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SUSTAINABLE FOOD PRODUCTION IN AUSTRALIA

This whitepaper outlines the opportunities for Danish Innovation and Technology in the food production industry in Australia towards 2030.

Sustainable Food Production in Australia
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Editor in Chief
Trade Council of Denmark in Australia Trade Council (um.dk)
Senior Trade Advisor, Dorothy Dellosa
Email: dordel@um.dk

Co-Editor: Maria Ingvardsen

Co-Author
The EcoEfficiency Group ecoefficiencygroup.com.au

Technical Consultants
Danish Technological Institute (DMRI) dti.dk
Au2mate Au2mate.com
NIRAS niras.com

Collaboration Partners and Advisory Support

- Food & Fibre Gippsland foodandfibregippsland.com.au
- Food and Agribusiness Network (FAN) foodagribusiness.org.au
- Sustainability Victoria sustainability.vic.gov.au
- Latrobe Valley Authority lva.vic.gov.au
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- Australian Pork Limited australianpork.com.au

To order copies of this white paper or request information, please contact the Danish Trade Council in Sydney at sydhkt@um.dk

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EXECUTIVE SUMMARY

The Australian market for food and beverage processing is significantly growing and there is an increased demand for sustainable solutions. The food and beverage industry is one of the largest and most important sectors of the Australian economy, accounting for approximately 30% of the domestic manufacturing sales and service income. This $127 billion sector significantly contributes to the Australian economy and directly employs over 276,000 people with 108,000 of these jobs in rural and regional Australia. The industry is facing several challenges including climate change, inflation, and labour shortage and are therefore seeking greater efficiency that provides opportunities for circular solutions.

This white paper shares an insight of the Australian food and beverage industry, and the gaps and opportunities identified for a sustainable food production towards its 2030 goals. These findings were based on research, feasibility studies and market reports that features the need for the industry to optimise its manufacturing capabilities, increase its efficiency and how to achieve its Sustainable Development Goals (SDG 12 and 13). Essentially, it complements the feasibility study executed by the Trade Council of Denmark together with Danish consultants and technical experts from the Danish Technological Institute (Danish Meat Research Institute), Au2Mate and NIRAS.

Denmark has a strong record of accomplishment in resource optimisation and efficient production particularly in the dairy, meat, food and beverage sector. The Danish competencies on circular solutions like upgrading waste streams into valuable products and introduction of ways to reduce consumption of resources like water, energy and raw materials can be of great importance for the Australian food and beverage industry.

The following sections provide an overview of the Australian food and beverage sector, with a focus on the meat and dairy sectors and their respective sustainability targets along with the environmental challenges, sustainability drivers and funding opportunities.

AUSTRALIAN NATIONAL TARGETS

Net Zero Carbon Emissions and Renewable Energy Targets
The Australian Federal Government has mandated for a 43% reduction in carbon emissions by 2030 compared to 2005 levels. There are also varying renewable energy targets for electricity for each state including targets of 80% renewables by 2032 for Queensland, 95% by 2035 for Victoria and 100% by 2030 for South Australia.

Food waste
Australia has set a target to halve its food waste by 2030, aligning with the United Nation's Sustainable Development Goal (SDG) 12.3: "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses." In response to this, The Australian Dairy sector has produced the Dairy Food Waste Action Plan. Similarly, in meeting the Australian target, the meat sector is currently undergoing a process of mapping and determining quantities of losses across the supply chain and opportunities for improvement.

Packaging requirements
The Australian Packaging Covenant Organisation (APCO) is the organisation charged by government to facilitate the delivery of the National Packaging Targets which includes that by 2025 packaging must be:

- 100% reusable, recyclable or compostable.
- 70% of plastic packaging being recycled or composted.
- 50% average recycled content across all packaging (revised from 30% in 2020).
- The phase out of problematic and unnecessary single-use plastic packaging.

Participation in APCO is currently volunteering and requires individual company action plans which can be found on the APCO website – www.apco.org.au.

In December 2023, the Australian Government announced a $127 million investment in research centres to cut emissions in the agriculture sector and eliminate plastic waste.

Water consumption
There are no national targets regarding water consumption. Some local jurisdictions will have water restrictions depending on local conditions. Australia is undergoing a El Niño weather event which means drier and hotter weather and a trend towards drought conditions. Previous droughts have severely impacted Australian manufacturers with regulatory requirements to prepare water management plans and reduce overall water consumption e.g., the Millennium Drought which lasted from 2001 to 2009. Currently, preparation of such plans is voluntary or regulated depending on each Australian state/local region and the drought conditions. For example, Queensland currently has voluntary development of water management plans.

ENVIRONMENTAL AND INDUSTRIAL CHALLENGES

Australia is facing serious environmental challenges and are especially exposed to the rising sea levels and climate change affecting the coastal areas where 85% of the 25,7 million population are living. These areas are also the ones hosting the majority of the food production industry. In addition to the environmental challenges affecting the industry, it often struggles with labour shortages providing opportunities for implementation of efficiency measures. The greatest environmental challenges Australia and the food production industry are facing includes the following:

Climate change

- Australia's climate has warmed by an average of 1.48 ± 0.23 °C since national records began in 1910.
- Australia is facing drier and hotter weather, intensified heat waves, increase in the severity of bushfires, and trend towards drought conditions as the country is heading towards another El Niño. During the last El Niño in 2019, Australia recorded the hottest and driest conditions. This is primarily felt in eastern Australia, corresponding with the location of the meat and dairy sectors.

Water scarcity

Further to the above, water security is an issue for some meat processors, particularly those in regional towns with increasing population and where water infrastructure and supply is not keeping up with requirements.

Waste management issues

- Australian manufacturers in regional areas are challenged by the vast spaces and lack of waste management services. Often waste must be transported for long distances and this becomes cost prohibitive with the default technique to send wastes to landfill which could potentially be recycled or reused. Some recycling has been developed and new recycling streams are slowly coming on board. However, contamination with animal products can further complicate recyclability. Generally, the waste management services available in Australia are lacking or well behind that of Europe.

Energy generation

- Extreme environmental events as floods and bushfires damage the energy infrastructure and impact energy security. In order to abate climate change, Australia's electricity grid is transitioning to renewables (see targets in following section) and there are ongoing challenges for the National Electricity Market to manage the transition to ensure energy security, particularly with the closure of a number of coal-fired power stations. The size of Australia often means that large scale renewable projects are often located in remote regions and connection to the grid is expensive and takes time. In addition, the fluctuating gas and coal prices affected by international supply and demand creates price volatility for the energy market.

SUSTAINABILITY DRIVERS

REPORTING REQUIREMENTS

Climate-related Financial Disclosure

Mandatory climate reporting will commence in 2024 for Australia's largest companies and financial institutions. The requirements will be aligned with the International Sustainability Standards Board (ISSB) and the Taskforce for Climate-related Financial Disclosure (TCFD) and focus on core elements including governance, strategy, risk and opportunities and metrics and targets. The objective is to provide Australians and investors with greater transparency and accountability when it comes to their climate-related plans, financial risks and opportunities. The reporting requirements will include annual reporting on:

- Governance of climate-related risks and opportunities;
- Risks and opportunities;
- Emission reduction targets and use of offsets.

