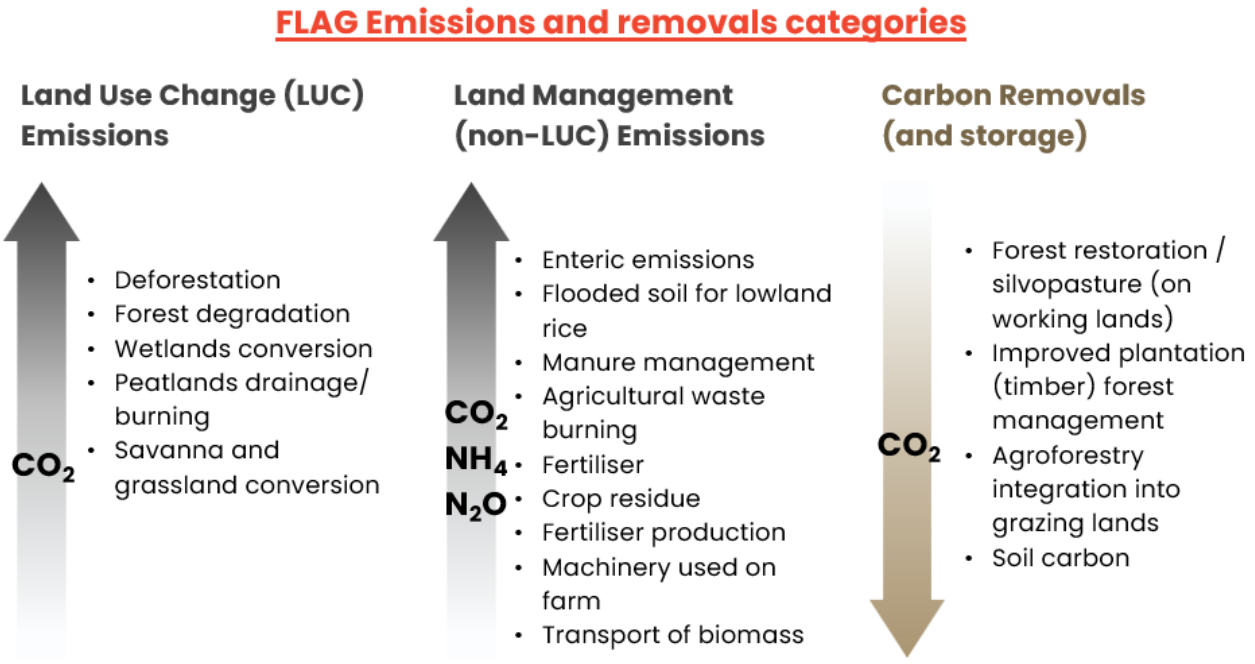


Figure 13. FLAG Emissions and removals categories. Source: Science Based Targets Initiative Webinar

[15] Science Based Targets. *Forest, Land and Agriculture (FLAG).* https://sciencebasedtargets.org/sectors/forest-land-and-agriculture

FLAG also includes **commodity-specific guidelines** for sectors with high emissions intensity, such as pork production, recognising the particular challenges and opportunities in these value chains. By setting clear requirements for separate accounting, target setting, and reporting, FLAG supports businesses in aligning their land sector climate action with the latest science and global best practices.

Why is SBTi FLAG important for the Pork Industry?

Australia's largest supermarket chains, Coles, Woolworths and ALDI have all set science-based net zero targets that have been validated by the SBTi. Woolworths and ALDI have gone further in specifying their FLAG target (See Table 3). The SBTi FLAG guidance is particularly important as it sets the framework for supply chain partners to claim carbon insetting within their value chain, e.g., investing at farm level to reduce emissions and effectively reduce their own scope 3 emissions.

Table 3. Scope 3 and FLAG targets of major supermarkets in Australia

Company	Scope 3 and FLAG targets
ALDI	• "Reduce absolute Scope 3 emissions 25% by 2030 from a 2022 base year* • "Reduce absolute Scope 3 FLAG greenhouse gas emissions 30.3% by 2030 from a 2022 base year**" *Source: ALDI South Group website*
coles	• "We will continue to consider how best to account for Scope 3 emissions – in particular, the aspects related to Forestry, Land and Agriculture (FLAG)…" *Source: Coles Sustainability Report - 2024*
Woolworths Group	• "Woolworths Group aims to reduce absolute scope 3 forest land and agriculture (FLAG) GHG emissions by 40% by F33 from a F23 base year" *Source: Woolworths Sustainability Plan - 2025*

2.11. What is carbon neutral certification?

Carbon neutral certification is a formal recognition that an organisation, product, service, event, building, or precinct has measured its GHG emissions, reduced them as much as feasible, and compensated for any remaining emissions through the purchase and retirement of carbon offsets. This process enables certified entities to credibly claim that their net climate impact is zero for a defined period.

2.11.1. Australia's leading carbon neutral certifier: Climate Active

Figure 14. Australia's Climate Active Certifications

The Australian Government's Climate Active program is the leading certifier of carbon neutral claims in Australia, operating as a voluntary initiative to drive climate action across the economy. According to Tempests and Terawatts, as of March 2025 there have been 540 entities in Australia who have obtained a carbon neutral certification[16].

Climate Active certification is grounded in international best-practice standards and aligns with the Global GHG Protocol. The program is open to a wide range of applicants, including organisations, products, services, events, buildings, and precincts, and requires participants to comprehensively report their Scope 1, 2, and 3 greenhouse gas emissions.[17]

To achieve certification, organisations must demonstrate meaningful activities to reduce their emissions, either by investing in certified carbon offset projects (such as those accredited by ACCU, Verra, or Gold Standard) or by changing their operational practices. Currently, only offsets from certified carbon credit programs are accepted, though draft policy is under consideration to allow non-certified offsets in line with emerging guidance such as SBTi FLAG.

The reality of carbon neutral certification in Australia

An analysis by Tempests and Terawatts highlights several notable shifts in the use of carbon credits under the Climate Active program between February 2023 and March 2025. During this period, the total volume of emissions offset through Climate Active declined by approximately 10%. Notably, a significant majority of participants (89%) relied on lower-cost international carbon credits to achieve carbon neutral certification.

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[16] Tempests and Terawatts. *Is Australia's "carbon neutral" scheme being abandoned? (2025).* https://www.tempestsandterawatts.com/p/is-australias-carbon-neutral-scheme

[17] Climate Active. *Certification Scheme Rules (2023).* https://www.accc.gov.au/system/files/public-registers/other/Climate%20Active%20-%20Certification%20Scheme%20Rules%20for%20ACCC%20-%20Updated%20April%202023%20(002)(15155195.1).pdf

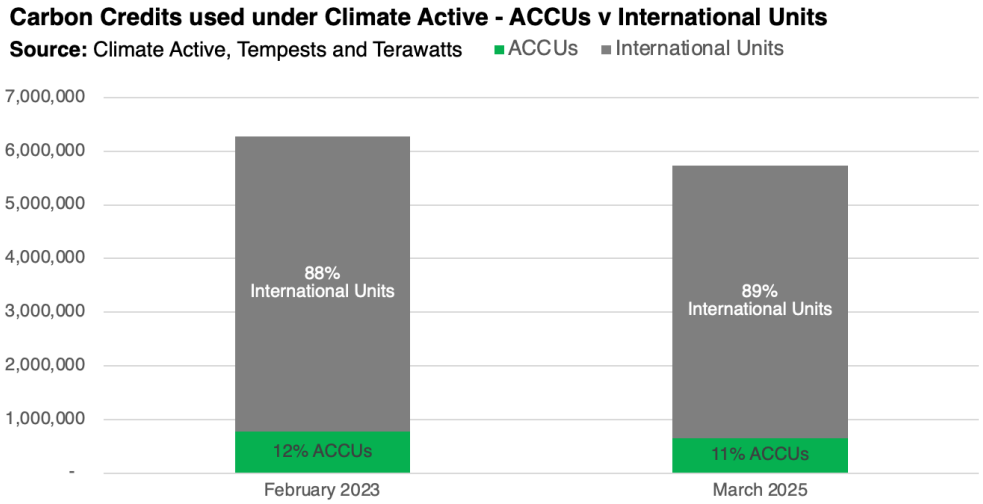


Figure 15. Carbon Credits used under Climate Active - ACCUs v International Units[18]

A marked shift has occurred away from Verified Carbon Units (VCUs) issued under the Verra standard, largely in response to heightened scrutiny and concerns about the integrity of such credits. Investigative reporting in 2023 by The Guardian and Corporate Accountability found that many of the world's highest selling offset projects were "likely junk," casting doubt on the credibility of these credits.[19]

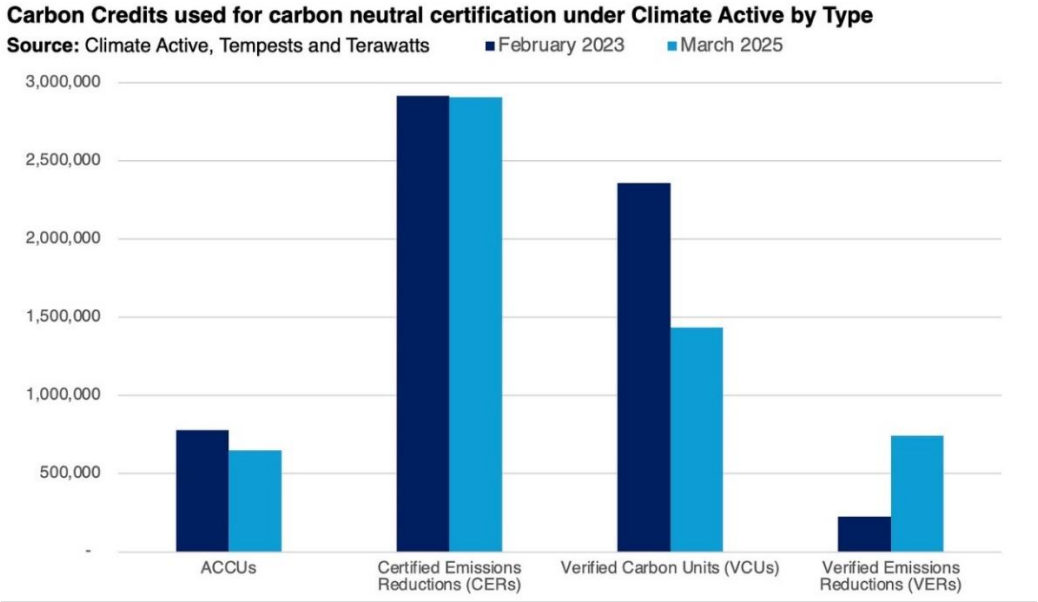


Figure 16. Carbon Credits used for carbon neutral certification under Climate Active by Type

Concerns extend to other credit types as well. Certified Emissions Reductions (CERs) generated under the Clean Development Mechanism have faced allegations of widespread issuance of 'fake'

[18] Tempests and Terawatts. *Is Australia's "carbon neutral" scheme being abandoned? (2025).* https://www.tempestsandterawatts.com/p/is-australias-carbon-neutral-scheme

[19] The Guardian. *Revealed: top carbon offset projects may not cut planet-heating emissions (2023).* https://www.theguardian.com/environment/2023/sep/19/do-carbon-credit-reduce-emissions-greenhouse-gases

carbon credits[20]. Similarly, Verified Emissions Reductions (VERs) from the Gold Standard have come under fire, with a 2023 Guardian investigation revealing that up to 90% of rainforest-related offsets may be "phantom credits" that do not reflect real emissions reductions[21].

Market response and brand withdrawals

Despite a notable increase in the number of Australian carbon neutral certifications in recent years, there has also been a wave of departures by major brands such as Australia Post, Afterpay, and Jetstar. Several consultancies specialising in carbon credit trading and offset advisory, including Pollination, Corporate Carbon Advisory, PathZero, and PwC Australia, have also exited the Climate Active program. These developments may signal two key trends:

- Organisations are reassessing their sustainability strategies and moving away from reliance on low-integrity carbon offsets.
- Some may be retreating from their broader ESG commitments altogether.

In June 2024, Telstra withdrew from Climate Active, citing a strategic shift toward directly reducing its operational emissions rather than purchasing offsets.[22]

Participation in agriculture

In agriculture, engagement with Climate Active among agricultural organisations remains limited. Wide Open Agriculture was the first in Australia to achieve carbon neutral certification for its OatUP oat milk in 2020 but withdrew both its product and organisational certifications on 12 April 2024[23]. Kilter Rural has maintained carbon neutral certification since FY2021[24], offset its emissions exclusively Australian Carbon Credits Units (ACCUs). Kilcoy Pastoral Company achieved certified carbon neutral status in 2024, sourcing 56% of their credits sourced from VCUs (despite the scrutiny facing this credit type), and the remainder from ACCUs[25].

[20] Friends of the Earth. *Trading in fake carbon credits: Problems with the Clean Development Mechanism* https://foe.org/blog/2008-10-trading-in-fake-carbon-credits-problems-with-the-cle/
[21] The Guardian. *Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows (2023).* https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe
[22] Telstra. *How we're evolving our climate change commitments (2024).* https://www.telstra.com.au/exchange/updating-our-climate-change-commitments
[23] Climate Active. https://www.climateactive.org.au/buy-climate-active/certified-members/wide-open-agriculture
[24] Climate Active. https://www.climateactive.org.au/buy-climate-active/certified-members/kilter-rural
[25] Tempests and Terawatts. *Climate Active Certification Data as at March 2025.* https://docs.google.com/spreadsheets/d/1hmgI8EnuwFiQQ_iromn-BpKrp9hDJsJY/edit?gid=139928780#gid=139928780

Participation in Pork

Figure 17. Coles Finest Carbon Neutral Products (Pork and Beef)

Coles launched its Finest Certified Carbon Neutral Pork and Beef range nationally in early July 2023.[26] The pork range included eight premium cuts and was developed in partnership with Western Australia's Milne AgriGroup. The products were certified carbon neutral from farm to shelf under the Australian Government's Climate Active Carbon Neutral Standard. As of 2025, Coles carbon neutral pork offering in Western Australia has been unavailable, however they still continue to offer some certified carbon neutral beef products[27].

2.11.2. International Carbon Neutral Certifications

Figure 18. International carbon neutral certification programs

There are a raft of choices when it comes to carbon neutral certification schemes. They operate across a wide range of global jurisdictions, but their credibility depends heavily on the reputation of the certifying brand and the rigor of its underlying policies.

[26] Coles Group. *Media Release: Carbon neutral pork hits Coles shelves as the retailer launches new campaign championing quality produce (2023).* https://www.colesgroup.com.au/news/2023/media-releases/?page=carbon-neutral-pork-hits-coles-shelves-as-the-retailer-launches-new-campaign-championing-quality-produce

[27] https://www.coles.com.au/about/our-partners/farming/carbon-neutral accessed 14 August 2025. *All pork products have been marked as unavailable*

These schemes differ significantly in their protocols, standards, administrative processes, and associated costs, reflecting the absence of a single, universally accepted global standard, although many reference the Global GHG Protocol for carbon accounting consistency. Regulatory oversight is limited, as there is no overarching global authority to govern or harmonise certification standards, resulting in varying levels of assurance and transparency.

This regulatory gap increases the risk of greenwashing, with recent EU and Australian legislation emphasising that holding a carbon neutral certification alone does not constitute sufficient evidence for making environmental claims; companies must provide additional substantiation and transparency. To promote integrity, it is generally considered best practice for certified entities to publicly disclose their emissions data and the details of any offsets used. Ultimately, the choice of which carbon neutral certification, if any, to pursue is a strategic decision driven by marketing objectives, cost considerations, and risk management priorities, and should be tailored to the expectations and requirements of the target market.

Unless there is a clear requirement or market expectation for Australian export pork to obtain international carbon neutral certification, pursuing such certification may not be justified.

2.11.3. Risks of pursuing Carbon Neutral Certification

Carbon neutral certification can enhance brand reputation, but it involves notable risks if not anchored by genuine emissions reductions and transparent communication. The main risks are:

Reputational and legal risk

- **Greenwashing exposure:** Claiming carbon neutrality without rigorous, ongoing emissions reduction exposes businesses to accusations of greenwashing, especially if certification is used mainly for marketing rather than meaningful climate action.
- **ASIC Greenwashing Guidance[28]:** The Australian Securities and Investments Commission has issued clear guidance warning that "simply holding a carbon neutral (or similar) certification is not sufficient evidence for making environmental claims". Companies must disclose clear, detailed information about how carbon neutrality is calculated, the quality of credits used, and the extent of real emissions cuts versus offsetting. Insufficient disclosures can lead to regulatory penalties, negative publicity, and reputational harm.

Regulatory uncertainty and integrity concerns

- **Climate Active review:** Australia's key carbon neutral certification scheme, Climate Active, is currently under review due to ongoing concerns regarding its credibility, the quality and

[28] Australia Government ASIC. How to avoid greenwashing when offering or promoting sustainability-related products. https://www.asic.gov.au/regulatory-resources/financial-services/how-to-avoid-greenwashing-when-offering-or-promoting-sustainability-related-products/

integrity of credits accepted, and a decline in participation[29]. The Australia Institute referred the scheme to the ACCC in 2024, highlighting that its broad flexibility allows participants to define, report, and offset emissions in ways that may enable claims of carbon neutrality for specific products or services rather than for entire operations. This flexibility has prompted accusations of "state-sponsored greenwashing" and has raised serious questions about the scheme's overall integrity and credibility.[30]

- **Certification alone not enough:** Across legal, consumer, and investor circles, there is growing demand for proof of actual emissions reduction, not just claims based on purchased offsets. Certification by itself is now considered inadequate for making broad environmental statements, as standards are raised globally.

In summary, carbon neutral certification should supplement, not replace, real and transparent emissions reduction. Relying on certification alone carries significant reputational, legal, and regulatory risks in a climate of increasing scrutiny and evolving expectations.

Does Carbon Neutral Certification make sense for me?

Carbon neutral certification is a voluntary option and pursuing certification only makes sense if it aligns with specific business goals such as:

- **Enhancing the brand value** as carbon neutral through third party recognition
- **Differentiating products** in premium or export markets **where sustainability credentials are valued** by customers and retailers
- Responding to **supply chain or retailer demands** for verified climate action
- **Accessing new market opportunities** that favour certified climate credentials

However, ongoing controversy and scrutiny surrounding the Climate Active program have raised the stakes for businesses. Without clear and ongoing evidence of real emissions reductions, rather than simply relying on offsets, there is an increased risk of being accused of 'greenwashing'.

[29] The Sydney Morning Herald. Consumer watchdog refuses to certify green labelling scheme (2024). https://www.smh.com.au/business/the-economy/consumer-watchdog-refuses-to-certify-green-labelling-scheme-20240422-p5flq3.html

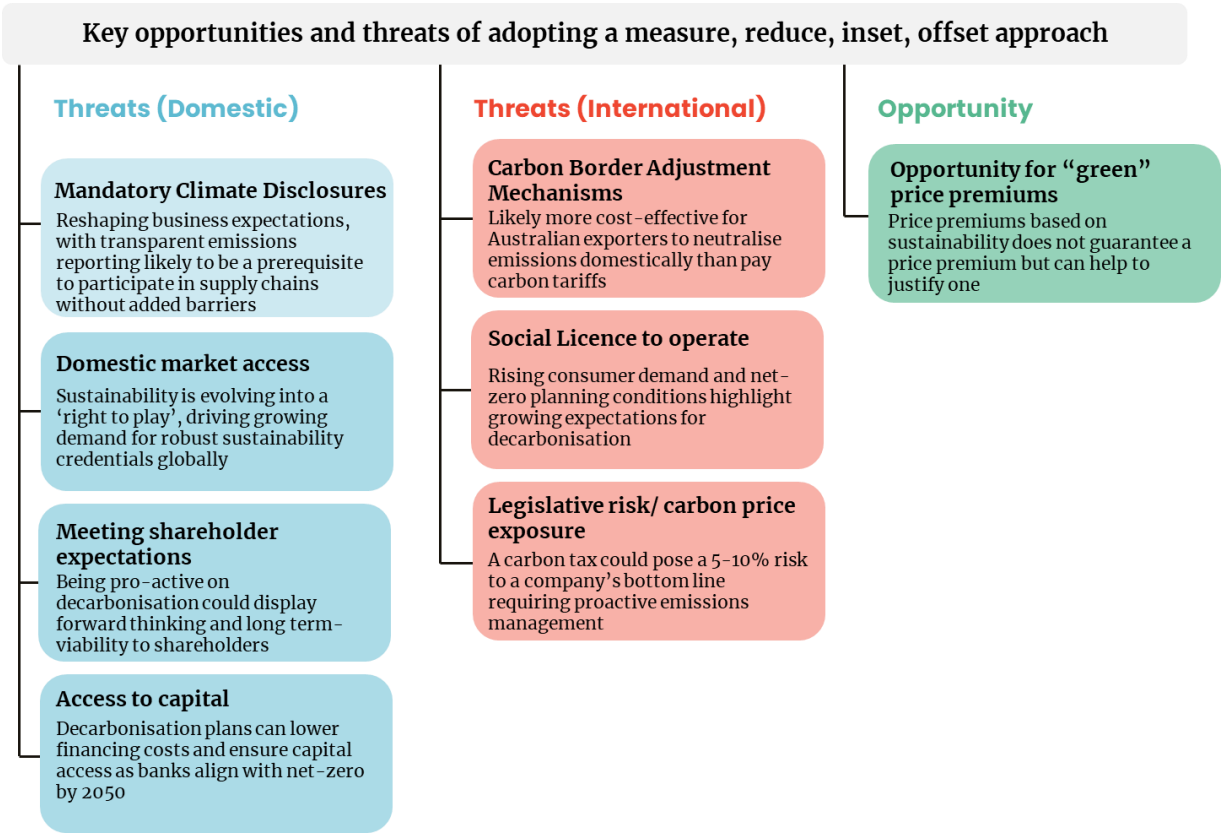
[30] Linkedin blog – Alexander Stathakis. *Navigating Australia's Climate Active Controversy (2024).* *https://www.linkedin.com/pulse/navigating-australias-climate-active-controversy-alexander-stathakis-wmybc*

3

Why Decarbonise?

