GREATER WHITSUNDAY BIOMANUFACTURING

BLUEPRINT 1.0

GW3D
GREATER WHITSUNDAY ALLIANCE
MACKAY ▶ ISAAC ▶ WHITSUNDAY

Queensland Government

Acknowledgement of Country

The Greater Whitsunday Alliance team live and work in Mackay Isaac Whitsunday region and long before these places were known by their colonial names they were actually known as Yuwibara, Koinmerburra Barada Bana, Wiri, Birri, Ngaro, Gia, Juru, Jangga and Birriah respectively. We would like to acknowledge the traditional owners of the Greater Whitsunday region, and their continuing connection to the land, water and community. We pay our respects to Elders past, present and emerging.

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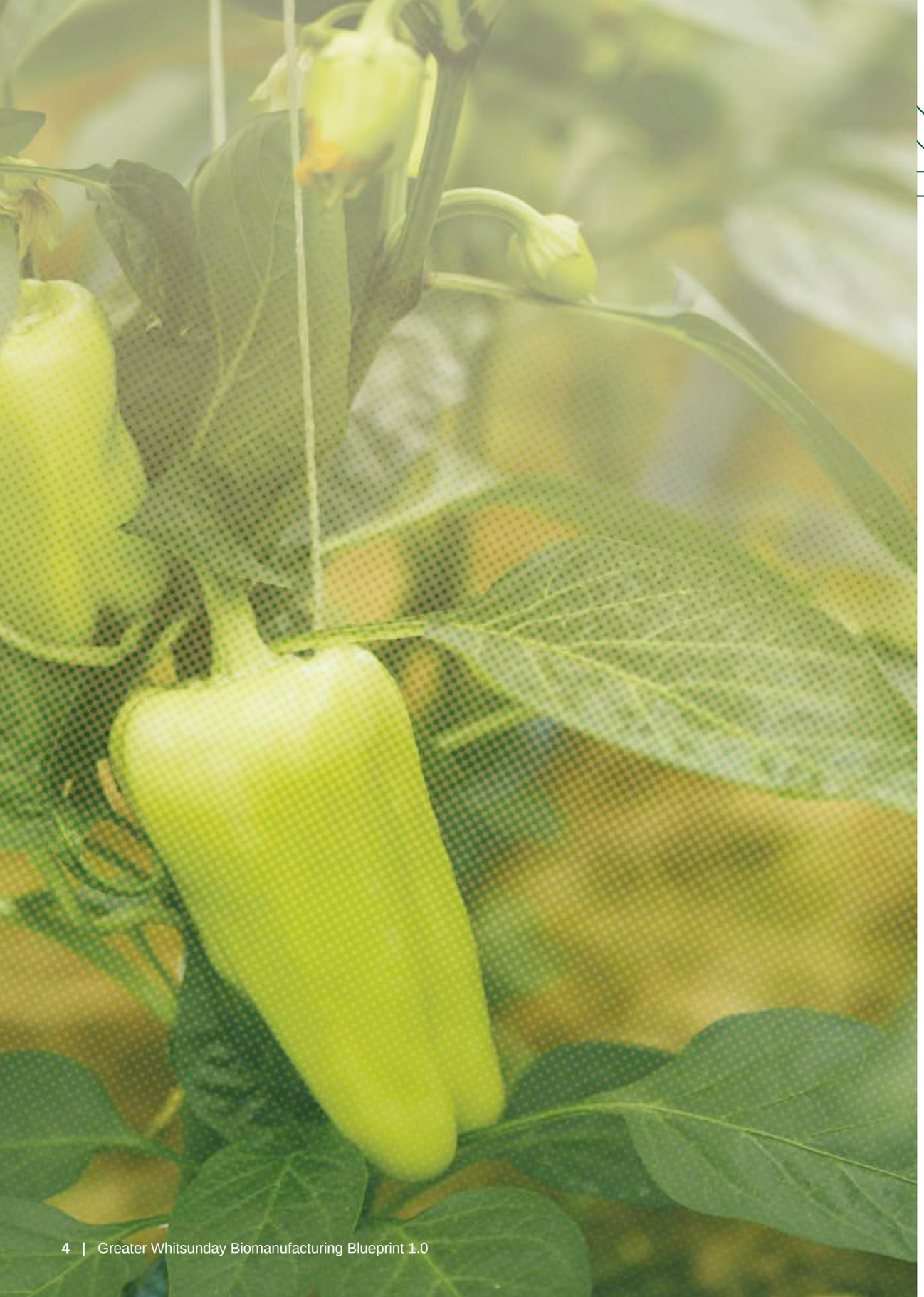