The current proposed timeframes for reporting are provided in the table below.

Table 2: Climate Related Financial Disclosure Reporting

Scope	Entities covered by the Australian Corporations Act 2001
FY24-25	Companies that meet at least two of three thresholds: >500 employees $1 billion or more in assets $500 million or more in revenue And those companies that are required to report under the National Greenhouse and Energy Reporting Scheme (NGERS).
FY26-27	Companies that meet at least two of three thresholds: > 250 employees $500 million or more in assets $200 million or more in revenue
FY27-28	Companies that meet at least two of three thresholds: > 100 employees $25 million or more in assets $50 million or more in revenue

Nature Related Financial Disclosure

In September, 2023, the Taskforce on Nature Related Financial Disclosure released recommendations and guidelines to help organisations with the identification, assessment, management and disclosure of their material nature-related issues. The overall objective is for organisations to take action to conserve and restore nature. Organisations will be required to report on the governance, strategy, risk and impact management and finally a set of appropriate metrics and targets for their sector.

SOCIAL LICENSE TO OPERATE

There is an ongoing driver for the Australian meat processing industries (red meat, pork, poultry) to maintain a social license to operate, particularly with respect to animal welfare; the contribution to greenhouse gas emissions and issues with competition for water supply, particularly in drought affected areas. Sustainability reporting and having a robust sustainability program is important to maintain this social license.

SUPPLY CHAIN PRESSURE

Many companies in the Australian meat processing and dairy industries are under pressure from their domestic supply chain to prove their sustainability credentials. The main Australian supermarkets, Coles and Woolworths and to a lesser extent Aldi, have their own sustainability targets such as emissions reductions and providing more sustainable products, and they are pushing this down their supply chain. Changes such as employing reusable boxes to transport meat products instead of cardboard boxes help reduce waste along the supply chain. Upcoming Climate Related Financial Disclosure Reporting will also put pressure across supply chains to be reporting on greenhouse gas emissions and developing Net Zero Plans.

CARBON BORDER ADJUSTMENT MECHANISM

The Carbon Border Adjustment Mechanism, or CBAM for short, is an EU measure that imposes a levy on imports of carbon-intensive goods. It will eventually require all goods imported into the EU to fulfil the climate standards that apply in all 27 member states. The phased implementation of CBAM began in October 2023, and initially targets hard-to-abate sectors such as cement, iron and steel, aluminium and fertilisers. The list is due to be reviewed in 2026 when agriculture is likely to be added which will then impact meat and dairy export companies.

BRISBANE OLYMPICS

The 2032 Olympics will be held in Queensland, Brisbane as the host city and with the surrounding regions like Sunshine Coast and is being billed as the first climate positive Olympic games. There is a requirement for companies supplying products or services to the Olympic games to be already carbon neutral or on the path to Net Zero Emissions, thereby affecting all industries that cater to the Olympics to implement sustainability measures. It is therefore expected that the Brisbane Olympics will increase demand for and investment in sustainable solutions and products in Queensland.

FOOD AND BEVERAGES

The combination of food and grocery manufacturing forms Australia's largest manufacturing sector, it represents 31.4% of the total manufacturing turnover in Australia. The industry employs more than 274,800 Australians, representing 32.2% of the total manufacturing employment in Australia.

Australian Food and Grocery Council

The Australian Food and Grocery Council (AFGC) whose vision is to increase the industry value to nearly $250 billion by 2030. The AFGC has three overarching policy streams which are Competitiveness and Growth, Nutrition and Regulation, and Sustainability. AFGC seeks to:

- Balance environmental, community and industry needs.
- Consider whole of supply chain environmental impacts.
- Develop a circular economy and assist in meeting federal government targets for halving food waste, National Packaging Targets and adopting the Australian Recycling Label.
- Assist in meeting federal government targets for carbon reduction (Net zero by 2050) with some AFGC members exceeding those targets.

Based from the AFGC 2021-2022 Pre-Budget Submission, the industry has a global reputation for high quality and safe products but currently constrained by:

- Declining international competitiveness
- Declining productivity growth
- Stagnant investment

In the latest AFGC report, Sustaining Australia Food and Grocery Manufacturing 2030, highlights the need to ensure resilience in Australia's domestic manufacturing capability, as well as to ensure sustained economic growth. It pointed out that this will not happen without intervention and a strategic approach with the ongoing risk of offshoring food and grocery manufacturing and importing increasing levels of high value-added food and grocery products into the country. Individual member companies have their own company goals and targets. The AFGC list of members: https://www.afgc.org.au/about-afgc/associate-member-directory

Australian Beverages Council Ltd

The Australian Beverages Council Ltd also advocates for beverage (non-alcoholic) companies and seeks to support companies in meeting the Australian Government Sustainable targets. ABCL has particular focus in circular economy, packaging standards, kerbside collection and container deposit schemes, and the challenges around the collection and recycling of beverage packaging.

MEAT PROCESSING

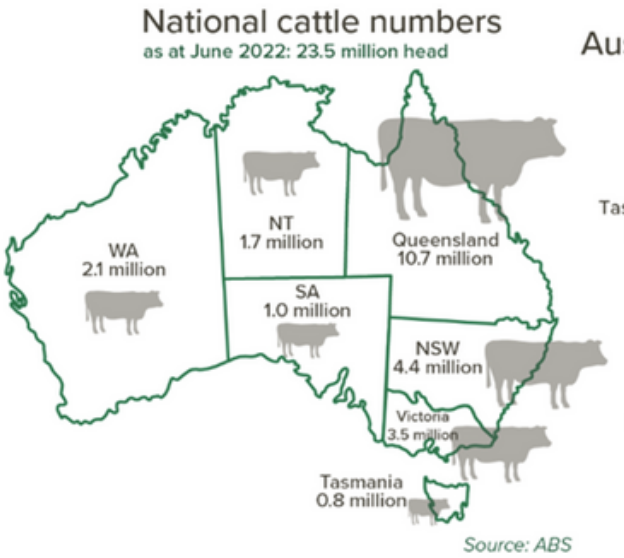
INDUSTRY OVERVIEW

Red Meat Processing

Australia has 110 red meat processors and 140 processing plants which were estimated to generate more than A$21 billion in industry value add during 2020-21. Key organisations in the red meat processing sector are Meat and Livestock Australia (MLA) and the Australian Meat Processing Corporation (AMPC). According to the AMPC Annual Report 22/23:

According to the Australian Butchers Guild, Australia is home to around 300 abattoirs (including boning rooms), with a workforce of around 34,600 people. This includes all red meat (beef, sheep, goat and kangaroo) as well as pork and poultry.

- As the 4th largest beef exporter (after Brazil, India and the USA), Australia produces 4% of global beef production and accounts for about 16% of world trade with about 70% of total beef produced exported.
- Australia was the largest sheep and goat meat exporter in 2022.
- 70% percent of processors are located in the Eastern states, Figure 1, primarily in medium-sized rural communities of between 10,000 to 50,000 people, where they are typically one of the largest employers.
- Industry Park and Teys Australia are the two largest employers (Table 1).