3. Drivers for change – why decarbonise?

Despite recent market instability, there is still a strong long-term business rationale for adopting a credible pathway to decarbonisation. These include eight key opportunities and threats: Mandatory Climate Reporting, domestic market access, meeting shareholder expectations, access to capital, carbon border adjustment mechanisms (exports), social licence to operate, legislative risk/ carbon price exposure and opportunity for "green" price premiums and/or preferential contracts.



3.1 Mandatory Climate Reporting

Australia's mandatory climate-related financial disclosure regime came into effect on 1 January 2025. The new rules require large businesses, including many agribusinesses and supply chain partners, to prepare annual sustainability reports that disclose climate-related risks, opportunities, and emissions in line with international standards.

The regime is being phased in over several years with largest[31] entities required to start reporting on or after 1 January 2025, medium-sized[32] entities on from July 2026 and smaller[33] entities meeting certain thresholds required to report from July 2027. Entities are captured based on size thresholds

[31] Group 1 includes entities that meet at least two of the following criteria: 1) $500 million or more in consolidated revenue 2) $1 billion or more in consolidated gross assets 3) 500 or more employees.

[32] Group 2 includes entities that meet at least two of the following criteria: 1) $200 million or more in consolidated revenue 2) $500 million or more in consolidated gross assets 3) 250 or more employees.

[33] Group 3 includes entities that meet at least two of the following criteria: 1) $50 million or more in consolidated revenue 2) $25 million or more in consolidated gross assets 3) 100 or more employees.

for revenue, assets, and employee numbers. Many companies involved in agriculture, such as banks, insurers, processors, and supermarkets, are included in the early phases, which means pork producers supplying these businesses will be impacted, especially through Scope 3 (supply chain) emissions disclosure requirements.[34]

Over time, increasing levels of external assurance will be required, with full mandatory assurance for all disclosures by 2030.[35]

Entities not directly required to report may still be affected through supply chain (Scope 3) disclosure requirements, as large customers and financiers demand emissions data from suppliers.

Mandatory climate disclosures in Australia are poised to become one of the most powerful catalysts for behaviour change across the economy as new targets and reporting requirements take effect. While most farmers and primary producers will fall below the direct reporting thresholds, the ripple effects of these regulations are likely to be profound and far-reaching.

What does this mean for the pork industry?

Although individual farms may not be required to submit climate disclosures themselves, their emissions data will become essential for a range of stakeholders, including:

- **Banks and lenders:** Financial institutions will increasingly require emissions data to assess climate-related risks in their lending portfolios. Farms unable to provide credible emissions information, or those with high emissions profiles, may find it harder to secure loans or mortgages in future.
- **Insurance providers**: Insurers are beginning to factor climate risk and emissions exposure into their underwriting processes. Producers lacking emissions data or with poor climate performance could face higher premiums or even difficulty obtaining coverage.
- **Downstream partners:** Processors, retailers, and exporters subject to mandatory disclosures will need accurate emissions data from their suppliers to meet their own reporting obligations. This creates a strong incentive for farms to measure, manage, and reduce their emissions in order to maintain market access.

Potential Consequences

As climate disclosure requirements become embedded in business practices, the landscape is rapidly shifting and over the next decade farms will increasingly be asked to provide robust, auditable emissions data and evidence of decarbonisation efforts. It is likely that that the following will occur:

[34] Beef Central. *Mandatory climate disclosures coming for ag (2024).* https://www.beefcentral.com/carbon/mandatory-climate-disclosures-coming-for-ag/

[35] Climate Governance Initiative Australia. *A director's guide to mandatory climate reporting (2024).* https://www.aicd.com.au/content/dam/aicd/pdf/tools-resources/director-resources/directors-guide-to-mandatory-climate-reporting-web.pdf

- Farms unable or unwilling to supply emissions data may be **excluded from supply chains**, **lose access to finance**, or **face increased costs**.
- **High-emission producers** could be **deprioritised or penalised** by buyers seeking to meet their own climate targets.
- Over time, **transparent emissions reporting** and **proactive decarbonisation** will become **prerequisites** for doing business, not just for regulatory compliance but as a condition of market participation.

Early action on measurement and emissions reduction will be critical for ongoing competitiveness and compliance as Australia's climate reporting landscape evolves.

3.2 Domestic Market Access

Sustainability is evolving from a differentiator to a basic requirement, or "right to play", in both domestic and international markets, where access is contingent on robust sustainability credentials. Furthermore, supply chain resilience and evolving customer expectations are influenced by changing market dynamics, regulatory shifts such as Australia's Mandatory Climate Disclosures which came into effect on 1 Jan 2025, and the need to disclose emissions and track progress against science-based targets. This landscape is expected to drive a significant increase in demand for sustainability credentials.

Without a tangible decarbonisation program, an agribusiness will be at increasing risk of losing access to domestic markets.

Coles and Woolworths have set net zero and net positive goals by 2050, driving significant changes across their supply chains, including requirements for suppliers to reduce their carbon footprints.

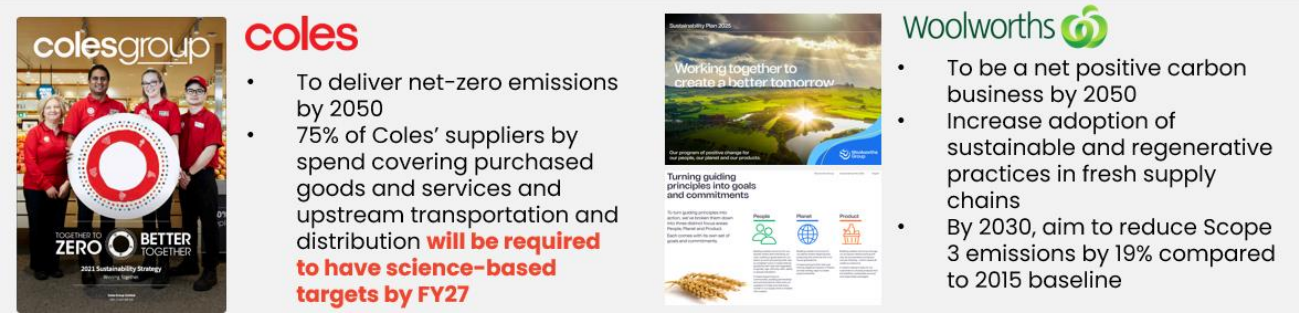


Figure 19. Coles' and Woolworth's sustainability goals

3.3 Carbon Border Adjustment Mechanisms (Exports)

Countries are beginning to introduce import tariffs in relation to the carbon footprint of products. One example is the European Carbon Border Adjustment Mechanisms (CBAM). It aims to address 'carbon leakage' in non-European countries and to address cleaner industrial production. Carbon leakage is the process where companies move carbon intensive production across to countries with less stringent climate policies or Europe-made products are getting replaced by carbon-intensive goods entering Europe.

CBAM will require importers to purchase emissions certificates, based on the amount of carbon emissions associated with imported goods[36]. Emissions certificates will be a form of import tariff. They are likely to be priced according to destination country costs of carbon. For example, the European carbon price as of January 2024 was around A$110[37], compared to an Australian Domestic carbon price of around A$35[38]. Agriculture is initially exempt but expected for inclusion in the near future. Other countries such as China, US and UK all have CBAM legislation in various stages of progress.

Agribusiness exports could be taxed based on carbon footprint, and it will likely be much cheaper to neutralise emissions in Australia compared to paying a carbon border tax.

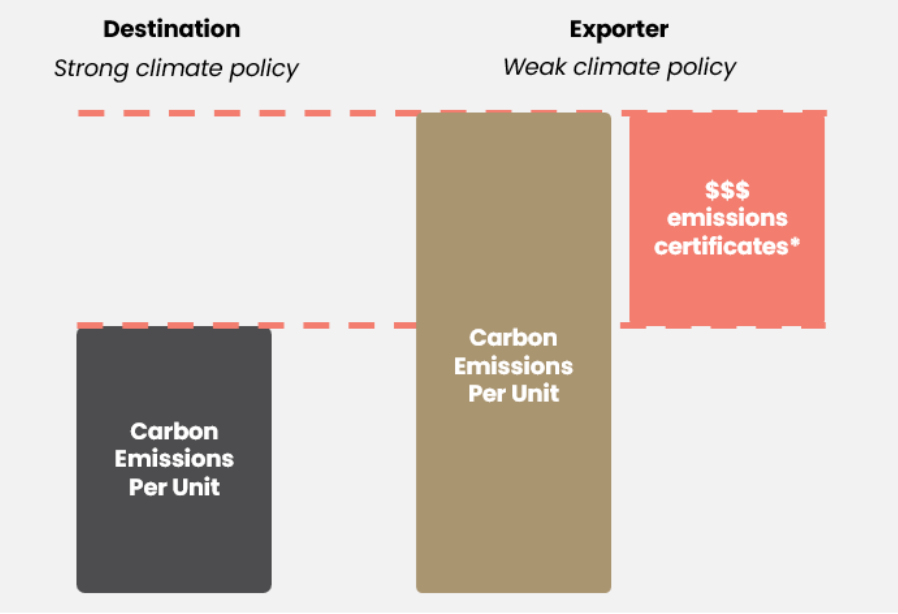


Figure 20. Businesses importing goods into countries with a Carbon Border Adjustment Mechanism will be required to purchase Emissions Certificates to address carbon leakage, where companies move carbon intensive productions to countries with a weaker climate policy

[36] European Commission. Carbon Border Adjustment Mechanism. https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

[37] Homaio. *European carbon market: Our Guide for 2025 (2024).* https://www.homaio.com/post/eu-ets-definitions-updated-guide#:~:text=EUA%20Prices%20in%202024,long%2Dterm%20positioning%20remained%20fragile.

[38] *Clima. The Carbon Guy: Australian carbon market update (2024).* https://www.clima.com.au/blog/2024/06/27/25-06-2024-the-carbon-guy-australian-carbon-market-update

Case Study: Denmark becomes first to impose carbon tax on agriculture[39]

In 2024, Denmark, a major pork and dairy exporter, introduced the world's first carbon emissions tax on livestock and hopes to inspire global action. The goal of the tax is to help Denmark to reach its 2030 goal to cut GHG gas emissions by 70%.

The agreement includes a tax on emissions of 300 Danish Krone (US$43.16) per tonne of CO and increasing to 750 Danish Krone (US$108.77) by 2035. For consumers, it will cost an additional 2 Danish Krone (US$0.29) per kilo of minced beef by 2030.

Denmark's move could set a precedent for other countries to introduce similar measures. Agribusinesses will need to monitor global trends closely and consider potential impacts on their business.

Figure 21. Chairman of Grøn Trepart (Denmark's Green Tripartite Agreement), Herik Dam Kristensen announcing the world's first carbon emissions tax on livestock. Source: Økonomiministeriet, 2024

3.4 Opportunity for "Green" price premiums or preferential contracts

Sustainability does not guarantee a price premium but can help to justify one. While price premiums can be generated in the short term, they often prove fleeting. Products with Environmental, Social, and Governance (ESG) claims tend to sell faster than those without, with such products averaging a cumulative growth of 28% over the past five years, compared to 20% for products lacking these claims[40].

However, consumer willingness to pay premiums varies significantly by region. In emerging economies like India, Indonesia, Brazil, and China, consumers are willing to pay a premium of 15-20%, whereas in advanced economies such as the UK, Italy, Germany, and France, this willingness is lower, at 8-10%. Moreover, as carbon-neutral food becomes more normalised, price premiums are likely to be short-lived and more applicable to niche, premium products rather than commodities.

[39] State of Green. Denmark announces historic tripartite agreement to cut agricultural carbon emissions and restore nature (2024). https://stateofgreen.com/en/news/denmark-announces-historic-tripartite-agreement-to-cut-agricultural-carbon-emissions-and-restore-nature/#:~:text=The%20agreement%20also%20unfolds%20principles,at%20least%2020%25%20protected%20nature.

[40] McKinsey & Company. Consumers care about sustainability, and back it up with their wallets (2023). https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/consumers-care-about-sustainability-and-back-it-up-with-their-wallets

There is limited evidence that these premiums are consistently passed back to producers[41]. In practice, any retail price increase for carbon-neutral or ESG-branded products tends to be modest and often absorbed by retailers or processors, rather than flowing directly to farmers.

The key commercial opportunity for farmers participating in carbon-neutral or sustainability programs is more likely to be preferential treatment within the supply chain, such as priority contracts, guaranteed volumes, or enhanced visibility at retail, rather than a significant uplift in price. As carbon-neutral and sustainability claims become mainstream in future, pork producers would benefit from becoming an early mover and achieving these supply chain advantages.

3.5 Shareholder expectations

Failure to be pro-active on a decarbonisation pathway could limit future opportunity for investment, could limit the pool of potential buyers in the event of a business sale, or could leave a company open for activist shareholder disruptions.

To ensure regulatory compliance and minimise legal risk, it is crucial to align with emerging legislation, such as the Australian Government's draft bill on mandatory climate-related financial disclosures.

This proactive approach not only ensures compliance but also demonstrates forward-thinking and long-term viability. As client demand drives investment managers to integrate sustainability into their decision-making, investors will increasingly view high-emission entities as high-risk under the lens of mandatory climate reporting. This perception can lead to:

- Discounted valuations for companies with significant unmanaged emissions,
- Increased cost of capital due to perceived transition and regulatory risks,
- More limited access to finance, as investment mandates shift towards low-carbon, future-proof portfolios.

By embracing decarbonisation, organisations can position themselves as leaders in sustainability, enhancing their appeal to environmentally conscious consumers and investors alike. This strategic move supports both regulatory compliance and long-term success in a rapidly evolving environmental landscape. In a market where climate-related disclosures become mandatory, companies that fail to lower emissions risk being left behind, both in valuation and in credibility with stakeholders.

[41] OECD. *Making Better Policies for Food Systems (EN).* https://www.oecd.org/content/dam/oecd/en/publications/reports/2021/01/making-better-policies-for-food-systems_0fd8c682/ddfba4de-en.pdf

3.6 Access to capital

As the global push towards decarbonisation accelerates, accessing capital without a credible decarbonisation pathway will become increasingly challenging. To enhance access to capital, it is crucial to align with the environmental goals of financial institutions.

Over 40% of global banks have joined the Net-Zero Banking Alliance, committing to transition their greenhouse gas emissions from lending and investment portfolios to net-zero pathways by 2050. Companies that demonstrate strong climate credentials can benefit from a lower cost of capital, typically around 10% lower. Sustainable brands not only grow faster but also achieve resource efficiency, leading to reduced operational costs and stronger regulatory relationships.

Moreover, purposeful work environments can boost employee productivity, potentially increasing stock prices by about 2% annually. Additionally, emission reduction and carbon insetting projects may qualify for concessionary green loan products, providing further financial incentives for decarbonisation efforts.

In Table 4 below, it shows the availability of green loans from three major banking institutions in Australia in September 2025. A tangible decarbonisation pathway may reduce the cost of debt finance and ensure ongoing access to finance.

Table 4. Availability of green loans from three major banking institutions in Australia in September 2025

Bank	Green Loans
nab	NAB Agribusiness Emissions Reduction Incentive Program support offers an interest rate discount of 1.15%[42]
	Green Vehicle and Equipment Finance offers a discount of up to 1% off the standard rate[43]
ANZ	ANZ Business Green Loan provides a discounted floating interest rate [44]

[42] NAB Agribusiness Emissions Reducation Incentive Program: https://www.nab.com.au/business/loans-and-finance/agribusiness-loans/green-finance-agri

[43] CBA launches green vehicle and equipment finance (2023): https://www.commbank.com.au/articles/newsroom/2023/04/green-vehicle-equipment-finance.html

[44]ANZ Business Green Loan: https://www.anz.co.nz/business/lending/anz-business-green-loan/

3.7 Social license to operate

Climate impact is fast becoming another baseline expectation for businesses to retain a social licence to operate. Trust, which is hard to earn and easy to lose, plays a crucial role in this context. The perceived environmental consciousness of a company hinges on balancing consumer expectations with actual environmental performance.

Stakeholders can quickly delegitimise businesses if their environmental impact is negative. Consumer behaviour is increasingly influenced by environmental concerns, with many receptive to businesses demonstrating strong climate credentials. For instance, a significant portion of consumers are willing to pay more for brands that commit to sustainable practices, while others rely on businesses to provide sustainable products as a standard offering.

Furthermore, regulatory environments are evolving, with the rise of net-zero conditions in planning and environmental approvals. Initiatives like Western Australia's Environmental Factor Guidelines[45] for greenhouse gas emissions set a precedent for other regions to follow, underscoring the importance of environmental responsibility in maintaining a social licence to operate.

In 2024, a survey by Deloitte found that reducing carbon footprint increased in priority compared to the previous year when consumers are considering what their most valued sustainable or ethical practices are[46].

[45] Environmental Protection Authority (Government of WA). *https://www.epa.wa.gov.au/policies-guidance/environmental-factor-guideline-%E2%80%93-greenhouse-gas-emissions-0*

[46] Deloitte. *The Sustainability Consumer (2024).* *https://www.deloitte.com/content/dam/assets-zone2/uk/en/docs/industries/consumer/2024/deloitte-uk-sustainable-consumer-2024.pdf*

3.8 Legislative / carbon pricing risk

A carbon tax or its equivalent poses a significant bottom-line risk of 5-10%, particularly for heavy-emitting industries like agriculture. The Australian political landscape suggests a growing likelihood of legislated policies akin to a carbon tax, with the Safeguard Mechanism serving as an example of a pseudo carbon tax for high-emission sectors.

Future policies may introduce more stringent decarbonisation mandates or a broader carbon tax across various industries. In the absence of formal carbon legislation, many industry groups are proactively committing to net-zero pathways, such as the MLA's Net-Zero 2030 initiative. Additionally, export markets may require the equivalent of carbon taxes, as seen with the Carbon Border Adjustment Mechanism (CBAM). Highlighted in Figure 22, the introduction of carbon pricing can cause a reduction in earnings across MSCI World Index sectors such as consumer discretionary and consumer staples. The higher the carbon price (i.e. USD 50, USD 100 and USD 300), the higher the reduction in earnings (4%, 9% and 25% respectively). This is due to a pass through of the carbon cost in the value chain.

To future-proof against these risks, proactive companies are adopting internal "phantom" carbon prices for long-term investment decisions, a strategy that could mitigate potential earnings reductions across all sectors if a carbon tax is implemented.