EXECUTIVE SUMMARY

Biomanufacturing refers to the development and manufacturing of products from plant based, organic or waste resources, rather than fossil fuels.

Biomanufacturing has the potential to address significant global challenges linked to health, agriculture, the environment, food production and more.

While the global biomanufacturing economy is still emerging, there is increasing momentum, shifting sector activity from a focus on science to commercialisation, to tackle these global issues more rapidly.

The Greater Whitsunday region is exceptionally well-placed to serve as a catalytic Queensland site for the emerging biomanufacturing industry.

As one of the fastest-growing and most economically diverse regions in Australia, Greater Whitsunday is strategically placed to embrace advanced biomanufacturing companies seeking to establish and scale-up commercial projects.

Greater Whitsunday's mature agriculture and sugar industries, proximity to Asia-Pacific markets, significant biomass feedstock, and a willingness to diversify, position the region to meet growing demand for biomanufacturing products in both domestic and international markets.

Deep support from and collaboration with the Queensland Government, Mackay, Isaac and Whitsunday Regional Councils and collaboration with key industry players underpins the region's push to realise these opportunities.

The Greater Whitsunday Biomanufacturing Blueprint 1.0 has synthesised an extensive body of work completed by key regional stakeholders in recent years. This Blueprint articulates region-specific strategies and actions, across three key phases – Attraction, Activation and Sustainable Operation – to ensure the region is planned and prepared for investment.

This Blueprint, Version 1.0, outlines initiatives designed to attract and secure commercial interest from the emerging and complex biomanufacturing sector and will be updated at regular and appropriate intervals to maintain accuracy and relevance to the evolving investment landscape.

Note:

For the purpose of this Blueprint, the term ***biomanufacturing*** is utilised in reference to concepts featured in the ***Queensland Biofutures 10-Year Roadmap and Action Plan*** that are specifically relevant to the opportunities available to Greater Whitsunday, namely commercial proponents using precision fermentation, synthetic biology and industrial biotechnology.

BACKGROUND

Queensland's regions are some of the best positioned in the world to harness the opportunities of a biomanufacturing economy, as identified by the Queensland Government in the *Queensland Biofutures 10-Year Roadmap and Action Plan*.

The *Biofutures Roadmap*, first released in 2016 and updated in 2022, outlines Queensland's plan to establish the state as a world-leading and sustainable region for the biofutures industry and the Queensland Government has undertaken significant work to elevate the state's profile as an investment destination.

Throughout this process, the Greater Whitsunday region has been identified as well-placed to play a significant role in global biomanufacturing, making it important to strategically play to the region's strengths as they align to loftier priorities and focus efforts accordingly.

The Greater Whitsunday region, has been identified as a potential home for new market opportunities related to biomanufacturing such as precision fermentation, synthetic biology and industrial biotechnology.

In recent years, Greater Whitsunday stakeholders have actively pursued the regional opportunity to be known, both nationally and internationally, as a place to realise biomanufacturing projects, research, investments and commercialisation.

It should be noted that the emerging status of the global biomanufacturing industry signals significant policy and regulatory hurdles to overcome within the Australian landscape. A strong regulation framework and agreed set of ethical principles is critical in addressing the issue of public trust and safety.

Several key pieces of work have been commissioned and endorsed by regional stakeholders since 2018 to build a solid evidence base to support informed decision making, shape effective policies and drive meaningful collaboration.

Highly invested stakeholders have been working alongside the Queensland Government to deliver a collaborative and coordinated approach to identify and realise the regional biomanufacturing opportunity.