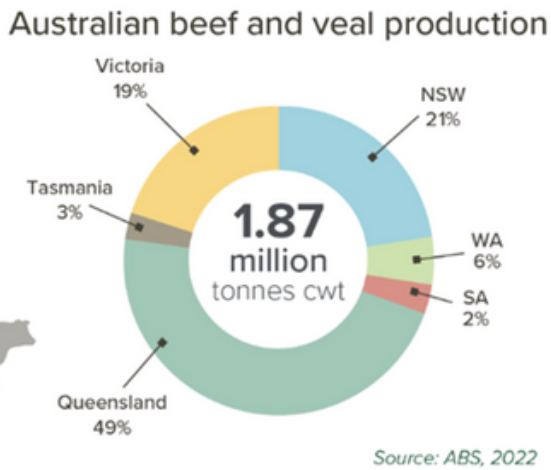


Table 1: Major Players in Australia's red meat processing sector

Rank	Company	Employees
1	Industry Park Ltd (JBS Australia and Australian Consolidated Food Investment)	12,926
2	Teys Australia	4,265
3	Thomas Foods International	1,987
4	NH Foods Australia	1,375
5	Australian Country Choice (ACC)	1,250
6	Kilcoy Pastoral Co. Ltd	1,064
7	Northern Co-operative Meat Co. (NCMC)	1,000
8	Yolamo Pty Ltd	900
9	Fletcher International Exports	808
10	Midfield Meat International	670
11	WA Meat Marketing International Co-operative (WAMMCO)	414
12	Craig Mostyn Group	533
13	Nolan Meats Pty Ltd	352
14	Australian Agricultural Co. Ltd (AACo)	423
15	M C Herd Pty Ltd	375

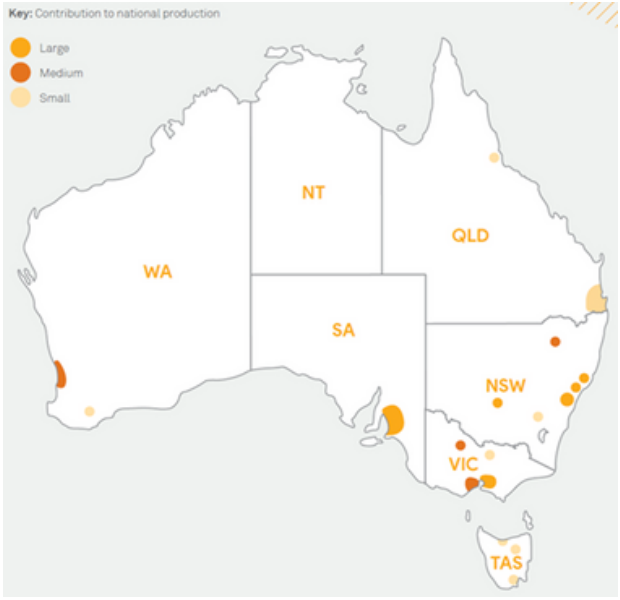
Pork Processing

There are 75 pig processors in Australia which includes 7 exporters processing 85% of Australian pigs. In 2022/23, the industry contributed $5.5 billion and employed about 36,000 people. Key pork processors in Australia include JBS / Rivalea, SunPork, and Linley Valley. Of the total pig herd of 2.2 million animals, 27% is located in Queensland followed by Victoria (24%), NSW (19%), WA (15%), SA (14%) and Tasmania (0.4%).

Poultry Processing

The Australian chicken meat industry contributes significantly to the economy, with an estimated gross value of production (2021-22) of $2.97 billion and an estimated retail value of $6.6 billion. The industry provides jobs for more than 58,000 people, many in rural and regional communities. The two largest integrated chicken producers in Australia are Baiada Poultry and Inghams Enterprises which supply approximately 70% of Australia's meat chickens. The balance of the market is supplied by several medium-sized and some smaller companies. Annual domestic chicken consumption is more than 50kgs per person. Figure 2 shows the major chicken production regions in Australia.

Figure 2: Major chicken production regions. Source: AgriFutures Chicken Meat Program RD&E Plan 2022-2027



INDUSTRY TARGETS

The following section presents goals and targets for the red meat processing, pork and poultry industries. Progress on the targets and resource intensity figures for these sectors are provided in the Appendix.

Read meat processing

The Australian Red Meat Processing Industry has set the following targets and vision:

- To be carbon neutral by 2030. This means that by 2030, Australian beef, lamb and goat production, including lot feeding and meat processing, aim to make zero net release of greenhouse gas (GHG) emissions into the atmosphere.
- By 2030, Australian processors are recognised as global leaders in environmental stewardship and acknowledged as responsible businesses with positive economic and social impacts on their communities.

The AMPC Strategic Plan 2020-25 highlights the following targets compared with pre-2020 levels:

- A further 10% reduction in energy intensity by 2025 through energy efficient practices and technologies.
- 100% renewable energy use by 2030.
- 50% (by throughput) measured plant annual energy and water use, with de-identified public portal reporting by 2025.
- Five feasible piloted alternatives to grid gas and fossil fuel use by 2025.
- A further 5% reduction in water intensity by 2025 through water efficient practices and technologies.
- 50% (by throughput) annual demonstration of best practice water stewardship by 2025.
- 50% adoption (by throughput) of advanced water-recycling by 2030.
- A further 50% reduction in solid waste to landfill by 2030.

Five feasible piloted alternatives for solid/liquid waste treatment and recycling and elimination of avoidable contaminants by 2025.

Pork Processing & Pig Farming

Goals for the Australian Pork Industry are to:

- Achieve climate friendly farming;
- Be carbon positive and zero waste by 2025;
- Be recognised as animal welfare leaders.

Key environmental targets for the industry are to be a low emissions protein with a target of 1kgCO2-e per kg of pork (2020 estimates put pork at 3.3 kgCO2-e per kg). Another target is to have 60% of production using waste recycling and renewable energy technology. In February 2022, over 20% of production was carried out with biodigesters that reduce methane emissions and the industry is working to significantly increase uptake of emissions reduction technology and manure management opportunities over the next 3 years. The pork industry is also investigating opportunities to reduce waste by maximising the value of non-edible food and agricultural waste as pig food or feedstock to optimise performance of digesters.

Poultry Processing

The Australian Poultry Industry is currently developing a Chicken Meat Sustainability Strategy. On the other hand, AgriFutures developed a Chicken Meat Program RD&E Plan 2022-2027 after a comprehensive consultation process. The Plan focuses on five priorities covering environmental sustainability, biosecurity, health and welfare, food safety, sustainable workforce, and secure production systems. Its overarching vision is to grow the long-term prosperity of the Australian chicken meat industry. The mission of the Program: “Through research, development and extension, increase knowledge, understanding and opportunities that foster an innovative and adaptive commercial chicken meat industry.”