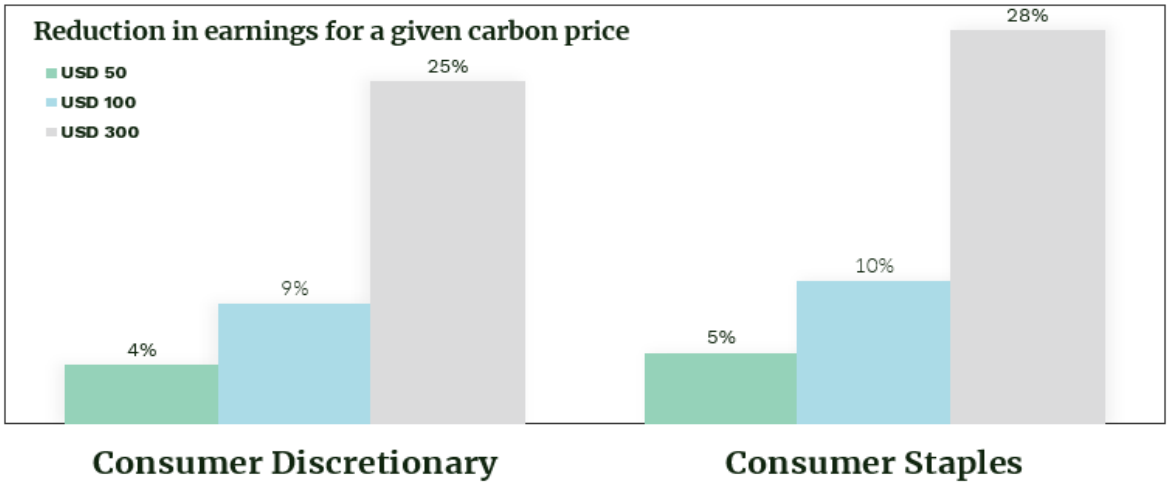


Figure 22. The higher the carbon price, the higher the reduction in earnings across MSCI World Index sectors such as consumer discretionary and consumer staples. Adapted from Amundi Asset Management, 2022

4 Emissions from Pork Production

4. Emissions from Pork Production

4.1 What are the main GHG emissions from pork production?

In the pork production value chain and when considered from the perspective of the pork producer, greenhouse gas (GHG) emissions can be categorised into three scopes as seen in Figure 23: Pre-farm (upstream), on-farm (piggery emissions), and downstream (post-farm emissions).

On-farm emissions are the most directly addressable and include Scope 1 emissions from enteric methane and manure management as well as fuel use (diesel, petrol, gas) and Scope 2 emissions from grid-supplied electricity. These emissions are within the producer's operational control and can be mitigated through strategies such as biogas systems, energy efficiency improvements, and renewable energy adoption which are further explored in Section 5 Exploring Emission Avoidance Options.

Upstream emissions, classified as Scope 3, originate from activities like feed production (grain and supplements) if purchased externally, purchased straw bedding, and purchased pigs. These are harder for producers to influence directly but can be addressed indirectly through procurement policies or partnerships with suppliers.

Lastly, downstream emissions, also Scope 3, arise from the transport of pigs to processing facilities, meat processing itself, retail operations, and the offsite disposal of manure or sludge. While these emissions fall outside the farm's operational boundaries, they can be mitigated by collaborating with downstream partners to adopt low-emission practices or technologies.

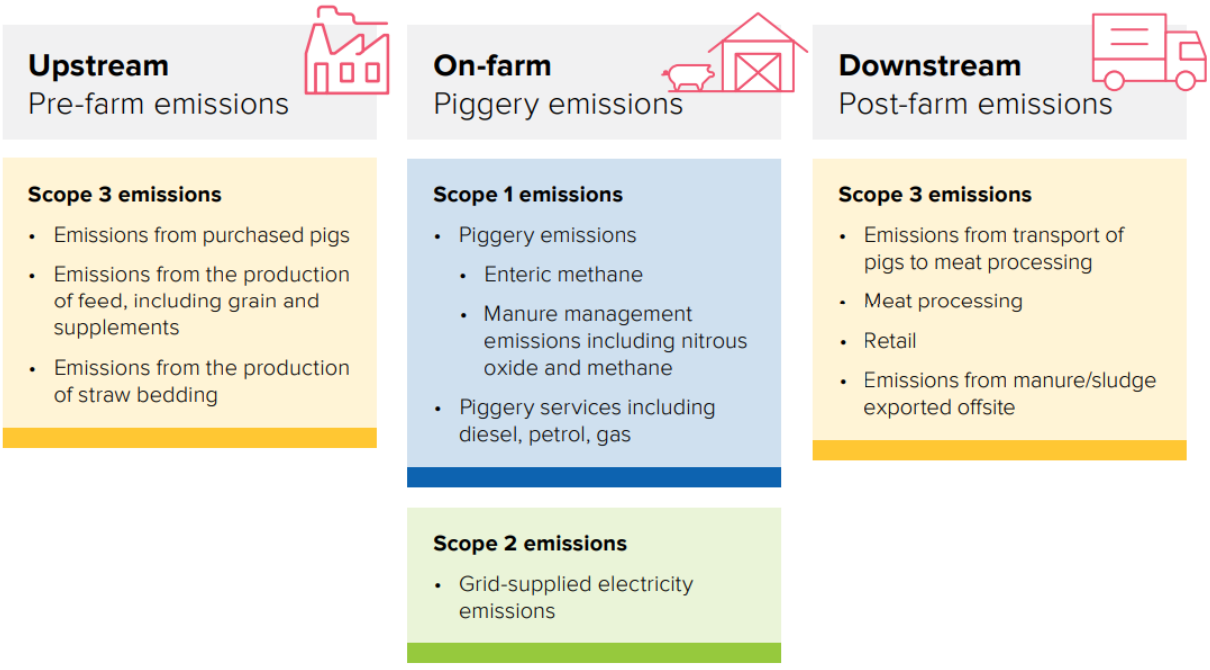


Figure 23 Breakdown of main emissions from pig production
Note: From "Low Carbon Emission Roadmap" by Australian Pork Limited (2022), n.d. Source

4.2 Trends over the last 40 years

Over the past four decades, the Australian pork industry has achieved significant reductions in its environmental impacts, as detailed in Wiedemann et al.'s report[47]. Greenhouse gas emissions, excluding those from land use and direct land use change, fell by 74% between 1980 and 2022, dropping from 11.7 to 3.0 kg CO_2-e per kilogram of liveweight. Emissions associated with land use and land use change declined even more sharply, with a 92% reduction over the same period. On average, the annual reduction in emissions per kilogram of liveweight was 1.8% across the 42-year timeframe.

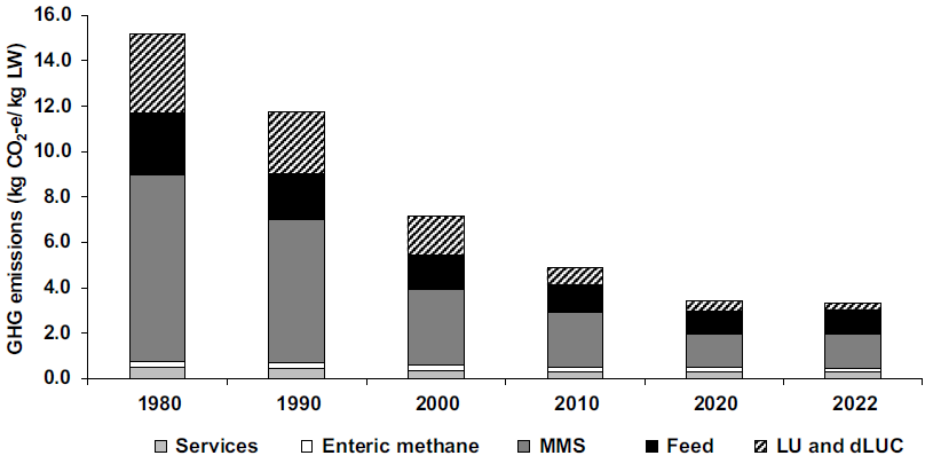


Fig. 3. Changes in greenhouse gases emissions (including LU and dLUC) from the production of 1 kg of live weight pork over the period 1980–2022.

Figure 24. Changes in GHG emissions (including LU and dLUC) from the production of 1kg of live weight pork over 1980-2022[47]

Resource use efficiency also improved markedly. Fossil energy requirements for pork production decreased from 35 to 13 megajoules per kilogram of liveweight. Freshwater consumption saw a dramatic decline, from 506 to just 52 litres per kilogram of liveweight, while water stress dropped from 671 to 43 litres of H_2O-e per kilogram. Land occupation required for pork production was reduced by 42%, from 22 to 13 square meters per kilogram of liveweight.

Several key drivers contributed to these improvements. Productivity gains, such as enhanced herd productivity, better feed conversion ratios, and increased slaughter weights, led to lower feed requirements and reduced manure production. Changes in feed production practices, including reduced tillage, higher crop yields, and less irrigation for feed grains, further lessened environmental impacts. Notably, the adoption of covered anaerobic ponds between 2010 and 2020 accelerated reductions in GHG emissions, although the rate of improvement has slowed since 2020. Additionally, improvements in system efficiency, such as lower feed wastage and more efficient housing systems, played a role in reducing emissions and resource use.

[47] Stephen Wiedemann, Erin McGahan, and Clemency Murphy, *Environmental Impacts and Resource Use from Australian Pork Production from 1980 to 2022: An Updated Historical Perspective (Toowoomba, QLD: Integrity Ag & Environment, 2023), prepared for Australian Pork Limited*

The Australian pork industry's environmental gains have been largely driven by efficiency improvements in herd management and feed systems. However, the slowing rate of improvement in recent years suggests that continued progress will require the adoption of new strategies and technologies.

4.3 Life Cycle Assessment of Australian Pork

In the life cycle assessment (LCA) for the pork industry report[48] conducted by Integrity Ag, a representative national herd sample was analysed to determine the average greenhouse gas emissions produced per kilogram of pork. The study found a single kilogram of pork at the retail shelf produced 7.1 kg CO_2-e over its production lifecycle for FY2022.

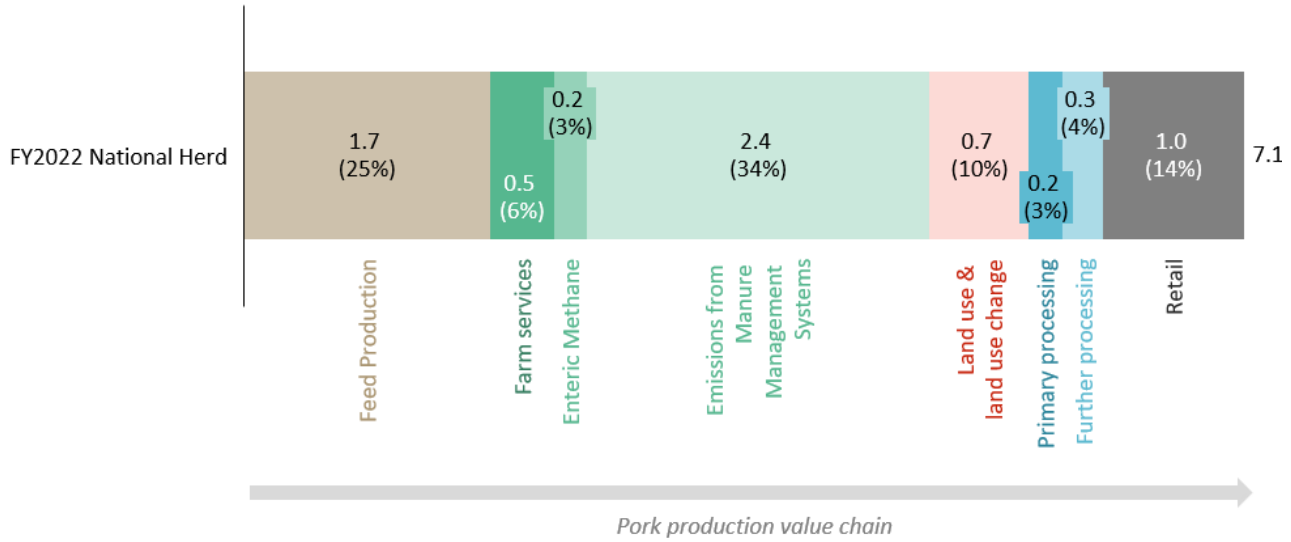


Figure 25 Greenhouse gas emissions intensity for FY2022, reported per kilogram of pork at the retail shelf (kg CO2 / kg pork at retail)
Source: Life Cycle Assessment for the Pork Industry - Final Report APL Project 2021/0014 (6 Sep 2023)

The majority of GHG emissions from pork production stem primarily from two main sources: manure management and feed production. Manure management is the largest contributor, accounting for the majority of total on-farm emissions and 34% of life cycle emissions. This is primarily due to methane released from anaerobic lagoons. The second major source is feed production (including processing, and transportation of feed), which accounts for about 25% of total supply chain emissions.

By prioritising solutions that address emissions from manure management and feed production, producers can target two of the most significant sources of greenhouse gas emissions in the pork industry.

[48] Integrity Ag. *Life Cycle Assessment for the Pork Industry - Final Report APL Project 2021/0014 (6 Sep 2023)*

5 Exploring Decarbonisation options

5. Exploring Emission Avoidance Options

Reducing greenhouse gas (GHG) emissions in pork production is both a critical environmental goal and an opportunity to improve operational efficiency and profitability. The pork industry has identified a broad range of strategies to mitigate emissions across different stages of production, including herd management and genetic improvement, feed efficiency, manure and effluent management, renewable energy and resource efficiency, alternative feeds and circular resource, and carbon sequestration and soil enhancement. An overview of these strategies has been outlined in Figure 26.

The list below aims to be exhaustive of the range of potential pathways to reduce the environmental footprint of pork production, however not all solutions are economically viable to adopt and the feasibility of implementing these solutions depend on the farming system and scale of production. These solutions are further assessed in Section 5.3.

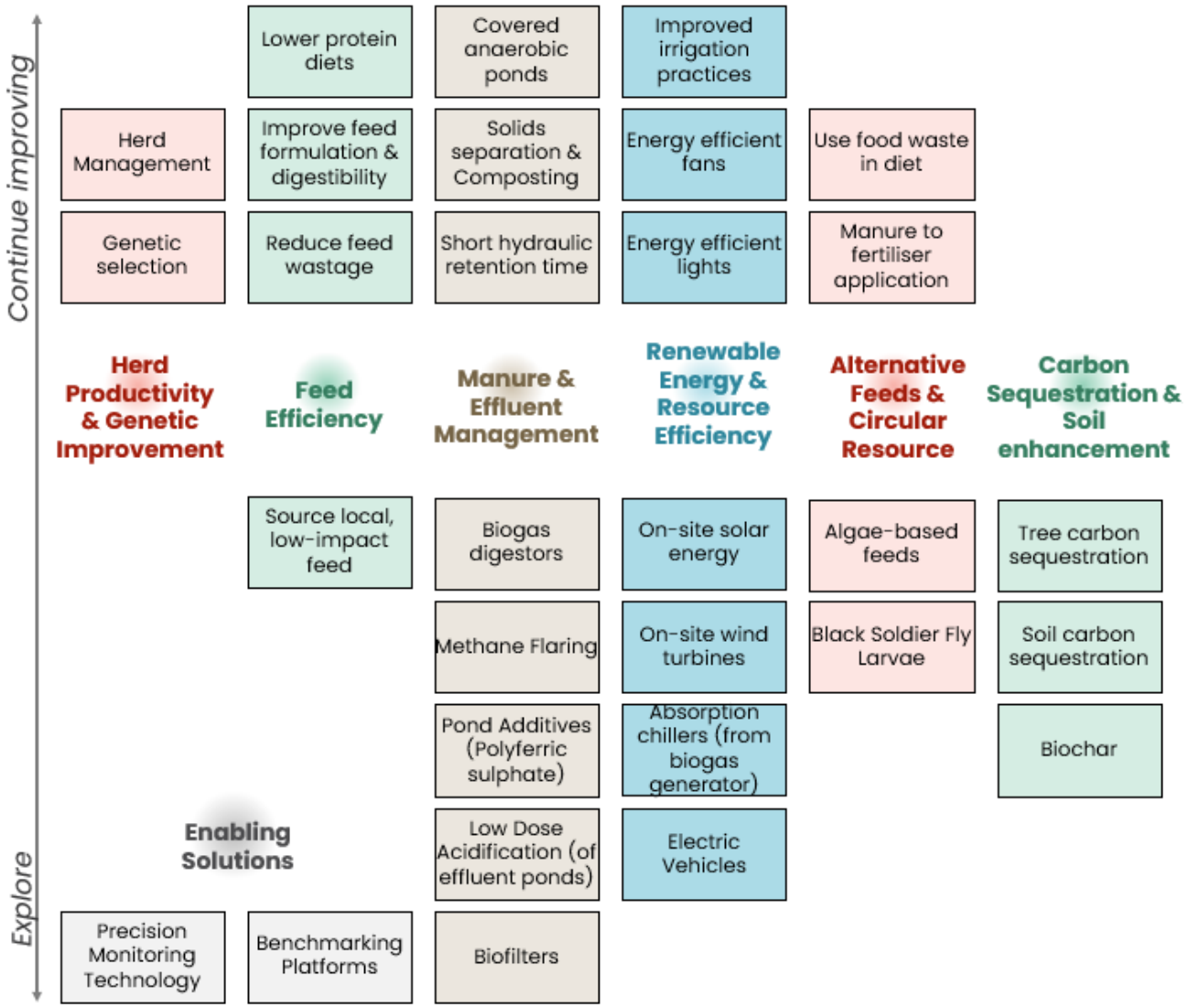


Figure 26. Overview of options to decarbonise pork production

5.1 Improving on-farm productivity

The Australian pork industry has achieved substantial reductions in greenhouse gas emissions and resource use over the past four decades, largely driven by improvements in on-farm productivity. Early advances were largely the result of adopting advanced manure management systems and making significant gains in herd efficiency, feed utilisation, and crop production[49]. However, in recent years, this momentum has slowed, and emissions intensity has plateaued, particularly between 2020 and 2022. This trend highlights that, while foundational strategies, such as optimising herd productivity, feed efficiency, and resource management, remain vital, sustaining future progress will require both broader adoption of best practices and the uptake of innovative approaches.

Key areas for ongoing improvement include:

- **Herd productivity and genetic improvement:** Continued gains in feed conversion, growth rates, and pigs weaned per sow directly reduce emissions per kilogram of pork. While herd performance has improved, there is still room for further gains, especially when compared to international benchmarks.
- **Feed efficiency and nutrition:** Feed production is the largest single contributor to pork's carbon footprint. Further optimisation of feed formulation, digestibility, and reduction of wastage can lower both costs and emissions. Many farms have yet to fully realise the benefits of precision feeding and waste-reducing technologies.
- **Manure and effluent management:** Methane emissions from manure remain a significant source of greenhouse gases. Expanding the use of covered anaerobic ponds, digesters, and composting offers substantial potential for further reductions.
- **Efficient crop production for feed:** Improvements in crop yields, tillage practices, and water use for feed grains have reduced upstream impacts. Sourcing feed from high-performing, low-impact cropping systems and supporting regenerative practices can deliver additional benefits.
- **Resource efficiency (energy and water):** Although energy and water use per unit of pork have dropped dramatically, further efficiency upgrades, such as energy-efficient equipment and water recycling, are still accessible for many operations, particularly those yet to modernise.
- **Circular resource use:** Incorporating food waste into pig diets and using manure as fertiliser reduces reliance on synthetic inputs and closes nutrient loops. There remains untapped potential for farms to integrate more circular practices, subject to local regulations and logistics.

[49] Stephen Wiedemann, Erin McGahan, and Clemency Murphy, Environmental Impacts and Resource Use from Australian Pork Production from 1980 to 2022: An Updated Historical Perspective (Toowoomba, QLD: Integrity Ag & Environment, 2023), prepared for Australian Pork Limited

5.2 Integrating Solutions for Further Decarbonisation

With traditional productivity gains delivering diminishing returns, the pork industry must now look to a broader suite of solutions to continue reducing emissions and enhancing sustainability. The integration of new technologies and management practices, spanning renewable energy, advanced manure management, carbon sequestration, and novel feed strategies, offers potential pathways for further decarbonisation.

Major categories and key options include:

1. Renewable energy and electrification

- **On-site solar, wind energy and battery storage:** Installing solar panels or wind turbines enables farms to generate clean electricity. Pairing these with battery storage systems helps capture excess generation, ensuring reliable power supply during periods of low sun or wind, and further reducing reliance on fossil fuels for heating, cooling, and ventilation.
- **Electric vehicles (EVs) and machinery:** Transitioning to electric-powered transport and equipment, especially when powered by renewable energy, further reduces direct fuel use and emissions.
- **Absorption chillers:** Using waste heat (such as from biogas generators) to provide cooling, which lowers grid electricity demand and operational costs.

2. Advanced manure and effluent management

- **Biogas digestors:** Covered anaerobic ponds or digesters capture methane from manure and convert it into renewable energy, lowering greenhouse gas emissions and providing on-farm energy. *Note: Economic returns may depend on being able to export excess power to the grid, which can face regulatory or infrastructure hurdles.*
- **Methane flaring:** Captures and combusts methane from manure storage, converting it to carbon dioxide and reducing the overall greenhouse gas impact where energy recovery is not feasible.
- **Pond additives (for example polyferric sulphate):** Chemical additives suppress methane-producing microbes in effluent ponds, reducing methane and nitrous oxide emissions.
- **Low dose acidification:** Lowering the pH of effluent ponds inhibits methane-producing bacteria, decreasing methane emissions and improving nutrient retention.
- **Biofilters:** Compost or soil-based filters biologically oxidise methane and other gases from manure storage before they are released, providing a cost-effective mitigation strategy.