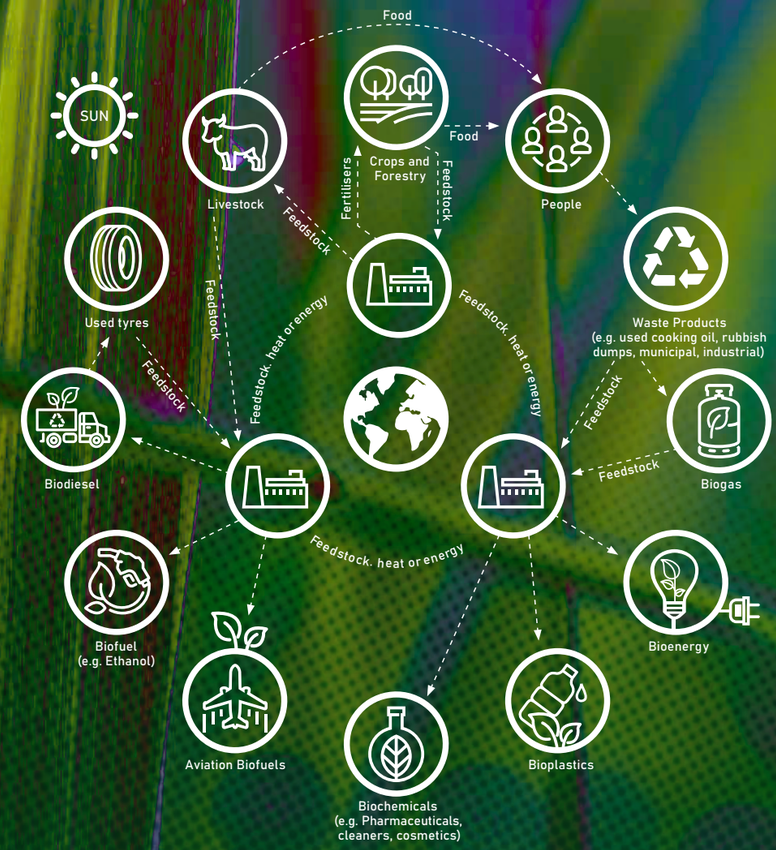
The progress and endeavours to date have focussed on integrating the region's key attributes into a distinct competitive advantage – namely, mature agriculture and manufacturing industries, abundance of biomass feedstocks, access to export markets, precinct development opportunities, established research capability, the presence of a highly skilled workforce and a willingness to diversify.

Current market conditions, including growing global demand and favourable investment settings, mean the opportunity to attract and establish commercial biomanufacturing proponents in the Greater Whitsunday region must be seized now.

The detailed strategies and actions presented in this Blueprint outline how the Greater Whitsunday region can continue to navigate the path to commercial biomanufacturing investment in a planned, prepared and coordinated way.

GREATER WHITSUNDAY BIOMANUFACTURING VALUE CHAIN

Source: Aurecon Group, Mackay



Overview of synthetic biology and precision fermentation

Synthetic biology *involves the engineering of biological components, such as DNA sequences, proteins, and cells, to create artificial biological systems or modify existing ones. Synthetic biologists aim to reprogram living organisms or create entirely new ones to perform specific tasks or produce desired products.*

These engineered biological systems can be used for a wide range of applications, including the production of biofuels, pharmaceuticals, biomaterials, and environmental remediation.

Synthetic biology has the potential to revolutionise industries and contribute to solutions for pressing global challenges by providing innovative and sustainable approaches.

Precision fermentation *also known as precision biomanufacturing, involves optimising the fermentation process to enhance the production of desired products while minimising waste and maximising yields. It is a specific application within synthetic biology that involves the targeted cultivation and manipulation of microorganisms for the precise production of desired compounds.*

Precision fermentation can efficiently convert feedstock, such as sugars or other organic compounds, into valuable products and has diverse applications across industries, including the production of bio-based chemicals, enzymes, pharmaceuticals, food ingredients, and alternative proteins. The fermentation process takes place in bioreactors or fermentation vessels, where environmental conditions are carefully controlled to support optimal microbial growth and product formation.