RESEARCH PRIORITIES

Research priorities for the red meat processing sector are driven by AMPCs Strategic Plan 2020-2025 and are focused on meeting the 2025 interim targets along with the 2030 targets. These include:

Energy

For Measurement

- Energy monitoring with diagnostic capabilities
- Machine learning with predictive maintenance alerts
- Industry 4.0 integration and automated reporting
- Best practice energy management
- Smart energy management systems investigation
- Energy benchmarking and savings opportunity tool

For Energy Efficiency

- Refrigeration Energy Efficiency Opportunity workshops
- Buying groups
- New process heat technologies
- Smart applications
- Retro-fit product awareness

For Renewable Energy

- Renewable energy investment calculators
- Business funding models
- Energy storage technology comparisons
- Grid connectivity and flexibility
- Industry policy
- Solutions for localised distributed energy

Alternatives to grid gas and fossil fuel

- Hydrogen and biogas national roadmap
- Biomass next generation energy tech
- Aggregated waste to energy solutions
- Geothermal energy

Water

For Measurement

- Sub-process level water use
- Industry 4.0 integration
- Beef Sustainability Framework adoption
- Water benchmarking and savings opportunity tool

For Water Efficiency

- Water re-use / recycling decision making matrix
- Equipment and process scan
- Business models (e.g. water savings or wastewater treatments “as a service”)
- Small equipment retrofits

Water Stewardship

- Dealing with retentates and discharges
- Non-chemical alternatives in wastewater treatment
- Australian Water Stewardship standards
- Localised water policies

Water Recycling

- Water recycling technologies
- Techno-economic feasibility for water recycling
- Global best practice water recycling pilots
- Market equivalence for direct planned potable water recycling
- Industry policy support for recycled water

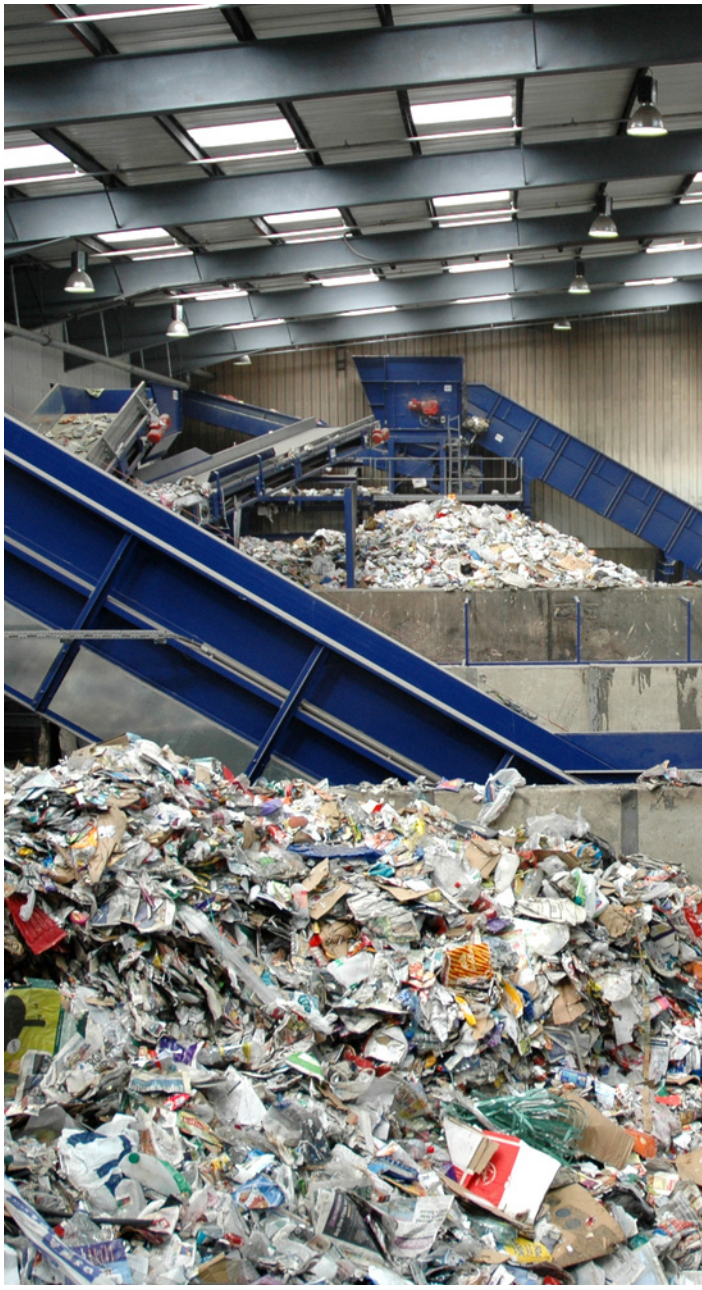
Waste

Reducing waste to landfill

- Aggregating localised wastes for regional energy
- Rural R&D 4 Profit — Wastes to Profit Program
- Utilisation of solid wastes in dual fuel biomass boilers
- Scalable technologies to suit varying waste volumes
- Integrative opportunities for energy, water and waste projects
- Benchmarking & savings opportunity tool

Feasible waste reduction alternatives

- Alternative waste treatment technologies and processes
- Renderable plugs and clips
- Detection and removal and/or avoidance of contaminants
- Alternative by-products and value add for niche markets (eg animal feeds)
- Industry policy for minimising untreated or non-recycled waste streams



Benchmark Assessments

AMPC undertook benchmark assessments of a number of its members as well as culture change maturity levels. The assessments compared energy and water intensity between 2020 and 2022 and indicated that the average energy intensities had not changed significantly, and the water intensity had increased (worsened) by 15%. This may be a result of the La Niña reducing drought conditions across most of Australia during this period.

Despite the lack of change in intensities, the industry has been implementing or considering improvements. The major categories of energy projects discussed included solar PV, batteries, refrigeration upgrades, biomass boilers and heat pumps. Nearly all sites had installed or are considering solar PV systems and in some cases batteries. Water improvement projects included hot water systems optimisation, upgrade of sterilisers, use of water recycling, cattle wash studies, new cattle wash plants, automation to reduce water use in non-production periods.

In addition, AMPC evaluated the economic returns from a sample of ten AMPC projects completed in the 2022-2023 financial year. The marginal costs and benefits from a project were modelled over a 30-year period. The following projects (relevant to the Council's interests) demonstrated a positive economic return (AMPC 2022/23 Annual Report):

- Zero waste to landfill
- Pinch analysis and heat integration opportunities
- Bio-solids upgrade
- Immersive reality — equipment maintenance training
- Cold plasma wash water technology for meat safety and shelf-life extension

For red meat processors, bioenergy has overtaken on-site coal use as the industry's third largest source of energy. Trials of multi-fuel biomass boilers are underway with fuels to be considered including woodchip and mixing paunch with woodchip as well as construction waste or dry plant materials with woodchip.
Other projects underway include:

- Developed and tested an industry first HACCP process for Class-A water recycling.
- Testing waterless spray and ultraviolet (UV) sterilizers.
- Reviewing the national packaging targets and associated co-regulatory framework and assessing new scenarios to divert facility level plastic from landfil