3. Carbon sequestration and soil enhancement

- **Tree carbon sequestration:** Planting trees or integrating agroforestry on or around pig farms captures and stores atmospheric carbon, providing long-term sequestration and co-benefits like biodiversity and livestock shelter.
- **Soil carbon sequestration:** Practices such as cover cropping, reduced tillage, and organic amendments (including biochar) increase soil organic carbon stocks, improving soil health and reducing net emissions.
- **Biochar production:** Converting manure or crop residues into stable carbon (biochar) for soil application, sequestering carbon for decades and enhancing soil fertility.

4. Alternative feeds and circular resource use

- **Algae-based feeds:** Cultivating algae as a protein-rich, low-impact feed ingredient, often using nutrients recovered from effluent streams, reduces the environmental impact of conventional feed crops.
- **Black soldier fly larvae:** Using organic waste to produce high-protein insect meal for pig diets, replacing conventional protein sources and reducing food waste.
- **Expanded food waste utilisation:** Incorporating pre-consumer food waste and by-products into pig diets closes nutrient loops and reduces the environmental footprint of feed production.

5. Integrated and Enabling Technologies

- **Precision livestock monitoring:** Digital tools for real-time tracking of emissions and resource use, supporting targeted interventions and continuous improvement.
- **Emissions benchmarking platforms:** Software to guide decision-making, monitor progress, and benchmark environmental performance across farms.

5.3 Assessment of further decarbonisation solutions

To guide effective decision-making for pork producers, each GHG mitigation option must be evaluated not only for its environmental benefits but also for its practicality and economic viability. The analysis outlined in Table 5 systematically assesses a comprehensive set of GHG reduction strategies across key criteria: solution maturity, suitability to different farm systems, feasibility of implementation, impact on GHG emissions, cost to implement, and return on investment (ROI). By comparing these factors, the analysis provides a framework for producers to identify the most effective and achievable options for their specific operations, in addition to the areas for improvement listed in Section 5.1 Improving on-farm productivity

Table 5. Assessment of options to decarbonise pork production (Part 1 of 2)

	Initiative Options	Solution Maturity	Farm system[1]	Feasibility to implement	GHG impact	Cost to implement	Return on Investment	Considerations
Feed Efficiency								
1	Replace high GHG intensity ingredients	Medium	Any	Medium	Medium	Variable	Medium	Soybean substitution shows promise; depends on local availability and access. Some may require reformulation research and development
Manure & Effluent Management								
2	Biogas systems	High	C / DL	High	Very High	High	High	60–80% emission reduction, digestate if produced could replace some mineral fertilisers
3	Methane Flaring	High	C	High	High	Low	Medium	Requires gas capture infrastructure; immediate emissions reduction
4	Effluent Pond Additives	Medium	C	Medium	High	Low	Med - High	Reduces CH_4 by 72–99% with Polyferric Sulphate; may require ongoing treatment
5	Low Dose Acidification	Medium	C	Medium	High	Low	Med - High	Proper acid handling and safety training required, not yet used in Australia
6	Biochar	Med	C / DL	Medium	Med - High	Very High	Medium	Requires pyrolysis equipment and skilled labour to operate, can enhance soil fertility
7	Biofilter	High	C	Medium	High	Medium	Medium	Requires existing tank and enough land space to direct methane to, 92% methane reduction in trials; needs compost maintenance

1) Farm systems: Conventional (C), Deep Litter (DL), Outdoor (O)

Table 6. Assessment of options to decarbonise pork production (Part 2 of 2)

	Initiative Options	Solution Maturity	Farm system[1]	Feasibility to implement	GHG impact	Cost to implement	Return on Investment	Considerations
Renewable Energy and Resource Efficiency								
8	Wind energy	Medium	Any	Medium	Medium	High	Medium	Space requirements; better suited to coastal regions. May require grid connection infrastructure which is costlier if low proximity to grid
9	Solar energy	High	Any	High	High	Medium	High	2 to 3-year payback periods common; thermal/PV options. Requires sufficient space to install solar panels (e.g., roof, ground)
10	Absorption chillers	Medium	C (Large-scale)	Medium	Medium	High	Medium	Requires certain threshold of biogas availability, limited local availability in Australia
11	Electric Vehicles	High	Any	High	Low	Medium	Low	Could consider if installing renewable energy solutions and new vehicle purchases are required
Alternative Feed								
12	Algae-based feeds	Medium	Any	Medium	Medium	Medium	Medium	Requires regulatory approval, potential for co-benefits (e.g., water treatment, nutrient recycling)
13	Black Soldier Fly Feed	Medium	Any	Medium	Medium	Low- Med	Medium	Proven at pilot scale, dispute in GHG impact claims. Requires further research and development, could reduce waste volume, and CO_2 up to 31%
Carbon sequestration & soil enhancement								
14	Tree carbon sequestration	High	Any	High	Med-High	Medium	Variable	Long payback period, benefits depend on scale and species. Requires project by project assessment to understand return on investment
15	Increase Soil Carbon	Medium	Any	Medium	Low	Variable	Unknown	Benefits depend on size and scale. Typically, not compatible with pork production systems and/or available areas are too small to be feasible. Feasibility to implement requires project by project assessment

1) Farm systems: Conventional (C), Deep Litter (DL), Outdoor (O)

5.4 Analysis of select decarbonisation solutions

As the pork industry intensifies its efforts to reduce its environmental footprint, producers and stakeholders can now choose from an expanding array of technologies and management practices. Some of these solutions have demonstrated substantial potential to cut emissions, while others remain in development, target specific operational challenges, or act as complementary measures within a broader sustainability framework. This section examines several of these options in greater detail, outlining how each can play a role in advancing the decarbonisation of pork production.

5.4.1. Decarbonisation of Pig Diets[50]

The 2025 Report 'Decarbonisation of NSW Pig Diets' released by NSW DPIRD identified several key strategies to reduce GHG emissions associated with pig diets in NSW. This includes:

- **Improving feed conversion efficiency:** Enhancing nutrition and herd health, along with precision feeding, lowers the amount of feed required per kilogram of pork
- **Incorporating by-products and co-products:** Using alternative ingredients such as millrun, canola meal, and food waste can replace higher-emission conventional ingredients and support circular resource use
- **Selecting low GHG diet ingredients:** Removing imported soybean meal (a high-emission ingredient due to land use change in Argentina) and replacing it with locally sourced protein meals, such a lupins and canola meal, can significantly reduce feed emissions

From the diet comparisons made in this study it is estimated that an achievable emission reduction of 5–15% is possible with current ingredient availability and without major cost increases, but larger reductions would require new low-emission ingredients or changes to dietary specifications.

5.4.2. Pond Additives

Polyferric Sulphate (PFS) for methane reduction in effluent

Polyferric sulphate is a recent innovation in effluent management that offers a potentially more cost-effective solution for reducing greenhouse gas emissions from effluent ponds. By inhibiting methane-producing microbes, this treatment can dramatically cut methane emissions, making it an attractive alternative to more capital-intensive options like covered anaerobic ponds.

A 2021 study from New Zealand has shown that treating farm dairy effluent with polyferric sulphate (PFS) can reduce methane emissions by up to 99%, with this effect lasting up to two months after treatment and being consistent across laboratory, pilot, and full farm-scale trials[51]. PFS treatment also reduces carbon dioxide emissions by about 50%, resulting in an overall greenhouse gas (CO_2e) reduction of approximately 70% from effluent ponds. The mechanism involves PFS introducing iron

[50] Department of Primary Industries and Regional Development, *Decarbonisation of NSW Pig Diets, Final Report, LPI–SF06, RDOC25/12142 (Tamworth, NSW: Intensive Livestock Systems, February 2025).*

[51] Cameron, K.C., Di, H.J. *Discovery of a new method to reduce methane emissions from farm dairy effluent. J Soils Sediments* ***21****, 3543–3555 (2021).* https://doi.org/10.1007/s11368-021-03014-w

and sulphate ions that inhibit methane-producing microbes, shifting microbial activity away from methane generation.

Potential application to the pork industry

While these results are from dairy effluent, the underlying biology of anaerobic effluent ponds is similar in pig and dairy systems. This means PFS could theoretically be applied to piggery effluent ponds to achieve comparable methane reductions. However, more research is needed to confirm its effectiveness in pig systems, as manure composition and decomposition dynamics may influence outcomes.

PFS vs. covered anaerobic ponds

A key advantage of PFS treatment is its potential for lower capital and operational costs compared to installing covered anaerobic ponds. Covered anaerobic ponds require significant investment in infrastructure, ongoing maintenance, and, in some cases, energy management systems for biogas capture and use. In contrast, PFS can be applied directly to existing effluent ponds with minimal infrastructure changes, making it an attractive option, especially for smaller or older farms where the economics of pond covers are less favourable.

Technology maturity

PFS treatment is still a nascent technology in terms of widespread commercial use. It has moved from research to early on-farm pilots in the dairy sector, but for the pork industry, it remains at the trial or research stage. Further studies are needed to establish its cost-effectiveness, environmental impacts, and operational considerations under piggery conditions.

New research into commercially viable pond additives[52] (Pork News - May 2025)

Anaerobic lagoons in pig production are responsible for over 60% of total on-farm greenhouse gas emissions. While biogas digesters are known to significantly cut these emissions, their high installation and maintenance costs have limited their uptake, particularly among small and medium-sized producers.

In response, Australian Pork Limited (APL), in collaboration with the University of Queensland and SunPork Group, has launched a multi-year initiative to evaluate commercially available additives that can be integrated into existing effluent treatment systems. These additives work by altering microbial and chemical processes within effluent ponds, thereby reducing methane production at its source. This approach is seen as a scalable, cost-effective and practical emissions reduction solution, offering accessibility to producers without the need for major infrastructure changes. Early laboratory results are promising, and the research is progressing to on-farm trials and, subsequently, full-scale demonstrations. The project is scheduled for completion in June 2027.

5.4.3. Low Dose Acidification[53]

Recent research led by Dr. Søren O. Petersen and colleagues at Aarhus University in Denmark has shown that low-dose acidification of pig slurry using sulfuric acid is a practical and cost-effective way to reduce methane emissions from manure storage. Methane, which accounts for about 85% of greenhouse gas emissions from pig manure management, is produced by methanogenic microorganisms during storage. By adding a small amount of sulfuric acid, about 2 kilograms per tonne of slurry, the chemical environment is altered, suppressing the activity and growth of these methane-producing microbes. Sulphate-reducing bacteria then outcompete methanogens, producing hydrogen sulphide, which further inhibits methane formation.

Pilot results

This method builds on Denmark's earlier use of acidification to control ammonia emissions, but more recent research since the mid-2010s has demonstrated its effectiveness for methane mitigation as well. Pilot-scale studies confirm that low-dose acidification can substantially cut methane emissions, though its impact on ammonia is less pronounced at these lower doses. The

[52] Australian Pork Newspaper, *"May 2025 edition," May 2025,* https://porknews.com.au/may-2025/
[53] Pig 333, S.O. Peterson, *Low-dose acidification of pig slurry: a cost-effective method for methane mitigation?, 2025,* https://www.pig333.com/articles/low-dose-acidification-of-pig-slurry-cost-effective-methane-reduction_21245/

process can be applied either in barns using automated systems or in outdoor storage tanks by trained contractors. For effective methane reduction, acidification must occur during storage, not just before field application. Timing is also important, as methane emissions peak in summer and early autumn; treating slurry before these periods maximises the benefit. Frequent transfer of slurry from sheds to storage tanks can further enhance the effect.

Latest research

Ongoing trials in Denmark are evaluating this approach in 16 slurry tanks across pig and cattle farms, and initial results confirm significant methane inhibition, although some untreated pockets remain, highlighting the need for improved mixing and technology. New systems are being developed to safely and efficiently add acid during slurry transfer. Preliminary cost analyses suggest that low-dose acidification, applied one to three times per year, could be a highly cost-effective greenhouse gas mitigation strategy for pig farms, especially when compared to current EU carbon permit prices. Overall, low-dose acidification offers a scalable, practical, and relatively affordable option for methane reduction in pig production, with ongoing research focused on optimising its effectiveness and safety.

5.4.4. Black Soldier Fly

Black soldier fly (BSF) larvae are emerging as a sustainable protein source for pig diets, offering both environmental and economic benefits. In Australia, research into BSF applications for the pork sector is advancing, with several pilot projects and feasibility studies underway. These larvae are reared on organic waste, such as food scraps and agricultural by-products, and processed into a high-protein meal that can replace conventional ingredients like soybean meal[54] or fishmeal in pig feed. This approach supports converts waste into valuable protein, reducing reliance on land-intensive crops, and potentially lowering the carbon footprint of pork production.

A 2024 UK government-funded research project (DEFRA Project SF2035) conducted a Life cycle assessment (LCA) to evaluate the use of BSF meal in pig and poultry diets[55]. The research compared BSF larvae meal to traditional protein sources like Brazilian soybean meal and fish meal from Scottish blue whiting across 16 environmental impact categories. The findings showed that insect meal had higher carbon emissions equivalent than both soybean and fish meal under typical UK production conditions.

[54] Kar SK, Schokker D, Harms, AC, Kruijt L, Smits MA, Jansman AJM. *Local intestinal microbiota response and systemic effects of feeding black soldier fly larvae to replace soybean meal in growing pigs. Scientific Reports 11: 15088 (2021).* https://doi.org/10.1038/s41598-021-94604-8

[55] UK Department for Environment Food & Rural Affairs. Life Cycle Assessment of UK Insect Protein Production Processes for Pig and Poultry Feed - SCF0235 (2024). https://sciencesearch.defra.gov.uk/ProjectDetails?ProjectId=21021

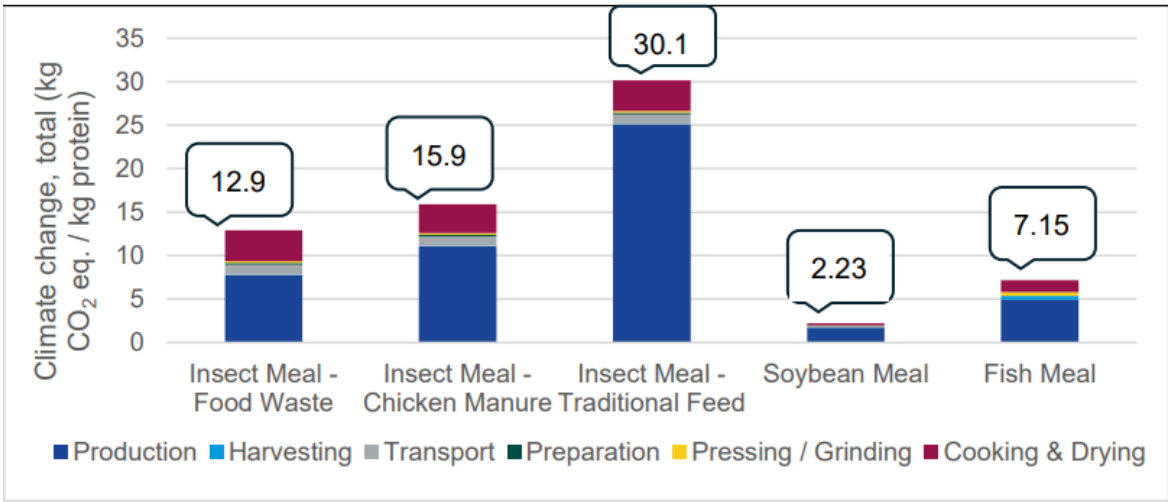


Figure 27. Comparison of CO2e emissions from various pig and poultry feed
Source: Life Cycle Assessment of UK Insect Protein Production Processes for Pig and Poultry Feed

However, industry debate continues with the Insect Bioconversion Association (INBIA), a UK trade group, disputing the findings and challenging the study's methodology, arguing it relied on outdated laboratory-scale data rather than reflecting current industrial practices[56]. A major point of contention was the assumption that insects are fed "traditional feed" (like wheat), rather than food waste streams, which undermines the waste valorisation benefits of insect farming.

In Australia, BSF larvae face significant barriers as a protein source for pig diets. Scaling up BSF production is difficult and costly, requiring substantial investment in infrastructure and technology. The industry has also experienced instability, with several large European BSF businesses recently facing bankruptcy or insolvency. Enorm Biofactory in Denmark filed for bankruptcy court reconstruction in 2025[57]. In France, Ÿnsect entered safeguard (insolvency protection) proceedings in late 2024, and Agronutris filed a safeguard plan with a French commercial court in January 2025[58]. These developments highlight the financial and operational difficulties in scaling BSF production for animal feed in Europe.

Given these challenges - feedstock restrictions, high costs, and market instability - BSF meal is unlikely to become a mainstream, viable protein source in Australia for pig diets in the near future.

[56] Feed Strategy. *Insect protein study sparks backlash over methodology, environmental claims (2025)* https://www.feedstrategy.com/animal-feed-additives-ingredients/alternative-protein/news/15748020/insect-protein-study-sparks-backlash-over-methodology-environmental-claims?utm_source=Omeda&utm_medium=Email&utm_content=NL-Feed+Strategy+eNews&utm_campaign=NL-Feed+Strategy+eNews_20250610_1600&oly_enc_id=2682G0227356J0W
[57] The Fish Site. *Insect producer seeks reconstruction in the face of bankruptcy (2025).* https://thefishsite.com/articles/insect-producer-seeks-reconstruction-in-the-face-of-bankruptcy
[58] The Fish Site. *Double trouble for French insect firms (2025).* https://thefishsite.com/articles/double-trouble-for-french-insect-firms

5.4.5. Algae Solutions for Waste Treatment and Protein Sources

Algae-based technologies offer promising solutions for both waste stream treatment and as alternative protein sources in livestock diets. In wastewater treatment, microalgae and macroalgae can be cultivated in high-rate algal ponds or integrated with membrane bioreactors to remove nutrients such as nitrogen and phosphorus, as well as organic matter and some heavy metals. These systems are robust, energy-efficient, and can generate valuable algal biomass as a by-product[59]. Recent Australian research has demonstrated the feasibility of growing algae in untreated piggery waste, effectively reducing nutrient loads and producing biomass that can be further valorised[60].

Algal biomass harvested from waste treatment can be processed into protein-rich feed ingredients. Microalgae such as Spirulina and Chlorella contain 50–70% protein and are rich in essential amino acids, vitamins, and omega-3 fatty acids, making them suitable for livestock diets[61]. While most research has focused on poultry and cattle, the integration of algae protein into pig diets could enhance nutrition and sustainability, reduce reliance on traditional protein sources, and lower the environmental footprint of pork production. Ongoing Australian trials and pilot projects indicate strong potential for adoption in the pork industry[62], though further research is needed to optimise inclusion rates and economic viability.

5.4.6. Solar

Solar energy is increasingly being adopted by Australian pig farms, particularly among larger operations, but comprehensive national data is limited. Across all farming sectors, solar adoption is significant and growing with farmers turning to solar power for irrigation, electric fencing, and machinery charging stations.[63]

Solar energy provides pig farms with a practical, mature, and cost-effective way to meet energy needs and reduce greenhouse gas (GHG) emissions. Solar photovoltaic (PV) panels generate renewable electricity for heating, ventilation, lighting, and feed milling, while solar thermal systems are ideal for water or air heating. These solutions are especially suitable for farms with large roof areas or open ground.

Although electricity is a smaller contributor to overall on-farm GHG emissions, solar offers a high return on investment and quick payback, while also improving resilience to rising energy costs or unreliable grid supply.

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[59] Queensland Government – Wetland Info. *Algae treatment (2022).* https://wetlandinfo.des.qld.gov.au/wetlands/management/treatment-systems/for-agriculture/treatment-sys-nav-page/algae-treatment/

[60] Murdoch University. *Microalgae potential to mop up waste in meat processing (2019).* https://www.murdoch.edu.au/news/articles/microalgae-potential-to-mop-up-waste-in-meat-processing

[61] Poultry World. *Scientists explore the benefits of algae for poultry (2024).* https://www.poultryworld.net/health-nutrition/health/benefits-of-algae-as-an-alternative-source-of-protein-in-poultry-diets-explored/

[62] Beef Central. *Algae 'farm' could help boost livestock productivity (2014).* https://www.beefcentral.com/production/research-and-development/algae-farm-could-help-boost-livestock-productivity/

[63] Sustainable Future Australia: Bioenergy solutions and innovations. *How Australian Farms Are Slashing Energy Costs While Saving the Planet (2024)* https://biomassproducer.com.au/policy-and-legislation/how-australian-farms-are-slashing-energy-costs-while-saving-the-planet/

Key benefits of solar energy:

- **Environmental Impact:** Replaces grid electricity, cutting Scope 2 emissions. A 100 kW PV system can offset around 140 tonnes of CO_2 per year.
- **Cost Savings:** Can reduce electricity bills by up to 60%[64]. While excess power can be sold back to the grid, feed-in tariffs are typically lower than retail rates.
- **Operational Resilience:** Solar with battery storage ensures energy independence during outages, maintaining critical operations.