Industrial Biology, *also referred to as white biotechnology, utilises living cells such as microorganisms, enzymes, or biological molecules and their biochemical processes to develop and manufacture products, processes, and materials with industrial or commercial applications.*

In industrial biotechnology, biological organisms and their components are harnessed to produce a wide range of products, including biofuels, pharmaceuticals, chemicals, enzymes, bioplastics, and specialty chemicals.

BIOMANUFACTURING IN GREATER WHITSUNDAY

There is no region better suited to embrace an emerging biomanufacturing sector than Greater Whitsunday.

The Greater Whitsunday region is one of the fastest growing and most economically diverse in Queensland, traditionally strong in resources, agriculture, horticulture, manufacturing and tourism.

Greater Whitsunday, in particular the Mackay region, is gaining rapid recognition, both nationally and internationally, as an emerging biomanufacturing hub, well-positioned to realise major investment, research, and commercialisation.

Conveniently positioned close to growing Asian markets, with significant biomass feedstocks and a willingness to diversify, Greater Whitsunday can meet the growing global demand for 'food, fuel, feed and fibre' produced through biomanufacturing processes.

The Greater Whitsunday region, in collaboration with the Queensland Government, is actively pursuing commercial opportunities in biomanufacturing, initially connected to sugarcane biomass.

A versatile and diverse feedstock profile expands the region's capabilities, beyond sugarcane, to capitalise on emerging precision fermentation processes that produce alternative proteins, biofuels, chemicals and a variety of other bioproducts.

> "The Mackay region is an economic powerhouse and one of the most naturally beautiful and resource-rich locations in Australia. The region's abundant feedstocks, available land for crops and industrial development, a thriving higher education sector and access to roads, rail and sea distribution channels make it an ideal location. Mackay's Future Foods BioHub will focus on the production of alternative foods, protein products and plant extractives"
>
> –
>
> ***Investing in the Mackay, Isaac, Whitsunday Future Foods Biohub***

Since the release of the *Queensland Biofutures 10-Year Roadmap and Action Plan* in 2016, the Greater Whitsunday region has invested heavily in identifying and understanding its strategic strengths and opportunities to attract commercial investment from the emerging biomanufacturing economy.

TIMELINE

2010
- QUT Mackay Renewable Biocommodities Pilot Plant established onsite at Racecourse Mill in Mackay

2016
- Advance Queensland, *Queensland Biofutures 10-Year Roadmap and Action Plan*

2017
- *MIW Feedstock Study*

2018
- Mackay Isaac Whitsunday Biofutures Steering Committee established
- Biofutures Precinct Site Assessment and Development Project

2019
- *Investing in Biofutures projects in the Mackay Isaac Whitsunday Region* (updated and re-released in 2020 as *Investing in the Mackay Future Foods BioHub in 2020*)
- Queensland Connects Sub-REAP Team Mackay commences with focus on Biofutures

2020
- Queensland Government commits $1 million to development of a Future Foods BioHub in Mackay

2021
- *Mackay Isaac Whitsunday Future Foods BioHub Market Sounding and Strategic Investment Analysis*
- *MIW Region Biofutures Precinct* Analysis & Report
- Greater Whitsunday Biofutures Leaders Group established
- Mercurius Biorefinery Pilot Plant established in Mackay

2022
- *Queensland Biofutures 10-Year Roadmap and Action Plan* Updated (2021-2026)
- Greater Whitsunday Biofutures Vision developed
- First major future food proponents visit Mackay region to conduct exploratory market research

2023
- Queensland Government announces additional funding contribution for the QUT Mackay Renewable Biocommodities Pilot Plant expansion
- Various announcements in Mackay from Queensland Government regarding commercial biomanufacturing investment

GREATER WHITSUNDAY BIOMANUFACTURING BLUEPRINT 1.0

VISION

By 2030, to be a globally significant biomanufacturing region, enabled by diverse biomass, human talent, research investment and supporting infrastructure.