DAIRY PROCESSING

INDUSTRY OVERVIEW

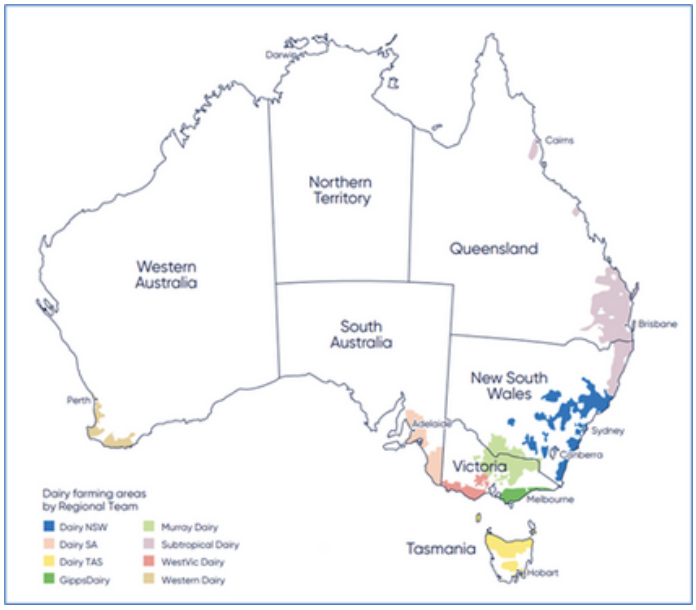
In Australia, there are 140 dairy companies including those that source milk direct from farms and from other companies. This includes 4,420 dairy farms and 455 processing factories across the country. Key organisations for the sector are Dairy Australia, the Dairy Manufacturers Sustainability Council (DMSC) and the Australian Dairy Products Federation. According to the latest Dairy Industry Sustainability Report (2021):

Together, the following listed main companies in the Dairy Processing Industry (2019/2020) represent up to 86% of the milk volume processed nationally. They are:

- Bega Cheese
- Bulla Dairy Foods
- Burra Foods
- Chobani Australia
- Lion Dairy & Drinks
- Fonterra
- Lactalis Australia
- The Union Dairy Company
- Saputo Dairy Australia.

- In 2021, the total annual milk production was 8,858 million litres, with 86% produced in south-east Australia (Figure 3).
- Australia is the world's 4th largest dairy exporter with 32% of milk production exported with the majority of this to Greater China (China, Hong Kong and Macau).
- Annual production of main commodities: 366,201 tonnes cheese, 206,199 tonnes milk powder and 81,704 tonnes butter.
- Annual per capita consumption is 94.4 litres milk and 13.4 kg cheese.
- Australian milk utilisation is 39% cheese, 29% drinking milk, 22% skim milk powder or butter, 4% whole milk powder and 6% other.

Figure 3: Location of Australian Dairy Industry farms and processors



INDUSTRY TARGETS

The Australian Dairy Processing Industry 2030 targets align with the United Nations Sustainable Development Goals – also set for achievement by 2030.

The industry has the following targets which are outlined in the Australian Dairy Sustainability Report 2020:

- 30% reduction in the consumptive water intensity of dairy companies (on 2010-11 levels) (ML water consumed per ML of milk processed).
- 30% reduction in greenhouse gas (GHG) emissions intensity across the whole industry (from a baseline of 2015).
- 100% diversion rate from landfill (for dairy companies) (tonnes of waste per ML milk processed).
- 100% silage wrap recycled (for farm).
- All dairy companies participate in the Australian Packaging Covenant (APCO) or equivalent scheme.
- 100% of Australian dairy packaging to be recyclable, compostable or reusable by 2025 or earlier.
- Halve food waste by 2030.

Progress on the targets and resource intensity figures for the dairy sector is provided in the Appendix.

RESEARCH PRIORITIES

Research priorities for the dairy processing sector are driven by the sector's 2025 interim targets along with the 2030 targets with general interest in technologies that can help meet these targets. The 2020 Sustainability Report briefly reports at a high level about projects undertaken by individual companies with respect to energy, water and waste efficiency and reducing greenhouse gas emissions.

In 2020, Dairy Australia undertook several research studies on specific technologies that could help the industry reduce water intensity, greenhouse gas emissions and waste. The technologies were assessed based on them being:

- Beyond current typical good practice in Australia;
- Cost-effective now or in the near term;
- Commercially available;
- Applicable to Australian dairy milk processors;
- Will result in materially significant savings to water or energy consumption and processing costs;
- Practical to implement.

The results are listed below.

Reducing Water Intensity Study

The study highlighted water conservation opportunities in the following areas:

- clean-in-place systems
- rainwater harvesting
- metering and monitoring
- washing
- leakage

Specific technologies which met the assessment criteria to help reduce water intensity were:

- Waterblade – a water saving device for taps
- Echologics - a wireless inline probe to operate as an early warning system for leaks by monitor water quality
- Apana – real time water management software
- Liqum – CIP optimisation by taking a chemical fingerprint of liquids and identifying variations in quality
- WaterGroup – rainwater and stormwater harvesting design model
- Babcock – alternative CIP method uses air vortex technology to achieve product removal in a two-phase process.

Source: Isle Utilities, 2020. Opportunities for Reducing the Intensity of Water Consumption in the Australian Dairy Processing Sector.

Reducing Greenhouse Gas Intensity Study

The study highlighted potential GHG reduction opportunities. Specific technologies which met the assessment criteria to help reduce water intensity were:

For milk processing:

- Heat pumps for heating purposes
- Two stage ammonia and carbon dioxide refrigeration systems
- High pressure processing for pasteurisation
- Membrane distillation for separation
- Advanced propeller design for drying
- Dehumidification of air intake for drying
- Niro Soavi Nano valves for homogenisation

For utilities:

- Wood chip and saw dust fuels for boilers
- Condensor heat recovery
- Removable steam valve blankets
- Dehumidifiers for compressed air systems
- Direct solar thermal and heat pumps for water heaters
- High efficiency screw compressors for chillers
- Two stage ammonia and carbon dioxide refrigeration for chillers
- Venturi system aerators for wastewater treatment
- Dosing control systems for water treatment

Source: Infotech Research, 2020. . Opportunities for Reducing Greenhouse Gas Emissions Intensity in the Australian Dairy Processing Sector.

Reducing solid waste intensity Study

Typical solid waste streams identified were organic, wastewater, solid and packaging related waste.

Organic waste streams:

- Off-spec raw milk/intermediates/final product
- Process first flush/product changeover
- Out of date final product (packaged/unpackaged)
- Process by-products (i.e. whey, mother liquor, lactose concentrate).

Wastewater:

- Wastewater treatment by-products
- Dissolved/induced air flotation sludge
- Aerobic treatment sludge
- Anaerobic digestion sludge.

Solid/Packaging-related waste streams:

- Plastic/paper powder bags
- Film wraps
- Cardboard
- Metal
- Timber/pallets
- Residual packaging from off-spec product.

Specific technologies which met the assessment criteria to help reduce waste intensity were:

Source: Isle Utilities, 2020. Opportunities for Reducing Cost and Intensity of Waste Production in the Australian Dairy Processing Sector

In process waste reduction

- Suez ice pigging for pipe cleaning/production transitions.
- Alvim – biofilm monitoring to detect bacterial colonisation.
- Arenal PCD analyser - online monitoring of COD and TSS in wastewater using ultrasonic sonochemistry and conductivity measurement.
- Biolonix – disinfection of liquids by applying an electrochemical field as it passes through a reactor.
- Process engineered fuel (PEF) - ResourceCo manufacture PEF from commercial and industrial, and construction and demolition materials. These typically include but are not limited to timber, metals, plastics, cardboard, paper and bedding, plus some concrete, bricks and rubble.
- Washing of plastics that are contaminated with organics. These are then shredded and sent for recycling.