Applicability by farm type:

- **Intensive systems:** Large solar arrays suit high daytime energy demands.
- **Deep litter/Eco-shelter:** Smaller systems (20–50 kW) can cover partial needs.
- **Free-range:** Off-grid solar works well for decentralised equipment like pumps and fencing.

Costs, considerations and implementation options

Installation costs depend on system size and technology. Maintenance includes annual cleaning, regular inspections (especially near dusty feed mills), and inverter replacement every 10 years. Optional battery storage and grid connection fees may apply.

When considering solar, piggery operators should assess their energy needs, site location, and available incentives. Intensive farms benefit most from larger or hybrid solar-battery systems, while smaller or free-range farms may only need modest or mobile solar setups. Remote or off-grid farms may prioritise battery storage for reliability. Policy incentives, such as state grants, can significantly reduce upfront costs.

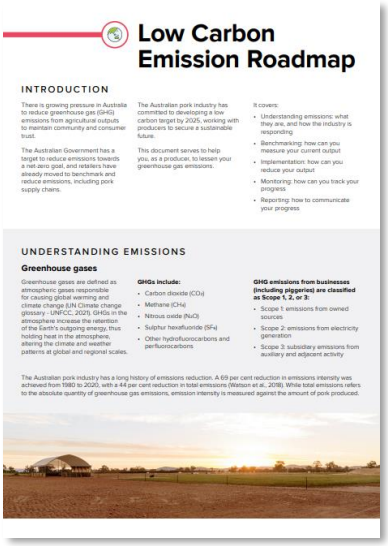
There are several resources that are available including from APL and Clean Energy Council who have developed a guide to Agri-solar. See Key Solar Resources: for more information.

Table 7. Solar implementation strategies

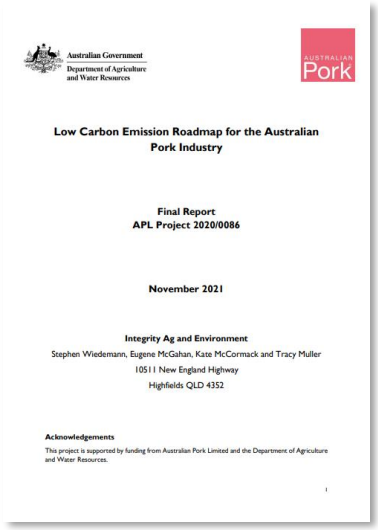
Strategy	Description
Buy Equipment Outright	Farm owns and maintains the system; maximises long-term savings and control.
Power Purchase Agreement/Lease	Third party installs/maintains system; farm pays for power at a discounted rate, reducing upfront costs.
Wholesale Renewable Provider	Farm buys renewable power from the grid; best for sites unable to install solar on-site.

[64] Sustainable Future Australia: Bioenergy solutions and innovations. *How Australian Farms Are Slashing Energy Costs While Saving the Planet (2024)* https://biomassproducer.com.au/policy-and-legislation/how-australian-farms-are-slashing-energy-costs-while-saving-the-planet/

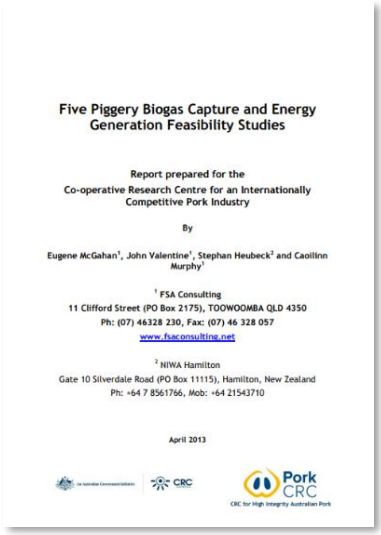
Australian pig farms are increasingly adopting solar to manage rising energy costs and improve sustainability. Installations range from small arrays powering water pumps to large systems supporting entire facilities. The following examples showcase a range of successful solar installations on pig farms, detailing system sizes, investment costs, and the partners involved in bringing these projects to life. For further detail on case studies see **Section**



Auastralian Pork Limited – Low Carbon Emission Roadmap (2022)



Australian Pork Limited – Low Carbon Emission Roadmap for the Australian Pork Industry (2021)



Pork CRC – Five Piggery Biogas Capture and Energy Generation Feasibility Studies (2013)

Solar Case Studies.

Table 8. A summary of farms and their solar systems, including solar size (kW), herd size, farm size/type, installer, cost/payback and key outcomes

Farm Name	Solar Size (kW)	Herd Size	Farm Size/Type	Installer	Cost/ Payback	Potential Key Outcomes
Westpork (WA)[1]	360 + wind/ battery	Not specified	Intensive, Multiple large sites	Advanced Energy Resources	Not specified	15% cost savings, 100% renewables planned
Merivale Farms (QLD)[2]	39.36	Not specified	Intensive, size not specified	Not specified	2-year payback (with LEDs)	Major cost reduction, tariff savings
McIvor Farm Foods (VIC)[3]	37.5 (total)	2,000/yr	Free-range, regenerative 200 ha	AEIP (Vic Govt)	Grant supported	Lower grid use, water/ energy/ labour savings

Darling Downs Piggery (QLD)[4]	Not specified	9,000+	Intensive, size not specified	Not specified	$57k/yr savings projected	48% energy savings, 196 tCO_2-e reduction

Note: [1]From 'WA's biggest pig farm about to go 100 per cent renewable energy' by G. Parkinson, Renew Economy, 2017 (https://reneweconomy.com.au/biggest-pig-farm-go-100-per-cent-renewable-energy-52164/)
[2]From 'Merivale Farms Pork' by Queensland Farmers' Federation, n.d. (https://www.qff.org.au/newsroom/case-studies/merivale-farms-pork/)
[3]From 'Sustainability with Solar' by Harman, J., Energy Smart Farming, 2023 (https://extensionaus.com.au/energysmartfarming/sustainability-with-solar/)
[4]From 'Darling Downs Piggery' by Queensland Ag Energy Hub, n.d. (https://www.qldagenergyhub.com.au/case-studies/darling-downs-piggery)

5.4.7. Biogas

Biogas presents a major opportunity for methane reduction in Australian pork production, with Australian Pork Limited estimating that up to 80% of on-farm emissions can be abated through biogas systems[65]. As of 2024, around 29% of national pork production is powered by biodigesters[66], reflecting significant industry progress in lowering greenhouse gas emissions.

Biogas technology enables producers to capture methane from manure, cutting Scope 1,2 and 3 emissions intensity by an estimated 53%[67]. Methane from uncovered anaerobic ponds typically accounts for 60–80% of total farm emissions, making biogas capture particularly impactful[68]. The viability of biogas depends on herd size, manure management systems, and specific energy needs.

Key economic and environmental benefits of biogas systems include:

- **Heat production:** Thermal energy from biogas can be used for heating sheds, reducing reliance on LPG or electricity.
- **Electricity generation:** Biogas can supply up to 90% of a property's electricity needs, with some farms achieving energy self-sufficiency and exporting surplus power.
- **Fertiliser production:** Digestate from biogas processes is a nutrient-rich organic fertiliser, improving soil quality and reducing chemical fertiliser requirements.
- **Emission reduction credits:** Participation in schemes like the Emissions Reduction Fund (ERF) and Renewable Energy Certificates (RECs) can provide additional income, though selling credits or RECs limits the ability to claim carbon neutrality or renewable energy use.
- **Odour reduction:** Covered biogas systems significantly reduce odour
- **Waste management:** Biogas systems reduce waste volume and pollution risks by converting manure into useful products.

The economic feasibility of biogas is greatest for large operations (1,000+ sows), but medium farms (500+ sows) have demonstrated viable payback periods, and smaller farms (400+ sows) may participate through innovative approaches.

Biogas Capture Methods

In the Australian pork industry, two main biogas capture methods are commonly employed: i) covered anaerobic lagoons and ii) mixed and heated digesters. Covered anaerobic lagoons are the most prevalent option, primarily due to their lower installation and operational costs. These systems involve covering existing anaerobic ponds with a gas-tight membrane, which effectively captures methane generated from the decomposition of manure. This method is efficient at methane capture, but biogas output varies seasonally.

In comparison, mixed and heated digesters offer a more consistent and reliable biogas yield throughout the year. By actively mixing and heating the substrate inside a sealed digester, these

[65] Australia Pork Limited. *Renewable energy (Biogas).* https://australianpork.com.au/environmental-practices/renewable-energy-biogas

[66] Australian Pork Limited. *Annual Report 2023-24.* https://australianpork.com.au/sites/default/files/2024-09/Annual%20Report%202023-24_FINAL.pdf

[67] Integrity Ag and Environment. *Pig Industry Low Emission Roadmap final report (2021). Prepared for Australian Pork Limited.* https://australianpork.com.au/sites/default/files/2021-12/Pig%20Industry%20Low%20Emission%20Roadmap%20final%20report.pdf

[68] Australian Pork Limited. *Reducing greenhouse gas (GHG) emissions from piggeries (2022).* https://australianpork.com.au/sites/default/files/2022-04/033022%20-%20APL%20-%20Reducing%20GHG%20emissions%20from%20piggeries.pdf

systems maintain optimal conditions for microbial activity, regardless of external temperatures. These digesters have higher costs and are less common in Australia.

Biogas Utilisation Technologies[69]

Once biogas is captured, several technologies are available for its utilisation, each offering distinct advantages depending on the needs of the operation. Hot water boilers represent one of the simplest and most efficient ways to use biogas, converting it directly into thermal energy for heating water or air. This is beneficial for breeder units needing heating, like piglet nests.

Combined heat and power (CHP) systems take biogas utilisation a step further by simultaneously generating electricity and capturing waste heat for on-farm use. These systems offset electricity costs and sometimes export surplus power.

Trigeneration systems expand on the CHP concept by also providing cooling, which is particularly valuable in hot climates where maintaining optimal temperatures is crucial for pig welfare[70]. These systems are more complex and costly but offer versatility for farms with diverse energy needs.

Advanced biogas utilisation options include upgrading biogas to biomethane for use as vehicle fuel or injection into natural gas pipelines[71,72]. Additionally, emerging technologies such as micro-turbines, Stirling engines, organic rankine cycle systems, and fuel cells are being explored to further enhance the flexibility and efficiency of biogas energy conversion[73]. These advanced solutions provide opportunities for producers to tailor biogas use to their specific operational requirements and future-proof their investments as technology evolves.

Development of biomethane production in Europe

Europe has recently seen significant development and uptake of biomethane production in the pork sector, supported by both policy targets and practical on-farm innovation. The European Union's REPowerEU plan calls for production of 35 billion cubic meters of biomethane annually by 2030[74], with animal manure as a key feedstock. Leaders like France, Germany, Poland, and the Netherlands have hundreds of digesters operating on pig farms producing biomethane for use as renewable energy or injection into the gas grid.

Biolectric, a Belgian company, has installed 20 mini digesters on pig farms across Europe, with the majority of new installations in Poland and several others in northern Italy, the Netherlands,

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[69] Pork CRC. *Options for Cost-effective and Efficient Use of Piggery Biogas Energy (2016).* https://porkcrc.com.au/wp-content/uploads/2016/08/4C-114-Final-Report.pdf

[70] BioCycle. *Biogas To Heat and Power (2023).* https://www.biocycle.net/biogas-to-heat-and-power/

[71] QED. *What is Biogas Upgrading?* https://www.qedenv.com/markets-applications/biogas-and-biomethane/biogas-upgrading/what-is-biogas-upgrading/

[72] Jian, Z., Feng, Z.-J., Wang, J., Wang, Y., Li, X.-Y., Zhang, P.-A., & Li, J.-P. (2019). *Research on the Combined Cycle of a Biogas Micro Gas Turbine and an Organic Rankine Cycle*. https://doi.org/10.1166/jbmb.2019.1898

[73] European Commission. *CORDIS – EU Research- Biogas-fired Combined Hybrid Heat and Power Plant* https://cordis.europa.eu/project/id/641073

[74] European Commission. https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/biomethane_en

Flanders, and France[75]. Poland leads adoption, driven by the need for carbon footprint certification to enable meat exports to the EU, and regulatory advantages in manure management.

Major cooperatives such as Cooperl in France operate large-scale methanisers to process manure from dozens of pig farms, producing millions of cubic meters of biogas per year for energy and fertiliser production[76]. Overall, Europe's pork industry is leveraging biomethane to support supply chain decarbonisation, energy independence, and farm profitability, though rapid expansion continues to invite debate over sustainability and sector impacts.

Case studies of biogas in Australia

Recent industry data indicates that biogas adoption has steadily increased across the Australian pork sector, with approximately 16% of piggeries operating bio-digesters for green energy generation[77]. The following table presents a summary of implemented biogas case studies from across the Australian pork industry, highlighting the diversity of system designs, operational scales, and the economic and environmental benefits achieved by producers.

[75] Pig Progress. *Number of mini digesters on European pig farms is growing (2024)* https://www.pigprogress.net/pigs/processing/number-of-mini-digesters-on-pig-farms-is-growing/
[76] Cooperl. https://www.cooperl.co.uk/environment
[77] Australian Pork Newspaper. *Pig waste turned into clean and green power (2022).* https://porknews.com.au/pig-waste-turned-into-clean-and-green-power/

Table 9. Implemented Biogas Case Studies in Australia – Cost & Benefits Summary

Organisation	Location	Year	Herd Size	Waste Resource	Biogas System	Energy Output	Benefits	Innovation
BettaPork[78]	Queensland	2015	2200 sows	120 kilolitres Manure & Organic waste	Two 3 Megalitre biogas tanks	Generate 200 kW power, farm & household energy requirements Excess energy sold back to network.	Process external organic food waste. Reduced reliance on electricity supply. Sustainable waste management. Additional income stream.	Collaboration with schools, restaurants & meat works. Aggregated organic waste resource. Reduced waste to landfill.
Westpork[79]	Western Australia	2017	-	Manure/ wastewater effluent	Covered Anaerobic lagoon (CAL)	Biogas utilised for CHP (Cogen) – electricity & heating Excess biogas flared (Not utilised)	Enhanced environmental compliance. Reduced odour through improved wastewater treatment. Improved operational efficiency.	Upgrading infrastructure with settlement trenches for sludge drying.
SunPork	Queensland & NSW	Multiple sites	NSW 2200 sows	Manure/ wastewater effluent	Covered Anaerobic lagoon (CAL)	Generates 280 kW of power plus heating for farrowing sheds 60 % exported to network	Payback period of 2.5 years / CAPEX $980,000. 60% exported to network. Energy savings of $15,000/month. Mitigated emissions 8,500 tonne CO2-e/year.	
Rivalea[80,81]	NSW, Corowa	2017	45,000 production	Manure/ wastewater effluent	Covered Anaerobic lagoon (CAL)	3 CHP (Cogen) – 500 kW electricity & 500 kW thermal heating Generates 4,000 MWh of electricity / year.	Generates 4,000 MWh of electricity/year. 25% of site's total energy demand. Energy savings $2.26 million/year. Payback period of 2.5 years / CAPEX $5.85 million. Mitigated emissions 28,000 tonne CO2-e/year.	Waste heat used for site hot water, improving energy efficiency. Gas cooling & sulphur removal to improve energy efficiency. Demonstrated industry leadership for clean energy adoption & GHG mitigation.
Blantyre	NSW Harden	2011– earlier adopter	40,000 production	Manure/ wastewater effluent & Organic waste	Covered Anaerobic lagoon (CAL)	Biogas utilised for CHP (Cogen) – electricity & heating Excess biogas flared (Not utilised)	Energy savings of $29,000/month. Excess biogas flared (not utilised). Mitigated emissions 65,000 tonne CO2-e/year.	Re-diversion of food waste – 8,000 tonnes/year. Minimise synthetic fertiliser use.

[78] Betta Pork. *Biogas Plant.* https://bettapork.com.au/biogas-plant/
[79] WA Department of Environment and Regulation. *Application for Works Approval – Westpork Pinjarra Piggery Operations (2019)* https://www.der.wa.gov.au/images/documents/our-work/licences-and-works-approvals/Decisions_/W6292_-_2019-1_d_compressed.pdf
[80] EVO Energy Technologies. *Rivalea Australia.* https://www.evoet.com.au/projects/rivalea-australia-3/
[81] 2G. *Green energy supply in Australia - Pork producer Rivalea generates energy from manure.* https://2-g.com/en/case-studies/green-energy-supply-in-australia~cs484

Organisation	Location	Year	Herd Size	Waste Resource	Biogas System	Energy Output	Benefits	Innovation
Pork CRC Case Study 2	Victoria	-	2000 sows	Manure/ wastewater effluent	Covered Anaerobic lagoon (CAL)	Generates 54 kW of power plus heating for farrowing sheds – additional 200 kW planned	Biogas displaces 633 MWh of electricity/year and 44 kilolitres of LPG/year. Energy savings $390,000/year. Mitigated emissions value $240,000/year.	Sludge extraction from CAL for direct injection cropping application

Pathways to participate in Biogas projects

Biogas production is now accessible to pork producers of all sizes through a range of participation models. For smaller farms, co-digestion, mixing pig manure with food waste or crop residues, boosts biogas yields and creates new income opportunities, including accepting external organic waste for gate fees. Shared biogas facilities are another option, where several farms collaborate to build a central plant, sharing costs and benefits. However, this model requires careful coordination of logistics, biosecurity, and fair cost-sharing.

Beyond these collaborative approaches, producers can engage with biogas projects through full ownership and operation, third-party build-own-operate (BOO) models or leasing. Each pathway has distinct financial, operational, and risk considerations. The following table outlines these main options, summarising their advantages, challenges, suitability for different farm types, and real-world examples from Australia and abroad to help producers choose the best strategy for their needs.

Table 10. A summary of several pathways to participating in biogas projects: Self-install and operate, third party Build-Own-Operate (BOO), leasing model, shared biogas facilities

Option	Description	Pros	Cons	Suitability	Examples
Self-Install and Operate	Producer funds, builds, manages the biogas system, and retains all energy and carbon credits	Full control, highest ROI, eligible for grants, all revenue streams retained	High upfront cost, requires technical expertise and ongoing management	Large intensive farms, centralised manure	BettaPork, SunPork, Rivalea
Third-Party Build-Own-Operate (BOO)	Developer funds/installs system, sells energy to farm, retains credits/RECs	No upfront cost, maintenance/compliance handled by developer, reliable energy supply	Limited financial upside, no carbon credit income, long-term contracts may limit options	Medium to large farms, intensive systems	Cooperl (France)[1] Gate 46 implementing this model on Australian dairy farms
Leasing Model	Producer leases biogas equipment, paying fixed monthly fees	Lower capital barrier, flexibility to upgrade or exit, less risk	Higher lifetime cost, less control over optimisation, may not own all credits	Medium farms, eco-shelter/hybrid	No prominent AU examples Public-private initiative (ELAN, France)[2]
Shared Biogas Facilities	Multiple farms or businesses pool resources, sharing costs and benefits	Cost-sharing, enables access for broader community, reduces individual risk	Complex logistics, biosecurity, revenue-sharing disputes, manure transport required	Small farms, clustered or free-range systems. Likely requires government support	No prominent AU examples Agro-Energy Cooperative in Dairy (Brazil)[3]

Note: [1]From 'Biogas, fertiliser, & algae from pigs: the company putting circular farming in practice' by World Bio Market Insights, 2022. (https://worldbiomarketinsights.com/biogas-fertiliser-algae-from-pigs-the-company-putting-circular-farming-in-practice/)

[2]From 'EIP-AGRI Focus Group: Enhancing the production and use of renewable energy on the farm. Minipaper: Business Models and Financial Alternatives for On-Farm Renewable Energy Projects' by EIP-AGRI Agriculture and Innovation, n.d. (https://ec.europa.eu/eip/agriculture/sites/default/files/fg28_mp_businessmodels_2018_en.pdf)

[3]From 'Cooperative Approaches To International Agriculture Biogas Projects' by BioCycle, 2014 (https://www.biocycle.net/cooperative-approaches-to-international-agricultural-biogas-projects/)

5.4.8. Tree and Soil Carbon Sequestration

Planting trees on-farm is an insetting strategy for pork producers aiming to remove greenhouse gases as part of their overall decarbonisation or net-zero plan. Unlike purchasing external offsets, insetting through tree planting demonstrates tangible climate action on the farm and allows producers to claim emissions removals directly. In addition to carbon benefits, trees provide shade, reduce erosion, and enhance biodiversity.

Integrating trees into underutilised land can create long-term financial gains through timber production if a plantation-based approach is pursued rather than biodiverse native reforestation. However, income from timber, firewood, or wood products is typically realised over many years (up to 25 years).