AMBITIONS

EFFECTIVE ADVOCACY, PLANNING, POLICY & INVESTMENT SUPPORT

Collaborative action that supports commercial biomanufacturing investment and is responsive to the emerging industry, including streamlining of regulation and approval processes

DEFINE THE REGION'S UNIQUE COMPETITIVE ADVANTAGE

Articulate the region's competitive advantage, including unique ESG value-add, and strategically promote the benefits to key stakeholders, including investors, industry, supply chain and community

DEVELOP THE EMERGING WORKFORCE

Establish skills development and workforce pipelines into the region's emerging biomanufacturing sector

PRECINCT ACTIVATION

Support the activation of biomanufacturing precincts by addressing land, logistics, digital and energy needs, including connecting to renewable energy

GENERATE LOCAL OPPORTUNITIES

Equip local industries and business to pursue diversification and value chain opportunities connected to the biomanufacturing sector

LEAD RESEARCH AND DEVELOPMENT

Attract ongoing research and development opportunities for new biomanufacturing products and technologies

KEY STAKEHOLDERS

SUGAR INDUSTRY AND MILLERS

Photo by QUT

COMMERCIAL PROPONENTS

Photo by QUT

RESEARCH AND INNOVATION

Photo by Courier Mail

ALL LEVELS OF GOVERNMENT AND AGENCIES

LOCAL SUPPLY CHAIN, LOGISTICS AND UTILITIES

AGRICULTURE PRODUCERS

BIOMANUFACTURING WORKFORCE

COMMUNITY

STRATEGIES AND ACTIONS

The Greater Whitsunday Biofutures Leaders Group has developed detailed and actionable strategies and initiatives as the next step in advancing the region's biomanufacturing vision and ambitions.

ATTRACTION	ACTIVATION	SUSTAINABLE OPERATION
Attract commercial biomanufacturing investment that aligns to the region's unique competitive advantage	**Activate a biomanufacturing ecosystem through precinct development, workforce planning, feedstock supply and local supply chain**	**Embed biomanufacturing operations into regional identity and facilitate ongoing industry expansion**
1. Activate and enhance research and evidence base to identify and target commercial proponents and focus marketing efforts	1. Strong Government leadership (local, state and federal) to enable commercial investment and communicate opportunities of emerging biomanufacturing sector	1. Embed sustainable biomanufacturing operations into regional identity
2. Showcase the region's biomanufacturing credentials by developing a unique digital presence and supporting marketing materials	2. Focused facilitation and support through proposed State Development Area (SDA) to navigate and streamline biomanufacturing precinct proposals and approvals	2. Leverage ongoing opportunities to drive industry expansion and unlock regional growth
3. Audit and articulate region's green energy and circularity credentials and plans	3. Support the region to embrace value-add biomanufacturing diversification opportunities, with initial focus on sugar as primary feedstock	
	4. Investigate the region's future skill needs and develop tailored biomanufacturing workforce development plan	
	5. Prepare local supply chain to service the emerging biomanufacturing industry	

GREATER WHITSUNDAY BIOMANUFACTURING CREDENTIALS

Extensive research and analysis identify the region's biomanufacturing credentials as:

Photo by Mackay Sugar

ABUNDANT AND DIVERSE FEEDSTOCK

Photo by QUT

PRECINCT DEVELOPMENT OPPORTUNITIES

SUPPORTING INFRASTRUCTURE, TRANSPORT, PORTS, SUPPLY CHAIN AND UTILITIES

Photo by Mackay Sugar

ACCESS TO RENEWABLE ENERGY

Photo by QUT

PROVEN RESEARCH CAPABILITY

DYNAMIC WORKFORCE DEVELOPMENT

ABUNDANT AND DIVERSE FEEDSTOCK

The Greater Whitsunday region's heritage sugar industry is an attractive cornerstone for commercial biomanufacturing investment, as a high-quality and versatile precision fermentation, synthetic biology and industrial biotechnology.

Emerging bioproduct feedstocks like grains, oil seeds, tallow, aquaculture waste and algae complement the opportunities enabled by sugar and expand the diversity of available feedstock within the region.