For wastewater treatment

- Enviplan - Aquatector Microfloat (eMF) is a microflotation process for water and wastewater treatment, utilising micro bubbles of 20-50 µm (>90% of the micro bubbles are in this range) for separation of suspended solids and colloidal material (FOG, solids, low BOD).
- Creative Water Technology - thermal distillation process (adiabatic recovery) to desalinate, dewater and/or recycle highly saline and highly contaminated wastewater.

For sludge treatment

- The Volute is a dewatering screw press made up of fixed rings and moving rings with a uniquely designed tapered shaft and flights. It has a modular design, operates on a continuous process and the shaft motor is controlled by a frequency drive and rotates at 2 rpm.
- PYREG 500 is a carbonisation technology that can treat a wide range of biomasses to produce a range of products including a mix of fixed carbon, biochar, and mineralised ash and heat.

In 2023, Dairy Australia published the **Dairy Sector Food Waste Action Plan** which is the sector's response to the Australian Federal Government's goal of halving food waste by 2030. The plan highlights that it currently costs dairy manufacturers approximately $700 million per year to manage all potential food waste, with an additional $120m of revenue lost from wasted finished products. Approximately 70% of waste occurs at the manufacturing stage via processing waste (DAF sludge and CIP losses) and generation of by-products (whey). Key root causes of manufacturing waste are:

- Lack of understanding of extent of food waste being generated at the site or true scale of impact.
- High number of products produced with inefficient coordination between planning and production leading to high frequency cleaning.
- External forecasting demands for short runs of multiple products leading to high frequency cleaning.
- Antiquated or outdated methods (e.g. timed or manual) used to control cleaning processes.
- Competing demands for capital for identified upgrades.
- Lack of availability of adequately trained staff.
- Unavailable capital, scale and/or land to value-add by-products.
- High transportation costs for composting/value-add options.
- Uncertainty regarding potential to donate products to food rescue.

Identified actions to reduce waste in manufacturing are:

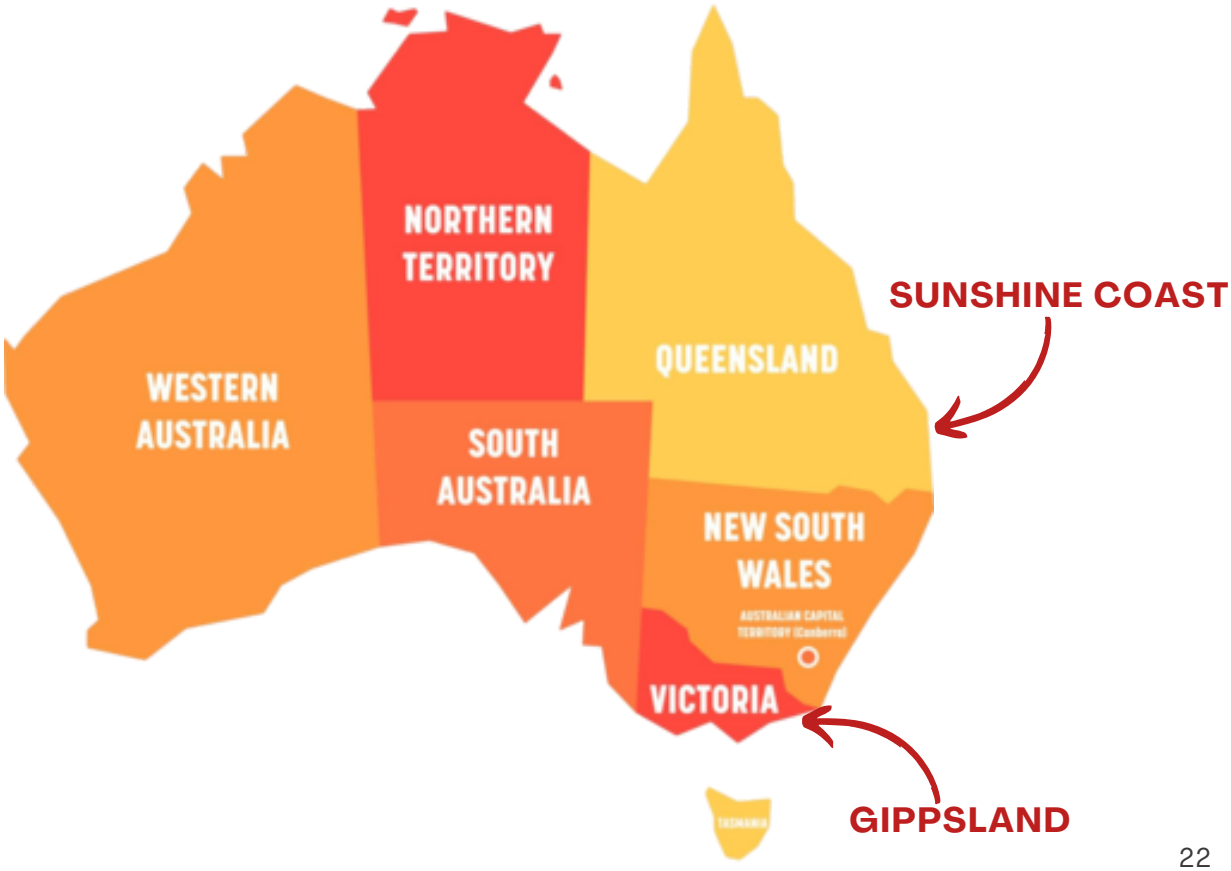
- Monitor dairy food waste across the supply chain and establish industry working group.
- Implement practices that prevent process wastes.
- Investigate (trial) technology solutions that turn processing waste and packaged goods into animal feed.
- Increase options for more DAF sludge to be composted.
- Increase awareness for more edible dairy food to go to food rescue sector.
- Assess commercial feasibility of diverting excess whey to third-party processors in regional networks for conversion to value-added products.

OPPORTUNITIES

This report has outlined the Australian market for sustainable food production including the targets, challenges, drivers and research priorities which provides gaps and opportunities for new innovation and technology. To overcome the environmental challenges affecting the industry, which was elaborated in section three, Australia has set ambitious targets to among others reduce carbon emissions, food waste, and water consumption.

To support the targets and the green transition of the food production industry in Australia, The Trade Council of Denmark undertook a study tour of Australian food processing sites across Gippsland (Victoria), Northern New South Wales and Southeast Queensland. The tour identified potential gaps in technology capability and requirements by Australian Food processors and this information, combined with a background study of the food sector's strategic plans and targets has highlighted opportunities for Danish companies to add value to the Australian food processing sector, in particular, meat and dairy processing.

The gaps identified during the study tour concur with background research of these Australian sectors. This includes software and hardware solutions, improved data collection and monitoring, energy and water efficiency, heat balances and waste heat recovery (heat pumps), waste to energy (biogas and biomass), improved wastewater treatment and reducing production losses.