Soil carbon sequestration is a highly complementary strategy to remove emissions. Through practices such as cover cropping, reduced tillage, rotational grazing, use of organic amendments (like compost or manure), and maintaining ground cover, producers can increase the amount of carbon stored in soils. Healthy soils not only hold more carbon but also support fertility, water retention, and long-term productivity, adding agronomic value on top of carbon benefits. However, it is unclear how many of these practices can be practically implemented within an intensive pork production system. More detailed research and suitability assessment is required.

Scale Considerations

A key challenge for both tree and soil carbon sequestration projects is achieving sufficient scale. Very small plantings are generally not viable, as administrative and monitoring costs can outweigh the potential carbon benefits. For soil carbon, aggregation (combining projects across multiple fields or farms) is increasingly used to achieve that necessary scale. Projects must be large enough to justify the investment in measurement, reporting, and verification (MRV) activities required for credible carbon accounting.

Accreditation and Long-Term Planning

Whether pursuing accreditation through formal programs such as the Australian Carbon Credit Unit (ACCU) scheme or Verra, or opting for an unaccredited insetting approach, proponents face similar requirements. Accredited programs impose strict eligibility, long-term monitoring, and permanence obligations to ensure the integrity of carbon sequestration outcomes. Even unaccredited insetting projects are increasingly expected to align with international standards, such as the GHG Protocol Land Sector and Removals Guidance, which sets out principles for accounting, permanence, and transparency in land-based carbon removals.

Soil carbon projects in particular demand regular sampling and advanced modelling to evidence real gains in soil organic carbon. Permanence agreements for both trees and soils often extend 25 years or more, obligating producers to ongoing stewardship, reporting, and risk management to ensure that sequestered carbon is maintained and protected from reversal (e.g., due to fire, land use change, or poor management).

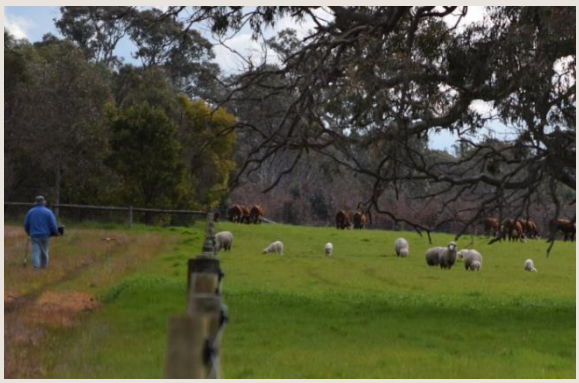
Importance of Farm-Level Assessment

It is essential to assess the feasibiltiy of tree and soil carbon sequestration solutions on a project-by-project basis, particularly at the farm level. Every farm operates within its own unique set of circumstances, including soil type, climate, management practices, and business objectives that significantly influence which approaches are suitable and effective. Draw conclusions about the viability of tree and soil carbon strategies is not possible without careful consideration of these specific farm-based factors.

Case Studies

Both Cobram Estate Olives and Blantyre Farms in Australia serve as notable case studies of agricultural businesses that have implemented tree carbon sequestration strategies, Cobram Estate Olives through large-scale native and mallee eucalypt plantings as part of their carbon farming initiatives[82], and Blantyre Farms by integrating tree planting and manure management to significantly reduce their carbon footprint and generate environmental and commercial benefits[83]. See Appendix 8.2.4 Tree Planting Case Studies for more information.

Carbon Sequestration & Net Zero in Grazing Systems: Jigsaw Farms Case Study[84]



A recent study at Jigsaw Farms in south-west Victoria explored whether carbon sequestration in soils and trees could sustain net zero greenhouse gas (GHG) emissions on a large-scale grazing property. This research was motivated by agriculture's increasing climate targets and sought to test if on-farm sequestration could reliably offset livestock emissions over time.

Between 2010 and 2014, the farm achieved net zero emissions, with carbon sequestration from trees and soils exceeding total GHG emissions. Notably, trees played the dominant role, accounting for 89% of total sequestration, while soils contributed 11%. This underscores the importance of tree planting and management as a strategy for offsetting emissions in grazing systems.

However, after 2014, as livestock numbers increased and sequestration rates declined with tree maturation, the farm was no longer able to maintain net zero status. By 2021, total emissions had risen to 10,870 t CO_2-e, while vegetation sequestered 6,704 t CO_2-e. Despite the increase in net emissions, the emissions intensity, GHG per unit of product, was halved, demonstrating the ongoing benefit of sequestration in reducing the carbon footprint of farm products.

The study also highlighted challenges in measuring ongoing soil carbon sequestration due to insufficient data, making robust assessment difficult. In conclusion, while tree and soil carbon sequestration can enable grazing farms to achieve net zero emissions for certain periods, maintaining this status indefinitely is not feasible without additional emission reduction measures. Trees offer substantial co-benefits, but sequestration should be considered just one component of a broader emissions mitigation strategy.

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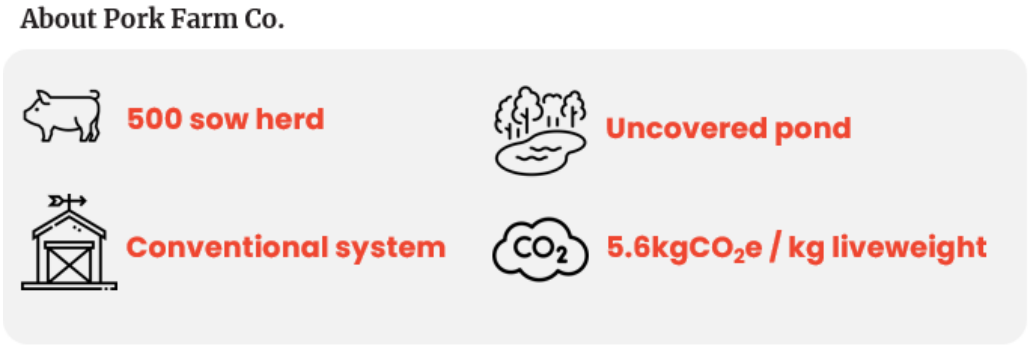
[82] Carbon Farming Foundation. *Cobram Estate Olives.* https://carbonfarming.org.au/success-stories/cobram-estate-olives/

[83] Shared Value Project. *Case Study – Blantyre Farms (2020).* https://sharedvalue.org.au/wp-content/uploads/2020/02/Blantyre-Farms-SVP-Case-Study-Feb-2020.pdf

[84] Macdonald A, Court J, Meyer R, Wootton M, Kantor E, Keenan R, Stewart H, Eckard R (2025) *Can soil and tree carbon sequestration maintain zero net emissions grazing? Animal Production Science 65, AN24346.* https://doi.org/10.1071/AN24346

5.5. A hypothetical scenario – how much can we decarbonise by?

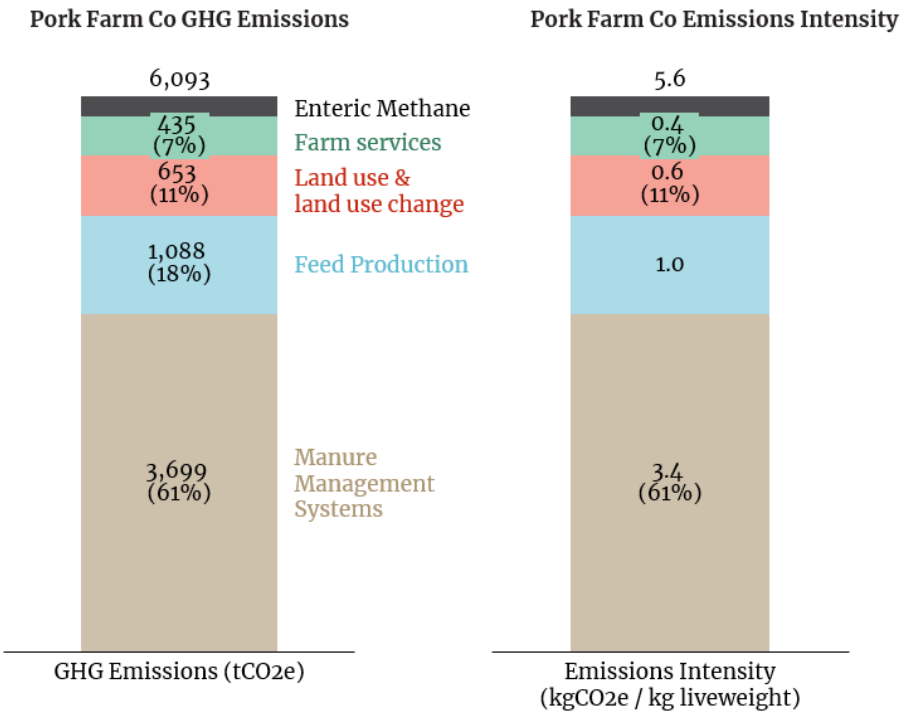
In this section we will explore how much in emissions reduction can be realistically achieved, by creating a hypothetical piggery in Australia called Pork Farm Co.



Pork Farm Co. has a herd of 500 sows, operates under a conventional production system and utilises uncovered ponds for manure management. 5% of their feed is comprised of soybean meal imported from Argentina, and they have spare land of which 50 hectares may be suitable for tree planting.

Baseline Farm Profile

The farm produces ~1.1 million kg of liveweight each year (assuming 2,176 kg liveweight per sow per year[85]). The GHG emissions intensity of Pork Farm Co. is 5.6 kg CO_2-e per kg liveweight, bringing their total GHG emissions to 6,093 tonnes of CO_2-e per year.



[85] Teagasc – Agriculture and Food Development Authority. *A summary of the National Pig Herd Performance Report 2023.* https://teagasc.ie/news--events/daily/a-summary-of-the-national-pig-herd-performance-report-2023/

The majority of their emissions (61%) come from methane generated in uncovered ponds. This is then followed by 18% generated from purchase of feed, then land use and land use change. Farm services including energy used in heating, lighting and operating machinery contributes to 7% of emissions and enteric methane contributes the smallest amount at 4%.

What are the decarbonisation options to consider?

Pork Farm Co. can lower their environmental footprint by adopting a suite of strategies. Upgrading manure management, either with additives or by installing covered anaerobic ponds, delivers the largest single emissions cuts. They could switch their imported soybean meal with local lupin or canola meal suppliers and reduce feed wastage to reduce the farm's carbon footprint, while improvements in genetics and the feed conversion ratio amplify these gains. With their spare land they could also plant trees to sequester carbon. The table below lists the potential options to decarbonise each category of emissions.

Table 11. Overview of potential levers to reduce emissions on-farm

Category	Levers to address
Overall	• Improved animal health and management • Improved genetic selection
Feed Production	• Minimising feed wastage • Sourcing lower GHG options (e.g., lupins, canola meal from local supplier) • Land application / fertiliser replacement
Enteric Methane	• Optimise diet and nutrition
Manure Management Systems (Conventional, uncovered ponds)	• Covered anaerobic ponds • Methane flaring • Effluent pond additives • Low dose acidification • Biogas
Farm services	• Energy efficiency improvements (e.g., energy efficient fans, heat recovery from air ventilation) • Electric vehicles • Absorption chillers for heating (if has biogas facilities)
	Renewables • Solar panels • Wind energy
Land use and land use change	• Tree carbon sequestration

What could be achievable?

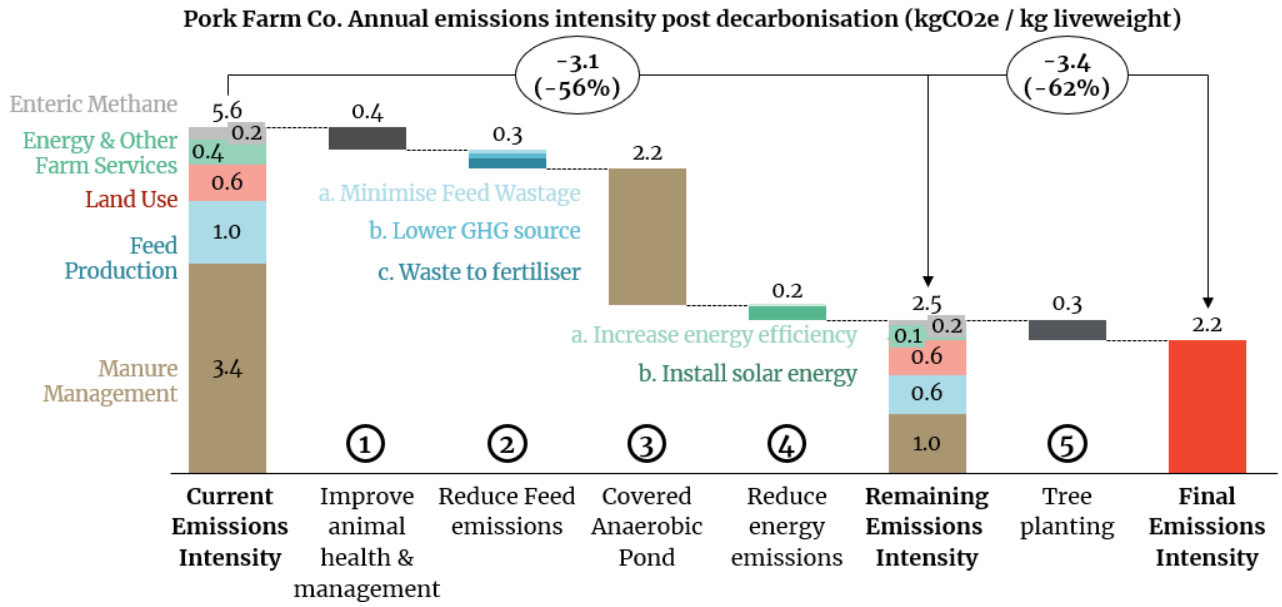


Figure 28. Hypothetical emission intensity reduction at Pork Farm Co.

By combining these approaches as outlined above, the farm could avoid 56% emissions on-farm and from feed purchase, reducing total on-farm emissions intensity to 2.5kg CO_2e / kg liveweight. If tree planting is implemented, this can further be reduced to 2.2kg CO_2e / kg liveweight. Total emissions would reduce from 6,093 to 3,397 tonnes. This comes from doing the following:

1. **Improve animal health & management:** Smaller incremental gains, such as improving feeding management, biosecurity, parasite control, and animal welfare (e.g., reducing lameness), are also shown to independently decrease emissions intensity by 1–8% each[86], and cumulatively add up.
   Assumptions: Have assumed cumulative total 7% decrease in emissions intensity
2. **Reduce Feed Emissions through**
   a. **Minimising Feed Wastage:** Regularly calibrating feeders, using technologies that reduce spillage, training staff in best practice feeding management and precision feeding solutions could ensure feed is converted into animal growth rather than being lost.
   Assumptions: 5% improvement in feed emissions
   b. **Sourcing lower GHG feed:** Sourcing feeds with a lower greenhouse gas footprint, such as locally grown grains or alternative protein meals instead of imported soymeal, lowers emissions embedded in the feed supply chain, including those from deforestation, transport, and production.
   Assumptions: 20% of feed is soybean imported from Argentina. Local feed has a 50% lower carbon footprint in comparison to imports.

[86] Krebs, I., Arnold, C., Alders, R., Cooks, J., Ezanno, V.O., Garnier, O.F., Klaas, M., Mathew, P.F., Ortiz-Pelaez, K., Rees, M.W., et al., (2024). *Improve animal health to reduce livestock emissions: quantifying an open goal. Proceedings of the Royal Society B: Biological Sciences, 291: 20240675.* https://doi.org/10.1098/rspb.2024.0675

c. **Using waste as fertiliser for food production:** Applying pig manure as fertiliser reduces emissions by displacing synthetic fertiliser use. This is done by collecting and treating manure, composting if necessary, and applying it at agronomically appropriate rates to crop or pastureland.
Assumptions: 20% lower carbon footprint for crop produced from manure treatments compared to synthetic fertilisers[87].

Covered anaerobic pond and methane flaring: Installing covered anaerobic ponds captures methane from effluent ponds, preventing direct release to the atmosphere and enabling its use for energy or flaring. Retrofit or construct ponds with durable gas-tight covers and establish systems for safe methane capture and flaring (which can reduce emissions by 80% assuming 91% flaring efficiency[88]), or reuse in biogas energy generation. A potential alternative could be to use pond additives such as polyferric sulphate which can reduce methane emissions by up to 99%.
Assumptions: 70% improvement in emissions from manure management

3. **Reduce energy emissions through:**
   a. **Increasing energy efficiency:** Upgrading to LED lighting, installing variable speed drives on fans, and optimising heating and cooling systems can lower emissions.
   Assumptions: 5% improvement from more efficient heating and lighting
   b. **Installing solar energy:** Installing solar PV panels reduces emissions by supplying renewable electricity, displacing grid or diesel-sourced power used for ventilation, lighting, and water pumping.
   Assumptions: Solar covers 90% of on-farm energy usage
4. **Carbon sequestration through tree planting:** Tree planting removes carbon dioxide from the atmosphere and stores it in biomass and soils, offsetting a portion of the farm's overall emissions. Integrate strategic plantings (e.g., shelterbelts, woodlots, riparian zones) using suitable native or productive species, with appropriate site selection, management, and monitoring for long-term carbon storage benefits.
Assumptions: 50 hectares of suitable tree planting space, with each hectare sequestering 7 tonnes of CO_2e[89]. Assumes farm is located in medium rainfall region. This would sequester 350 tonnes of CO_2e each year for 15 to 25 years. This conservative estimate is based on sequestration rates specific to Western Australia's wheat belt. In higher rainfall regions with better soils, actual sequestration rates could be up to three to four times higher, indicating significant additional potential for carbon removal.

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[87] *Niu, J., Chang, L., Wu, Z., Hou, Y., & Zhao, K. (2024). Manure replacing synthetic fertilizer improves crop yield and sustainability in a winter wheat–summer maize rotation. Science of The Total Environment, 912, 168188. ttps://doi.org/10.1016/j.scitotenv.2024.168188[][2]*

[88] Chemical & Engineering News. *Methane flaring may be less efficient than previously thought (2022).* https://cen.acs.org/environment/greenhouse-gases/Methane-flaring-less-efficient-previously/100/web/2022/09

[89] Jonson, J. H. (2010). *Carbon values of environmental tree plantings at the farm and catchment scales, and their economic implications to farming systems in the central wheatbelt of Western Australia (Master's thesis, University of Western Australia).* https://research-repository.uwa.edu.au/en/publications/carbon-values-of-environmental-tree-plantings-at-the-farm-and-cat

6

Measure, reduce, inset and offset

6. The four levels of approaches for businesses

Decarbonisation is a structured process that involves four essential levels: Measure, Reduce, Inset, and Offset. Each level builds on the previous one to ensure a comprehensive and credible approach to reducing greenhouse gas (GHG) emissions.

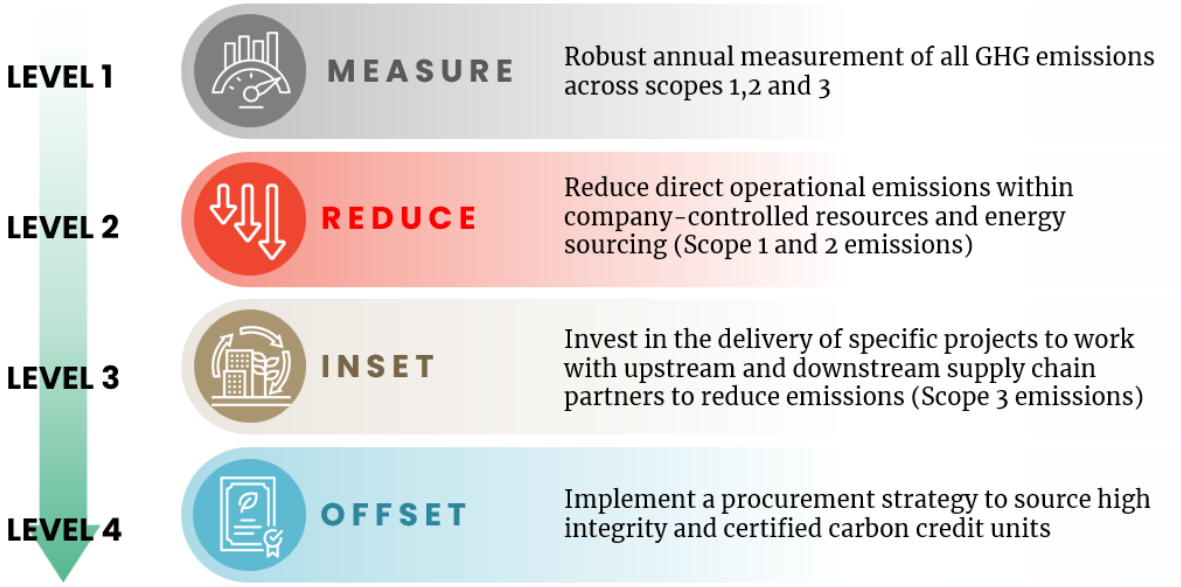


Figure 29. The four key of engagement for decarbonisation

6.1 Level 1 - Measure

Why do it? Without measurement, it is impossible to manage or credibly communicate progress, and lack of data will soon become a barrier to market access.

Who should do it? All organisations within the supply chain.

The foundational step for any business, including pork producers, is to robustly measure greenhouse gas emissions across all scopes (1, 2, and 3). Accurate measurement is now a baseline expectation, driven by both industry best practice and regulatory requirements. Australia's new mandatory climate disclosure rules, effective from 2025, require large businesses and their supply chains to report emissions data, climate risks, and progress against targets in their annual reports.

For pork producers, this means that even if not directly required to report, customers (such as processors and retailers) will increasingly demand accurate, auditable emissions data from their suppliers. Initiatives at this level include adopting emissions measurement software, engaging consultants for life cycle assessments (LCA), and establishing systems for regular data collection.

Lessons Learnt: Getting Started with Carbon Accounting in the Pork Industry

RSM Australia | ESG & Climate Services

Why it Matters

In January 2025, mandatory climate-related financial disclosures commenced in Australia under **AASB S2**, applying first to large, listed entities and those already reporting under the National Greenhouse and Energy Reporting (NGER) Scheme. However, the **ripple effect across agricultural supply chains is immediate and material**.

Businesses in the pork industry, even if not directly captured in Group 1 or 2, are increasingly expected to provide **carbon footprint data** to customers, processors, and retailers who must report **Scope 3 emissions**. Understanding and quantifying your own emissions baseline is therefore not just a compliance exercise, it is a **strategic imperative** for supply chain positioning, cost reduction, and credibility.

Key Insights from Early Engagements

1. **Carbon Accounting in Agriculture is Complex but Not Impossible**
    - Emissions arise from **natural biological processes** (e.g., manure, feed digestion, soil), which makes measurement and mitigation less straightforward than in other sectors.
    - Data collection at the **farm level** is highly variable and often not digitised.
    - **Pork production-specific metrics** such as liveweight gain, feed conversion ratios, and manure handling practices must be captured in a consistent format.

Action: Establish clear boundaries, data collection templates, and use trusted methodologies / tools (e.g., APL's PigBal 5 tool, Pork Greenhouse Accounting Framework (P-GAF), AIA Environmental Accounting Platform, GHG Protocol) to ensure alignment with downstream reporting needs.

2. **Data is the Biggest Barrier, But Also the Gateway to Opportunity**
    - Many farms lack centralised records of energy use, feed volumes, or fertiliser applications, creating **initial friction** in calculating a baseline.
    - Once captured, the data enables visibility of **energy inefficiencies**, **cost drivers**, and **emission hotspots**.

Action: Start small, build a carbon data inventory using easily available data (e.g. electricity bills, fuel usage, livestock records). This provides a **foundational carbon baseline** that can be refined over time.

3. **Understanding Scope 1 and 2 Emissions is a Key First Step**
    - Scope 1 (direct on-farm emissions) includes manure, diesel, and livestock methane.
    - Scope 2 covers purchased electricity. In some cases, this is a **high leverage point** for reduction via solar or efficiency upgrades.

Opportunity: Quantifying these scopes can uncover practical improvements (e.g., LED lighting, pump upgrades, renewable energy), often linked to government grants or rebates.

Lessons from the Field: What Worked Well

Clear internal champions (e.g., farm owners or managers) made a significant difference in data collection and prioritisation.

Benchmarking against industry averages motivated action, knowing how a farm compares to peers is a powerful tool.

Linking carbon to productivity (e.g. emissions per kg of pork produced) helped reframe sustainability as profitability.

Common Obstacles and How to Overcome Them

Obstacle	How to Overcome It
Poor or inconsistent data records	Use a **data discovery session** to map out what exists and where; estimate where needed and disclose assumptions
Uncertainty about standards or methods	Follow best practice methodologies like the GHG Protocol Agriculture Guidance; align to AASB S2 disclosures for comparability (reporting of carbon emissions)
Perceived lack of return on effort	Connect emissions data to **input cost savings**, **market access** and **potential premiums** through verified carbon reduction efforts
Limited internal capacity	Work with external advisors on a **phased approach**, start with a baseline, then build scenarios, strategies and disclosures over time

Opportunities for the Pork Sector

Supply Chain Readiness: Be seen as a reliable, low-carbon supplier to retailers and processors already reporting under AASB S2.

Carbon Footprint Labelling: Enable differentiated products by providing emissions intensity per kg of pork.

Decarbonisation Finance: Attract lower-cost finance or grants by demonstrating emissions reductions and transition planning. See NAB Farming for the Future.

Reputation and Market Access: Communicate progress with credibility to export markets and conscious consumers.

Getting Started – RSM Recommendations

Establish Your Carbon Baseline
Focus on core Scope 1 and 2 data using existing operational information.

Engage with the Supply Chain
Understand what customers and partners need from you, proactively respond to Scope 3 data requests.

Set a Roadmap for Reduction
Identify key emissions drivers and prioritise low-cost, high-impact interventions (e.g. energy, feed efficiency). Being able to tell your story to your key stakeholders will only help future proof your business.

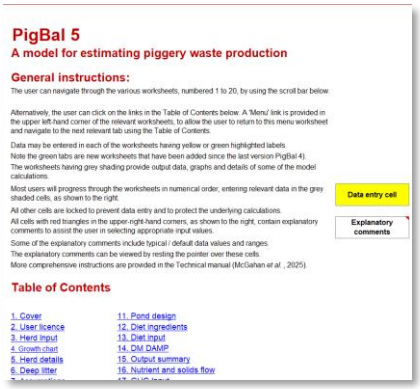
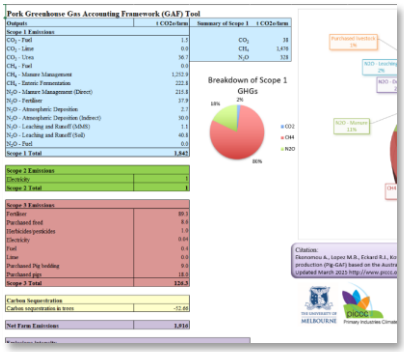
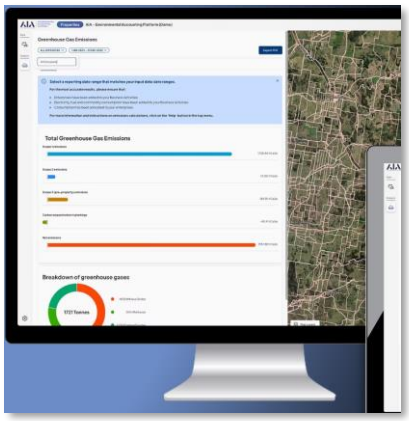
Understand your Disclosure Requirements
Ensure your data and methodologies can support future **carbon reporting disclosures**, especially if you supply to large retailers such as Coles, Costco and/or Woolworths.

Final Thought

Carbon accounting is no longer optional, it is becoming the cost of doing business in agriculture. By taking early steps to understand and manage carbon emissions, pork producers can protect profitability, build resilience, and remain competitive in a rapidly changing marketplace.

Seeking early support to build and embed carbon accounting into your business can set you up for long-term success.

6.1.1. Measurement tools and frameworks

Measurement Tool and Framework	Description
APL's PigBal 5 tool 	PigBal 5 is an Excel-based model developed by Australian Pork Limited to estimate piggery waste production and nutrient flows using a mass balance approach. Users input detailed dietary and herd data to calculate manure volumes, nutrient outputs, and greenhouse gas emissions. The tool supports design of effluent systems, biogas economic assessments, statutory emissions reporting, and planning for new or expanded piggery operations.
Pork Greenhouse Accounting Framework (P-GAF) 	The Pork GAF is an Excel tool developed by the University of Melbourne, Primary Industries Climate Challenges Centre and Agricultural Innovation Australia (AIA) designed to estimate greenhouse gas emissions from pork production at the farm gate. Developed to align with the Australian National Greenhouse Accounts, the tool allows users to input pork-specific data (such as herd structure, feed use, and manure management) and instantly generate summaries and charts of scope 1, 2, and 3 emissions. Pork GAF is part of a suite of sector-specific accounting frameworks supporting Australian agriculture's sustainability goals.
AIA Environmental Accounting Platform 	Agricultural Innovation Australia's Environmental Accounting Platform provides a national, pre-competitive carbon calculation engine for agriculture, fisheries, and forestry. It offers consistent, standardised emissions calculations reflecting Australian conditions, enabling producers and supply chain partners to track, report, and benchmark GHG emissions across commodities. EAP supports integration with industry tools and platforms and will be available as open source until June 2028 to support market access and regulatory compliance.

6.2 Level 2 - Measure & Reduce

Why do it? Measuring and reducing emissions is about future-proofing market access, maintaining competitiveness, and meeting evolving customer and regulatory expectations. For pork producers, reducing emissions on-farm will soon be essential for continued participation in major supply chains, as emission-based procurement becomes standard practice.

Who should do it? All organisations within the supply chain looking to reduce their emissions within their own operations.

As emission-based procurement becomes mainstream, measuring and actively reducing emissions will become essential, likely within the next 1–3 years. Major retailers such as Coles and Woolworths have already indicated that suppliers with high emissions may eventually be excluded from their supply chains. Reduction initiatives can include improving feed conversion ratios, reducing feed waste, installing solar panels, upgrading to energy-efficient equipment, or implementing biogas systems. These actions not only cut emissions but also often deliver operational savings and improved productivity.

Example initiatives:

- Improving feed efficiency and herd management
- Installing solar panels or energy-efficient equipment
- Adopting biogas or composting systems

See Section 5 Exploring Emission Avoidance Options for a full list of options.

Takeaways:

Pork producers who establish robust measurement systems will maintain market access and be ready for new regulatory and customer demands. Brands should support their suppliers in building measurement capability, as supply chain transparency will soon be a baseline requirement.

6.3 Level 3 - Measure, Reduce, and Inset

Why do it? Insetting can open up new commercial opportunities, strengthen supply relationships, and enhance brand reputation, especially as the market shifts towards valuing genuine, supply chain-embedded climate action. This can set a business apart as a leader and innovator in sustainability.

Who should do it? Insetting is more suited towards downstream organisations in the supply chain, such as larger processors and retailers who are looking to reduce their Scope 3 emissions by investing in emissions reduction projects within their value chains.

Taking the next step, businesses can invest in insetting, undertaking emissions reduction or removal projects within their own operations or direct supply chain (e.g., planting trees on-farm or supporting supplier adoption of methane-reducing practices). Insetting is increasingly seen as a mark of leadership and innovation, positioning a business as a first mover and allowing it to claim higher-integrity emissions reductions within its own value chain. For pork producers, this might include integrating silvopasture systems or collaborating with supply chain partners on low-emissions feed. See Section 2.6.3 for a case study on how UK supermarkets have collaborated to inset within their value chain.

Example initiatives:

- Planting trees or establishing silvopasture systems
- Supporting feed suppliers to adopt low-emissions practices (e.g., applying manure fertiliser instead of synthetic fertiliser, subject to government regulations)

Takeaways:

Pork producers who invest in insetting can differentiate themselves, strengthen supply relationships, and future-proof their operations. Brands that facilitate insetting within their supply chain enhance the credibility of their climate claims and improve resilience.

6.4 Level 4 - Measure, Reduce, Inset and Offset

Why do it? Offsetting may be necessary for certification or to meet specific customer requirements but should only be pursued after all practical reduction and insetting options have been exhausted.

Who should do it? Organisations who want to make company-wide carbon neutral claims or sell carbon neutral products. These typically would be at a pork brand level.

The last level of engagement involves offsetting any remaining emissions by purchasing high-integrity carbon credits from outside the value chain. While this approach is more common for food brands seeking carbon-neutral certification or making consumer-facing claims, it is less relevant for primary producers unless a brand partner is funding the offsets. For most pork producers, offsetting is costly and delivers little direct value unless required by a customer or certification scheme.

For others in industry, offsetting is increasing seen as an inauthentic manner to lower emissions. The first approach should be collaborating with others in supply chain and investing to avoid emissions there and if carbon neutral is the goal, to use offsets as a last resort.

Example initiatives:

- Purchasing high integrity carbon credits for any remaining emissions

Takeaways:

For most pork producers, offsetting is only worthwhile if required by a customer or for carbon neutral certification, as it can be costly with limited direct benefit. Brands should use offsetting strategically, ensuring it complements, rather than replaces, genuine on-farm and supply chain action.

7

Conclusion

7 Conclusion

The journey toward carbon neutral pork production is both a formidable challenge and an important opportunity for the Australian pork industry. Over the past four decades, producers have achieved an impressive 74% reduction in emissions intensity, driven by advances in herd productivity, precision feeding, improved manure management, and smarter resource use. These gains have not only cut environmental impacts but also enhanced operational efficiency and set a strong foundation for future action.

Yet, the landscape is evolving rapidly. Mandatory climate disclosure, commencing in 2025, signals a fundamental shift, requiring robust measurement, transparent reporting, and clear progress on emissions avoidance and reduction. Major retailers, financial institutions, and customers now expect detailed and auditable data across Scopes 1, 2, and 3, and increasingly favour suppliers who demonstrate real reductions, rather than just reporting or offsetting.

The report outlines a structured four-level approach, Measure, Reduce, Inset, and Offset, that underpins credible decarbonisation. At every stage, examples are provided for actionable steps:

- **Measurement:** Adoption of emissions tracking tools and systematic data collection are now baseline requirements.
- **Reduction:** Actions like optimising feed conversion, reducing food and resource waste, investing in advanced manure and biogas systems, and embracing renewable energy are both environmentally and commercially smart.
- **Insetting:** On-farm carbon sequestration, tree planting, and collaborative supply chain projects deliver deep and tangible reductions, reflecting rising expectations from both buyers and regulators.
- **Offsetting:** High-quality carbon credits from outside the value chain may have a role, but only as a last resort, following aggressive emissions avoidance and insetting within the value chain.

The hypothetical scenario of a 500-sow conventional farm demonstrates that integrating these strategies can reduce on-farm emissions significantly and even further with carbon sequestration initiatives. The largest levers remain upgrading manure management (e.g., covered anaerobic ponds), feed optimisation, animal health gains, and the circular reuse of nutrients and energy.

Risks of greenwashing, regulatory uncertainty, and consumer scrutiny are highlighted throughout the report, cautioning producers to back any sustainability claim with genuine, transparent progress, in line with ASIC and ACCC guidance. Controversies around carbon neutral certification and the future of schemes like Climate Active reinforce the need for credible, data-driven action rather than “badge only” solutions.

The report also acknowledges broader business drivers: tightening market access, carbon border adjustment mechanisms, green finance eligibility, and social licence to operate all increasingly hinge on climate performance. Early measurement and abatement efforts, especially in feed, manure

management, and energy, are crucial to preserving competitiveness, accessing growth opportunities, and reducing risk.

However, this transition is not just about compliance. It is about unlocking new value: operational savings, stronger supply chain partnerships, and brand leadership in a rapidly changing food system. Collaborative supply chain models, such as shared investment in on-farm improvements and carbon insetting, offer blueprints for shared success.

In summary, the path ahead is clear and within reach. By prioritising systematic measurement, deep operational abatement, innovative insetting, and limited offsetting, Australian pork producers can secure their place in global markets, meet rising stakeholder expectations, and leave a lasting legacy of sustainability and resilience.

8 References & Appendix

8.1. References

Adenot, T., Briere, M., Counathe, P., Jouanneau, M., Le Berthe T. & Le Guenedal, T. (2022). *Cascading effects of carbon price through the value chain: impact on Firm's valuation.* Amundi Investment Solutions. https://research-center.amundi.com/article/cascading-effects-carbon-price-through-value-chain-impact-firm-s-valuation

Aither & Beanstalk AgTech. (2021). *Sustainably produced food: opportunities for Western Australia. A Summary Report prepared for Department of Primary Industries and Regional Development.* https://www.agric.wa.gov.au/sites/gateway/files/DPIRD%20AITHER%20Sustainably%20produced%20food_final%20summary%20report_2021.pdf

Australian Government The Treasury. (2023). *Policy Impact Analysis: Climate-related financial disclosures.* https://treasury.gov.au/sites/default/files/2024-01/c2024-466491-pia.pdf

Australian Pork Limited. (2022). *Low GHG Emission Roadmap* (Version 3). Retrieved from https://australianpork.com.au/sites/default/files/2022-05/031722%20-%20APL%20-%20Low%20GHG%20Emission%20Roadmap%20-%20V3.pdf

Australian Pork Limited. (2023). *Life Cycle Assessment for the Pork Industry*. https://australianpork.com.au/sites/default/files/2024-05/1285%20APL%20LCA%20Project%20Report%20-%20FINAL.pdf

Bain & Company. (2023). *Press release - Consumers say their environmental concerns are increasing due to extreme weather; study shows they're willing to change behavior, pay 12% more for sustainable products.* https://www.bain.com/about/media-center/press-releases/2023/consumers-say-their-environmental-concerns-are-increasing-due-to-extreme-weather-study-shows-theyre-willing-to-change-behavior-pay-12-more-for-sustainable-products/

Brown., S. & Nuttall, R. (2020). Why ESG is here to stay [Audio podcast]. McKinsey & Company. https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/why-esg-is-here-to-stay

Coles Group Limited. (2024) *Sustainability Report.* Retrieved from: https://www.colesgroup.com.au/FormBuilder/_Resource/_module/ir5sKeTxxEOndzdh00hWJw/file/Sustainability_Report.pdf

Deloitte Center for Financial Services. (2022). *Ingraining sustainability in next era of ESG investing*. https://www2.deloitte.com/content/dam/insights/articles/us154481_cfs-the-next-era-of-esg-investing-sustainability-at-the-core/DI_The-next-era-of-ESG-investing.pdf

Devine, K. & Moberg, E. (2023). *Reducing Greenhouse Gases with Incentives at the Farm: How companies are moving from setting climate targets to delivering on them*. World Wildlife Fund. https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/4u5n95bhrj_5b9pj28bm3_GHG_Incentives_8_10.pdf

Diaz-Rainey, I., Griffin, P. A., Lont, D. H., Mateo-Márquez, A. J., & Zamora-Ramírez, C. (2024). Shareholder activism on climate change: Evolution, determinants, and consequences. *Journal of business ethics*, *193*(3), 481-510. https://doi.org/10.1007/s10551-023-05486-x

Environmental Protection Authority. (2020). *Environmental Factor Guideline: Greenhouse Gas Emissions*. Western Australian Government.

https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/EFG%20-%20GHG%20Emissions%20-%2010.04.2020.pdf
Exposure Draft: Treasury Laws Amendment Bill 2024: Climate related financial disclosure. https://treasury.gov.au/sites/default/files/2024-01/c2024-466491-leg.pdf
Fenech, C., Walton, B. & Majury, A. (n.d.) *The Sustainable Consumer*. Deloitte. https://www.deloitte.com/uk/en/Industries/consumer/perspectives/the-sustainable-consumer.html
Marti, E., Fuchs, M., DesJardine, M., Slager, R. & Gond, J. (2023*). A More Impactful Strategy for Sustainable Investing*. Harvard Business Review. https://hbr.org/2023/09/a-more-impactful-strategy-for-sustainable-investing
McKinsey & Company & NielsenIQ. (2023). *Report - Consumers care about sustainability – and back it up with their wallets*. Retrieved from https://nielseniq.com/wp-content/uploads/sites/4/2023/02/Consumers-care-about-sustainability%E2%80%94and-back-it-up-with-their-wallets-FINAL.pdf
Perez, L., Hunt, D. V., Samandari, H., Nuttall, R. & Biniek, K. (2022*). McKinsey Quarterly: Does ESG really matter – and why?*. https://www.mckinsey.com/capabilities/sustainability/our-insights/does-esg-really-matter-and-why
Reuters. (2024). Denmark will be first to impose a CO2 emission tax on farms. *Fast Company*. https://www.fastcompany.com/91146039/denmark-will-be-first-impose-co2-emission-tax-farms
UN Environment Programme – finance initiative. (2024). *Net Zero Banking Alliance Commitment*. https://www.unepfi.org/net-zero-banking/commitment/
Woolworths Group. (2023). *Woolworths Group Sustainability Plan 2025*. Retrieved from: https://www.woolworthsgroup.com.au/content/dam/wwg/sustainability/documents/sustainability-plan/Woolworths_Group_Sustainability_Plan_2025_v2.0_2022.pdf?ref=csofutures.com
Z. Hanna. (2024) World's first carbon tax on livestock will cost farmers $100 per cow. *CNN Business.* https://edition.cnn.com/2024/06/26/business/denmark-cows-carbon-tax/index.html

8.2. Appendix

8.2.1. Feasibility of developing a Carbon Neutral Pork brand

Developing a carbon-neutral pork brand is a strategic decision that requires careful consideration of both environmental impact and commercial viability. For organisations, the investment in carbon neutrality must yield tangible benefits that outweigh the associated costs.