Technology gaps identified by the Trade Council of Denmark (2023)

GAP 1
Limited efficiency in current manufacturing equipment

Opportunity for products and services as:

- Software solutions
- Equipment & tools for automation
- Hardware solutions

GAP 2
Lack of proper use & plans for waste streams

Opportunity for products and services as:

- Resource saving technologies
- Sensing and monitoring measures
- Technology for converting heat & energy

GAP 3
Lack of technologically updated solutions

Opportunity for products and services as:

- System integration
- Data collection and monitoring
- Energy and water efficiency tools
- Technology for reducing production losses

GAP 4
Growing demand for techniques to reduce CO2-emissions

Opportunity for products and services as:

- CO2 Capture technologies
- Waste to energy initiatives
- Technology for overall equipment efficiency and carbon footprint monitoring

OPPORTUNITIES IN GIPPSLAND

Gippsland is one of the regions in Australia where many meat and dairy processors are located providing great opportunities for contributing to Australia's national targets by providing sustainability solutions to the industry in this area. Gippsland is located in the state Victoria and is a powerhouse of Victoria's natural resources and commodities economy with A$14.1 billion and additionally A$7 billion per year in the Food and Fibre sector. The region is transitioning from traditional industries connected with coal and gas to new, emerging industries. The region has developed a regional transition plan that recognises the Agri-Food sector as a key economic strength, and supports its continued growth and development to maximise its role.

In 2020, the Victorian Government released *Recycling Victoria: A new economy to move Victoria towards a circular economy*. Recycling Victoria will help deliver on the national target to halve Australia's food waste by 2030. In 2021 the Victorian Government released *The Path to Half: Solutions to halve Victoria's food waste by 2030*, setting out the true cost of food waste in Victoria and food waste solutions including the diary, livestock, horticulture and cereals sectors

Gippsland has implemented the Regional Circular Economy Plan (RCEP) with the following aspirations for 2030:

- The circular economy is part of everyday life in Gippsland
- Collaboration and partnership drive action
- End use markets are aligned with resource recovery processing and supply
- An established and maturing circular economy
- Organics processing capacity and capability is strengthened

The Trade Council of Denmark and Food and Fibre Gippsland has signed a Strategic Partnership Agreement based on the following Objectives:

- Reduced operating costs and energy-related carbon emissions for businesses and owners;
- Increased awareness on resource optimisation (i.e. water and energy efficiency);
- Enhanced production reliability through plant automation and digitalisation;
- Boosting of energy productivity and introduction of renewable energy;
- Improved productivity through circular production with less carbon footprint.

OPPORTUNITIES IN QUEENSLAND

Queensland is Australia's leading economy and currently has an economic growth that exceeded the national average. Its primary industries (agriculture, fisheries, forestry and food) are central to its growing economy with an estimated value of $23.44 billion (DKK 104 billion) total for 2022–23. It is focused on seizing the opportunities that global decarbonisation brings.

The Queensland government launched the new Industry Partnership Program which will invest A$350 million (DKK 1.5 billion) over four years to continue to grow and create jobs across a number of priority industry sectors which includes advanced manufacturing and bio-futures.

The Trade Council of Denmark visited Queensland in collaboration with Food and Agribusiness Network (FAN). FAN aims to grow the industry by creating an ecosystem that supports collaboration, accelerates innovation and drives trade locally and globally. This initiative is to support Queensland with its new-industry development strategy that acknowledges the global shifts and the demand for cleaner, greener, and more responsibly sourced products.

Table 3: Environmental Sustainability Opportunities in Australian Meat and Dairy Processing

Opportunity	Sector* (RM, P, C, D, F)
General	
Integrated sustainability reporting software	All
Food Industry (meat, dairy and general) processing equipment	All
Use of cobots and exoskeletal devices in meat processing i.e. for cutting, skinning, boning	RM
Improvements in traceability and process integrity e.g., radio frequency identification devices for stock and detection of defects in offal	RM
Smart glasses for use in remote auditing e.g., auditor or a vet	All
Machine learning	All
Carbon	
Carbon offset projects	All
Carbon accounting software	All
Energy Sources - renewables	
Biomass boilers – chicken litter, sludge, construction wastes	All
Biogas (depending on size)	All
Solar, wind, geothermal, battery	All
Energy supply, monitoring and management	
Energy monitoring platforms	All
Process modelling software – energy – electric and thermal, refrigeration systems, steam	All
Smart energy management systems including demand management	All
Alternative fuels and multi-fuel boilers e.g. wood chips and saw dust	
Energy efficiency technologies	
Heat pumps – for less than and greater than 100°C.	All
Heat exchangers for heat recovery	All
High efficiency motors e.g., electrically commutated motors	All
Efficient refrigeration systems and low carbon refrigerants	All
Refrigeration as a service	All
Efficient air compressors and related systems – improved monitoring	All
Water and wastewater treatment	
Membrane technology	All
Wastewater treatment technologies including biogas	All
Non-chemical alternatives in wastewater treatment	
Improved clean in place systems – transmitters for liquid transitions, improved pigging systems	D, F
Efficient valves, pumps, impellers	All
3D Modelling tools for rainwater/stormwater harvest - very successful in red meat processing (AMPC Annual Report)	
Water Stewardship	
Packaging	
Packaging machines	All
Packaging materials e.g., compostable and recyclable	All
Solid Waste	
Circular economy opportunities	All
Milk and whey protein technologies	D
Value add on meat waste streams such as blood	RM, P
Value add on dairy whey and proteins	D, F
Sludge treatment - dewatering	All
Alternative by-products and value add (animal feeds)	

**Legend:*
RM – Red Meat
P – Pork
C – Chicken
D – Dairy
F – Food and Beverages

FINANCE OPTIONS

Australian Government grants and other programs can be found at business.gov.au/grants-and-programs/. There is also the option to source funding via Green Loans which are available from numerous Australian banks.

One particular grant program, is the Industrial Energy Transformation Studies Program which some meat and dairy processors may be eligible for, however this is generally for large companies which are required to report under the National Greenhouse and Energy Reporting Scheme. This covers only a few of the large food manufacturing companies.
(https://arena.gov.au/funding/industrial-energy-transformation-studies-program/).

Grant funding is provided in two streams:

Stream A – **Feasibility Studies:** A Feasibility Study aims to provide an independent assessment that examines all aspects of a proposed Project, including technical, economic, financial, legal, and environmental considerations. The Study should demonstrate the economic case for the technology and associated energy or emission reductions while ensuring that the technological barriers are identified and are manageable.

Stream B – **Engineering Studies:** Engineering (or FEED) Studies have the purpose of providing sufficient Project detail to enable a Final Investment Decision to be made and a subsequent EPC (Engineering, Procurement and Construction) contract to be executed.

Applicants can seek $100,000 to $500,000 for feasibility studies or $250,000 to $5 million for engineering studies.