Benefits of a Carbon Neutral Pork Brand

Developing a carbon-neutral pork brand offers several benefits including market differentiation, premium pricing, enhanced brand reputation, improved regulatory preparedness, supply chain resilience and helps unlock access to green financing.

Table 12. Benefits of developing a carbon neutral product

Benefits	Explanation
Market Differentiation	Attract environmentally conscious consumers and gain a competitive edge in domestic and international markets.
Premium Pricing	Potential to charge higher prices for carbon-neutral products, especially in premium markets.
Brand Reputation	Enhances brand image and demonstrates leadership in sustainability.
Regulatory Preparedness	Future-proofs the business against potential carbon taxes or stricter emissions regulations (e.g., Carbon Border Adjustment Mechanisms).
Supply Chain Resilience	Strengthens partnerships with retailers and suppliers by meeting sustainability expectations.
Access to Green Financing	Eligibility for green loans or incentives tied to sustainability initiatives.

Challenges of developing a carbon neutral pork product

However, there are several considerations that must be taken into account before proceeding with the development of a carbon neutral pork product.

Table 13. Challenges of developing a Carbon Neutral Pork Product

Challenge	Explanation
Cost-of-living pressures	Consumers are prioritising affordability over sustainability. In the UK outdoor-bred pork is seeing an 11% volume reduction year-on-year due to price increases.[1]
Regulatory complexity	Applying for and complying with the Emissions Reduction Fund (ERF) to access Australian Carbon Credit Units (ACCUs) is complex and costly, especially for smaller producers.
Measurement and reporting	Additional costs may arise from measuring and reporting on-farm emissions to comply with potential future regulations.[2] Mandatory climate-related financial disclosures are already in effect as of 1 January 2025 for larger entities that meet certain criteria see footnote 31.
Brand Risks	Failure to meet expectations for genuine emission reductions (relying too heavily on offsets) could damage brand reputation.

Note: [1]From 'Consumer desire for outdoor bred pork hindered by cost-of-living crisis' by AHDB, 2023. (https://ahdb.org.uk/news/consumer-insight-consumer-desire-for-outdoor-bred-pork-hindered-by-cost-of-living-crisis)
[2]From 'The Australian pork industry: Understanding climate change impacts' by Australian Government Land & Water Australia: Climate Change Research Strategy for Primary Industries, n.d. (https://crspi.com.au/wp-content/uploads/australian-pork-industry-understanding-climate-cha.pdf)
[3]From 'Mandatory climate-related financial disclosures' by Australian Government: The Treasury, n.d. (https://treasury.gov.au/sites/default/files/2024-01/c2024-466491-policy-state.pdf)

Marketing Considerations

Successfully marketing a carbon neutral pork brand requires addressing consumer perceptions, pricing challenges, and strategic positioning. Outlined below are several key considerations:

- **Consumer Understanding:** Consumers may not understand terms like "carbon neutral", "climate neutral" and "net-zero". Clear communication is essential to differentiate the product and educate consumers about what "carbon neutral" means in the context of pork production.
- **Pricing Strategy:** A carbon neutral pork brand may appeal to higher-income or environmentally conscious segments willing to pay a premium, but this market may shrink during economic downturns. Coles strategically paired its carbon-neutral brand with an already premium pork product i.e., free-range for consumers who already have a higher willingness to pay and prioritise both sustainability and quality.
- **Branding Strategy:** Creating an entirely new carbon neutral line allows for a fresh narrative but requires significant investment in branding and marketing. Storytelling is a critical element to share the journey of achieving carbon neutrality to increase transparency and trust in the sustainability claims.

Current Climate challenges

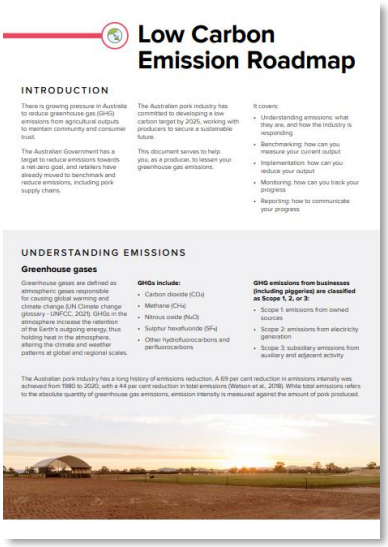
The current economic and political climate presents complex challenges for companies considering the development of carbon-neutral pork products. Cost-of-living pressures have markedly influenced consumer purchasing behaviour, with many prioritising affordability over sustainability despite strong intentions to choose sustainably produced goods. Concurrently, the shift in U.S. climate policy under a new administration in 2025 has created uncertainty for corporations regarding their sustainability commitments. While these challenges are a deterrent from pursuing fully carbon-neutral pork products in the short term, there remain viable strategies for enhancing sustainability which are explored in the following section.

Developing a carbon-neutral pork brand is only one aspect of a larger value proposition for implementing sustainability initiatives on-farm. Reducing GHG emissions offers broader benefits beyond branding such as driving cost savings and increases in productivity and profitability.

Integrating sustainability with profit-driven strategies can reduce costs, improve efficiency, and move closer to net-zero without the need to rely on profits from premium pricing on carbon neutral

pork products. The next section explores key GHG mitigation strategies that deliver both sustainability and financial benefits.

8.2.2. Low emission resources

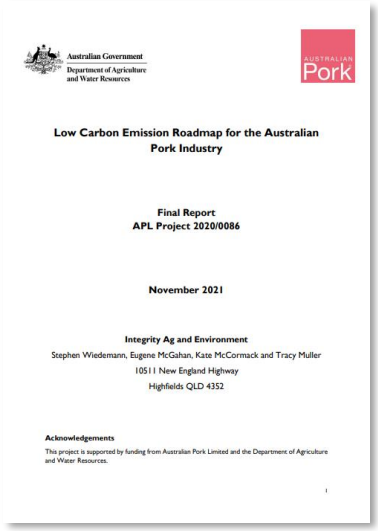

Low Carbon Emission Roadmap

INTRODUCTION

UNDERSTANDING EMISSIONS

Greenhouse gases

[Auastralian Pork Limited – Low Carbon Emission Roadmap (2022)]


Australian Government
Department of Agriculture and Water Resources

Low Carbon Emission Roadmap for the Australian Pork Industry

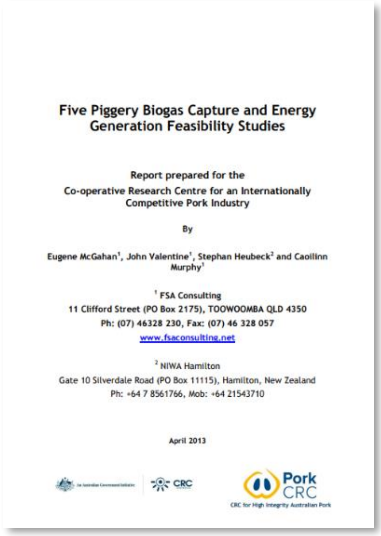
Final Report
APL Project 2020/0086

November 2021

Integrity Ag and Environment
Stephen Wiedemann, Eugene McGahan, Kate McCormack and Tracy Muller
10511 New England Highway
Highfields QLD 4352

Acknowledgements

[Australian Pork Limited – Low Carbon Emission Roadmap for the Australian Pork Industry (2021)]


Five Piggery Biogas Capture and Energy Generation Feasibility Studies

Report prepared for the
Co-operative Research Centre for an Internationally Competitive Pork Industry

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[Pork CRC – Five Piggery Biogas Capture and Energy Generation Feasibility Studies (2013)]

8.2.3. Solar Case Studies

Westpork, WA

Westpork, the largest pig producer in Western Australia, has made significant strides in renewable energy adoption by installing a 360 kW solar panel system across its multiple intensive farming sites, including Serpentine, Mindarra, and Gingin. The installation, managed by Advanced Energy Resources (AER), currently supplies about 20% of the company's electricity needs, resulting in a 15% reduction in energy costs. It has plans to expand its renewable portfolio with 1.8 MW of wind power and battery storage, aiming to eventually meet 100% of its energy requirements from renewable sources. While the exact pig herd size is not specified, Westpork's operations are among the largest in the state, and this investment demonstrates the scalability and impact of solar energy in large-scale, intensive pig farming.

Merivale Farms, QLD

Merivale Farms, located in Queensland's Southern Downs region, has invested in a 39.36 kW ground-mounted solar PV system with two 15 kW inverters to power its intensive pig farming operations. Although the exact herd and farm size are not specified, the solar installation, combined with a switch to LED lighting, paid for itself within two years. The farm has seen a significant

reduction in energy costs and has been able to shift to a more favourable electricity tariff, further increasing savings. Merivale Farms is also planning to convert its main water bore to solar power, which will provide additional operational efficiencies and cost reductions.

Figure 30. Installation of a 39.36 kW ground mounted solar system with a 2 x 15 kW inverters. Source: Queensland Farmers' Federation, n.d.

McIvor Farm Foods, VIC

McIvor Farm Foods, a regenerative free range pig farm in central Victoria, has embraced solar technology to support its sustainable farming model. The farm, which runs about 150 sows and produces around 2,000 pigs per year on 200 hectares, has installed a 15 kW solar PV system with battery storage for its cool storage and farm shop, and an additional 22.5 kW system for its new butchery facility. Supported by the Victorian Government's Agriculture Energy Investment Plan, McIvor Farm also uses mobile, trailer-mounted solar water pumps to provide reliable water for livestock. These investments have led to a sharp decline in grid electricity use, improved water security, and a significant reduction in on-farm petrol use.

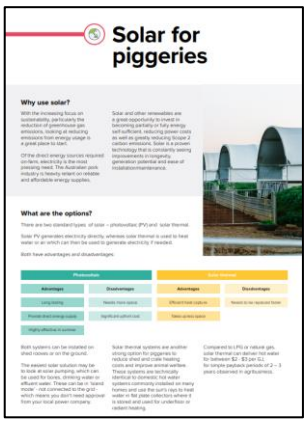
Figure 31 Mobile solar panels, mounted on a trailer at McIvor Farm Foods. Source: Energy Smart Farming, 2023

Darling Downs Piggery, QLD

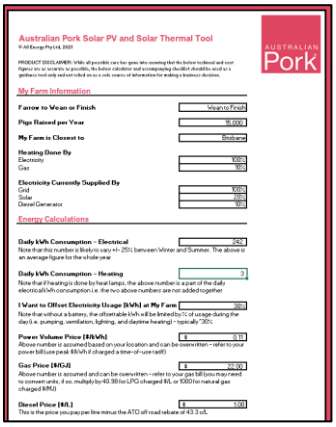
A large piggery in Queensland's Darling Downs region, with a herd of over 9,000 pigs, has implemented a range of renewable energy and efficiency upgrades, including solar power. While the specific size of the solar installation is not detailed, the farm's energy audit identified extensive opportunities for solar and other renewables, leading to projected annual cost savings of $57,460. The upgrades have resulted in a 48% reduction in energy use and an annual emissions reduction of 196 tonnes of CO_2-equivalent. This case demonstrates how even large, year-round intensive pig operations can benefit significantly from investing in solar and energy efficiency measures.

Key Solar Resources:

Clean Energy Council – Australian Guide to Agrisolar for Large-Scale Solar: For proponents and farmers



Australian Pork Limited – Solar for Piggeries Fact Sheet



Australian Pork Limited – Australian Pork Solar PV and Solar Thermal Tool

8.2.4. Tree Planting Case Studies

Blantyre Farm

Blantyre Farm, located near Young in New South Wales, stands out in Australian agriculture for its innovative and impactful sustainability practices. Known for its combination of broad-acre cropping and intensive piggery operations, the farm has implemented a range of significant environmental initiatives that distinguish it from the average pork producer. Each year, Blantyre Farm repurposes approximately 8,000 tonnes of food waste as animal feed, effectively diverting waste from landfill and reducing feed costs. Through the conversion of pig manure into biogas, the farm meets all of its electricity needs and even supplies surplus energy to the grid, while simultaneously generating carbon credits by destroying methane, a potent greenhouse gas. Collectively, these strategies have led to a 95% lower environmental footprint compared to typical Australian pork producers and have resulted in the removal of about 65,000 tonnes of CO_2 from the atmosphere. The remaining solid

effluent after biogas extraction is used as a carbon-based fertiliser for grain production, reducing reliance on synthetic fertilisers and fostering soil health. These sustainability measures not only shield the business from grain price fluctuations and contribute to reduced input costs but have also earned Blantyre Farm industry awards, recognising its leadership in environmental performance.

Cobram Estate Olives

Cobram Estate Olives' approach included detailed measurement, strong commitment to emissions reduction, and multiple carbon credit projects within the supply chain (insetting).

Cobram Estate Olives conducted two Life Cycle Assessments (LCAs), showed that they capture more carbon than they emit to grow, produce and market their extra virgin olive oil. For every 1 litre of olive oil, they sequester 4kg CO_2 –e. In total, they planted over 200 ha of trees in Victoria, using mixed natives planted in strategic locations, project registered with the Emissions Reduction Fund to generate ACCUs.

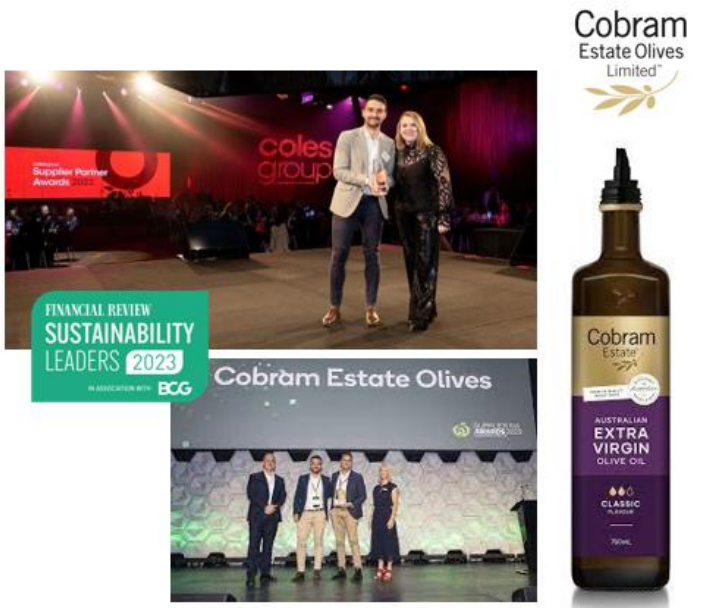


Figure 32. Cobram Estate Olives won multiple sustainability awards from Coles and Woolworths, and named as Financial Review x BCG's Sustainability Leader 2023. Source: Cobram Estate Olives, n.d.

On top of this, they registered a carbon credit project via the international Verra carbon regulator and use a methodology for GHG removals as part of the agricultural farming system, including soil carbon. Other zero waste initiatives include olive pits used as renewable energy, remaining flesh used as fertiliser and stock feed, pruned branches are mulched and used as soil amendment to reduce chemical fertiliser requirements. Cobram Estate Olives' transparency and communication on its environmental efforts have been lauded by industry and customers.

It can be prudent to formally accredit carbon insetting activities to create carbon credits. Carbon insetting programs can bring a host of other benefits beyond emission reduction alone.

8.2.5. Biogas Case Studies

BettaPork, QLD

BettaPork, operated by the Brosnan family in Queensland, is recognised as a leader in sustainable pork production, having installed a pioneering biogas plant in 2015. The system consists of two three-million-litre anaerobic digesters that process around 120,000 litres of organic waste daily, including pig manure and food industry by-products. The methane produced is filtered and used to power two 100 kW biogas engines and a later-added 360 kW engine, together supplying up to 200 kW of electricity, enough to meet the farm's entire energy demand for a night and half a day, including all housing on site.

The installation, supplied by Evo Energy Technologies, allows BettaPork to significantly reduce its energy costs, saving hundreds of thousands of dollars annually, and to export surplus power to the grid. The farm also partners with local schools, abattoirs, and restaurants to process additional organic waste, further enhancing its environmental credentials and reducing landfill contributions. The Brosnan family continues to innovate, with plans for further expansion towards complete energy self-sufficiency.

Figure 33. EvoET's 2G Filius and 2G Agenitor CHP solution for BettaPork. Source: Evo Energy Technologies, n.d.

Blantyre Farms, NSW

Blantyre Farms, a large mixed farming enterprise near Young, NSW, has become a leader in sustainable pork production by integrating biogas and solar energy into its operations. With a herd size ranging from 22,000 to 40,000 pigs, Blantyre uses covered effluent ponds to capture methane, which is then used to generate electricity through biogas generators installed by Quantum Power. While the specific size of the solar installation is not detailed, renewable energy is central to the farm's operations, making it energy self-sufficient and even allowing it to sell excess power back to the grid. The biogas system paid for itself within three years, saving the farm $350,000 annually on power and gas and generating an additional $68,000 per year from electricity sales. Blantyre Farms has also achieved a 95% lower environmental footprint compared to the industry average due to its innovative approach to energy and waste management.

Westpork, WA

Westpork, Western Australia's largest pork producer, is undertaking a major transition towards 100 per cent renewable energy across its operations. At its new Moora piggery complex, designed for up to 68,000 pigs, Westpork is installing a hybrid renewable energy system comprising covered anaerobic ponds for biogas capture, alongside substantial solar and wind generation and battery storage. The biogas system will process effluent from two modules, each with 24 sheds, and is designed to capture and flare methane, significantly reducing odour and greenhouse gas emissions.

Advanced Energy Resources is leading the renewable energy integration, which will ultimately supply all of the site's electricity needs. Westpork's existing solar installations already provide 20 per cent of its power, with the new hybrid system expected to deliver major cost savings, energy security, and a substantial reduction in the company's environmental footprint.

SunPork (QLD, SA, NSW, VIC)

SunPork is Australia's largest fully integrated pork producer, operating across multiple states with more than forty farms and five biogas facilities. The company's biogas plants convert methane from piggery effluent into electricity, generating approximately 5.7 GWh annually. In cooler months, this can supply over 20 per cent of the energy demand at some sites.

SunPork's sustainability strategy includes using a wide range of agricultural by-products as pig feed, further reducing waste. The group's investment in biogas infrastructure not only lowers operational energy costs but also significantly reduces greenhouse gas emissions. SunPork continues to focus on expanding its renewable energy generation and improving water efficiency, setting a benchmark for large-scale, environmentally responsible pork production in Australia.

JBS (formerly Rivalea, NSW)

JBS Australia is a leading integrated agrifood company and a pioneer in the application of biogas technology within the Australian pork industry. The company operates three covered anaerobic ponds across its sites, capturing methane from piggery effluent and converting it into energy via advanced combined heat and power (CHP) units.

The flagship installation includes three 2G Avus 500plus CHP units, each delivering 500 kW of electrical and thermal output, together supplying around 25 per cent of the site's total energy needs. The biogas project, delivered in partnership with Evo Energy Technologies and 2G Energietechnik AG, boasts energy efficiencies of up to 90 per cent and offsets over 28,000 tonnes of CO_2-equivalent emissions annually. Since 2012, Rivalea has avoided more than 120,000 tonnes of CO_2-equivalent emissions, achieved substantial energy cost savings, and set an industry standard for sustainable farming and environmental stewardship.

A look into a Fully Funded Covered Anaerobic Digesters Provider: Gate46

Gate46 is an Australian company pioneering the deployment of fully funded Covered Anaerobic Digesters (CADs) tailored for the dairy and broader agribusiness sectors. Unlike traditional biogas projects that require significant upfront investment from farmers, Gate46's model removes capital expenditure entirely, offering a zero-capex solution. The company manages the entire process, from

procurement and installation using local suppliers and contractors, to ongoing maintenance and equipment replacement. This ensures seamless integration and minimal disruption for farm operations.

The CAD systems provided by Gate46 are designed to capture methane from farm waste, converting it into renewable energy in the form of heat and electricity. At larger facilities, this energy can be used for on-site heating and cooling, as well as generating electricity to power farm operations, thereby reducing reliance on external energy sources and lowering operational costs. Additionally, the process yields valuable by-products such as nutrient-rich compost and enables full water recapture, further enhancing farm sustainability.

A key benefit of the Gate46 approach is the generation of Australian Carbon Credit Units (ACCUs). These credits provide an additional revenue stream for participating farms, as the system is fully compliant with both state and federal carbon credit schemes. The aggregated model employed by Gate46 leverages economies of scale, driving down costs and increasing accessibility for farms of various sizes.

Beyond environmental benefits, such as significant reductions in carbon emissions and odour, Gate46's CADs support the financial viability of agricultural businesses by improving wastewater management, stabilising energy supply, and boosting the bottom line. By handling all aspects of the project and ensuring compliance with regulatory frameworks, Gate46 enables Australian agribusinesses to adopt biogas technology with minimal risk and maximum benefit.

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