Food and Beverage Accelerator (**FaBA**)
FaBA is Australia's Food and Beverage Accelerator that is backed by industry and innovation partners and is an alliance between the University of Queensland, the University of Southern Queensland and the Queensland University of Technology. It is funded by the Australian Government, under the Department of Education. Its purpose is to accelerate the commercialisation of university research, increase engagement with industry and deliver science at 'start-up speed'. The program is focussed on new products, processes and ventures, innovative ingredients and developing premium products. Australian Food and Beverage Manufacturers could apply for a share in $20 million in previous funding rounds.
See https://faba.au/partner-with-us/second-investment-round/

APPENDIX

Red Meat Industry Energy and Water Intensity

Table 1 Energy and water intensities and benchmark ratings

Resource intensity	2020 High	2020 Low	2020 Average (± variation)	2020 Benchmark ratings*	2022 High	2022 Low	2022 Average (± variation)	2022 Benchmark ratings*
Electrical intensity (kWh/tHSCW)	428	194	309 (±39%)	15 G, 2 F	577	169	313 (±84%)	19 G, 3 F
Thermal intensity (MJ/tHSCW) (rendering)	5,321	1,329	2,727 (±95%)	7 G, 4 F, 3 P	3,701	1,171	2,458 (±51%)	9 G, 7 F, 1 P
Thermal intensity (MJ/tHSCW) (non-rendering)	1,329	725	1,002 (±33%)	3 G	2,293	791	1,266 (±81%)	4 G, 1 F
Thermal intensity (MJ/tHSCW) (all sites)	3,772	725	2,186 (±73%)	10G, 4F, 3 P	3,701	791	2,187 (±69%)	13G, 8F, 1 P
Total energy intensity (MJ/tHSCW)	5,314	1,556	3,297 (±61%)	N/A	5,069	1,537	3,315 (±53%)	N/A
Water intensity (kL/tHSCW)	11.1	5.1	7.8 (±42%)	16 G, 1 F	16.3	3.8	9.0(±80%)	20 G, 2 F

*Good (G), fair (F), and poor (P) ratings are based on comparison to idealised model for a plant with the same processes.

Source: AMPC, Project Report Code No. 2023 – 1008. Horwood and Phan. Energy and water benchmarking and efficiency culture change

Poultry Processing

Table 5. Meat-processing inputs (n = 11) reported per 1000 kg of carcase weight processed.

Input	Australian average	Range
Electricity (kW h)	146.2	80.0–233.0
Renewable generated electricity (kW h)	0.8	0.0–27.0
Heat energy generated from biogas (MJ)	43.6	0.0–241.4
LPG (MJ)	3.5	0.0–25.4
Natural gas (MJ)	347.5	0.0–1270.0
Diesel (L)	0.6	0.0–3.0
Fresh water (L)	6919.7	2826.5–10230.0

Source: Weidemann et al, 2022. Environmental Impacts of the Poultry Industry, https://integrityag.net.au/wp-content/uploads/2023/03/Copley-Wiedemann-2022-Environmental-impacts-of-the-Australian-poultry-industry-chicken-meat.pdf

Dairy Processing

			Baseline	2019	2020	2030 Target	Progress
Reducing environmental impact							
8 Improve land management	8.1	100% of stock excluded from waterways[x]	76% (2015)	n/a	75%[xi]	100%	●
	8.2	100% of riparian zones actively managed and maintained	n/a	n/a	Under development	100%	n/a
	8.3	100% of farmers complete and implement a soil and nutrient management plan[x]	58% (2015)	n/a		100%	n/a
	8.4	100% of farmers have and implement a documented biodiversity action plan[x, xiii]	81% (2018)	n/a		100%	n/a
	8.5	Zero net deforestation by 2020[xiv]	n/a	n/a	Under development	100%	n/a
9 Increase water use efficiency	9.1	Reduce the consumptive water intensity of dairy companies by 30% by 2030 (on 2010/11 levels) (ML water consumed per ML of milk processed)[xii, xv, xxi]	1.75	1.97	1.86	1.22	●
	9.2	Improve water use and water productivity to utilise 2.0 tonnes of dry matter per ML used[xvi]	n/a	n/a	n/a	2.0 t	n/a
	9.3	100% of farmers recycling water from dairy sheds[x]	75% (2015)	n/a	74%	100%	●
	9.4	100% of farmers monitoring water consumption	n/a	n/a	45%	100%	n/a
	9.5	100% of farmers have a water security risk management plan by 2020 and are implementing it by 2030	60%	n/a	55%	100%	●
10 Reduce greenhouse gas emissions intensity	10.1	Reduce greenhouse gas emissions intensity by 30% across whole industry on 2015 levels[xxi]					
		– Manufacturers (tonnes CO_2 ~e/ML milk processed)[xii, xvii]	140	141.4	136.7	98	●
		– Farmers (kg CO^2 ~e/kg FPCM)[x, xviii]	1	n/a	1	0.72	●
11 Reduce waste	11.1	100% diversion rate from landfill (for dairy companies) (tonnes of waste per ML milk processed)[xii, xxi]	2.69 (2011)	1.74	1.69	0	●
	11.2	100% of silage wrap recycled (for farm)[x, xix]	28% (2015)	n/a	30% of farmers	100%	●
	11.3	All dairy companies participate in the Australian Packaging Covenant (APCO) or equivalent scheme	9	10		All dairy companies	●
	11.4	100% of Australian dairy packaging to be recyclable, compostable or reusable by 2025 or earlier	n/a	n/a	Work underway	100%	n/a
	11.5	Halve food waste by 2030 (placeholder – tonnes of dairy products per ML of milk processed)	630,000 (2017)	n/a	Work underway[xx]	n/a	n/a

x Land Water Carbon Survey 2020
xi 75% of dairy farmers do some fencing, with 44% fencing all waterways – up from 35% in 2015
xii Dairy Manufacturers Sustainability Council
xiii Question changed in 2020, so unable to compare with 2018. The proportion with a formal documented biodiversity plan has dropped – but 43% of farms use a map to highlight areas of environmental management, 54% fence native vegetation, 68% fence shelter belts, 26% provide buffer zones and 30% have areas specifically managed or conservation
xiv Dairy farmers are ensuring native vegetation or shelter belts are included on their farms and only 1% appear to be reducing significant amounts of native vegetation
xv Recalculated for 2018/19 to be 1.97 – additional processor information
xvi 77% of farms have some irrigation automation to use water more efficiently
xvii Recalculated for 2018/19
xviii 94% of farms have implemented practices to reduce GHG emissions. 71% of farms use some renewable energy
xix 88% of farms use silage wrap (77% in 2015), and of those: 30% recycle; 49% recycle where recycle facilities are available. Many areas have no facilities. The silage wrap project underway aims to provide viable long-term recyclable options
xx DMSC have several projects to map waste streams and look for ways to reduce or utilise waste product better
xxi Baseline figures updated. Since publication of the *2019 Dairy Sustainability Report*, data was submitted from an additional company which increased coverage

Source: Australian Dairy Industry 2020 Sustainability Report

MINISTRY OF FOREIGN AFFAIRS
OF DENMARK
The Trade Council

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ROYAL DANISH CONSULATE GENERAL /
TRADE COUNCIL OF DENMARK
SUITE 33.02, LEVEL 33, 1 O'CONNELL STREET
SYDNEY NSW 2000 / AUSTRALIA
EMAIL sydhkt@um.dk
WEB Australien.um.dk/EN

The Trade Council of Denmark (TCD) is an integrated part of the Ministry of Foreign Affairs of Denmark.