Additionally, with developing decarbonisation strategies and the subsequent growth of the circular economy sector, material disposal within key industries, such as mining, METS (mining equipment, technology and services) and agriculture may provide new value opportunities by applying biomanufacturing processes to repurpose industrial waste streams.

> "The Greater Whitsunday region has the capability to produce some of the world's most energy dense and productive feedstocks such as sugarcane, eucalypts and algae"
> –
> ***Investing in the Mackay Future Foods Biohub***

A DIVERSE FEEDSTOCK PROFILE

Greater Whitsunday Feedstocks

Cropping	• Sugar • Sugarcane trash • Sugarcane bagasse • Sugarcane fermentation • Sorghum straw • Grain and pulses from local regions • Yeast and vinasse from ethanol processing
Food processing	• Meat processing - tallow
Timber	• Wood waste
Horticulture	• Grains • Horticultural residues • Bananas • Tomatoes • Capsicums • Mangoes
Intensive livestock	• Cattle, poultry and pig manure • Aquaculture waste – prawns, barramundi

Source: Queensland biomass mapping and data tool www.statedevelopment.qld.gov.au/industry-development/queensland-biomass-mapping-and-data.html

Greater Whitsunday Feedstock Volumes

The current top seven feedstock volumes in the Mackay Isaac Whitsunday region (dry tonnes per annum) are:

Sugarcane trash
1,518,000

Cattle feedlot manure
17,090

Sugarcane bagasse
1,386,000

Sorghum waste
12,810

Paper waste
38,610

Meat processing
10,850

Timber waste
20,730

Source: Queensland biomass mapping and data tool www.statedevelopment.qld.gov.au/industry-development/queensland-biomass-mapping-and-data.html

Emerging Feedstocks in Greater Whitsunday

Beef tallow:
5% of Australia's beef is produced in the Greater Whitsunday region and meat processing from the Thomas Borthwick & Sons facility at Bakers Creek, delivers potential feedstock from a variety of by-products, including tallow

Horticulture waste:
Home to one of the largest winter produce growing regions in Australia, including tomatoes and capsicums, and additional horticulture waste, including mangoes, that can be converted into high value bioproducts such as bioplastics, biofuels, animal feeds, pharmaceuticals, nutraceuticals and cosmetics

Oilseeds and crops:
Oilseed and broadacre crops, including chickpeas, sorghum and wheat, are well established within the region with opportunities for crop expansion on available land including mine rehabilitation areas or fallow ground

Aquaculture:
A burgeoning regional industry with existing synergies between bioprocessing facilities and by-products from waste

Algae:
The region provides ideal conditions for the cultivation of algae as demonstrated by established algae farms, opportunities in mine site rehabilitation, as well as by-products from aquaculture developments, creating value-add opportunities due to its high feedstock yields

Industrial waste:
An example of industrial waste as a feedstock are end-of-life mining tyres and conveyor belts, which are being utilised by Australian innovators Novum Energy in biomanufacturing processes to reclaim carbon, develop a bio-cogeneration system and produce high-grade by-products like fuel oil, syngas, carbon black and steel

SUGARCANE AS THE CORNERSTONE

Photo by Mackay Sugar

> “
>
> Mackay has an abundance of high-quality sugarcane, which places the region at a known advantage to the rest of the state as well as other international competitors"
>
> –
>
> ***Market Sounding & Strategic Investment Analysis***

Sugarcane is abundant within the Greater Whitsunday region, producing 28% of Australia’s sugarcane, with 100,000+ hectares harvested for milling.

Five working sugar mills support the region’s sugar industry and include Mackay Sugar owned mills at Racecourse, Farleigh and Marian; and Wilmar owned at Proserpine and Plane Creek, Sarina. Sugar Australia also operates Australia’s largest white sugar refinery co-located at Racecourse Mill in Mackay.

Wilmar’s operations at Plane Creek, Sarina features a BioEthanol distillery, which has been operating since 1927, and has the capacity to produce 60 million litres of pure methylated ethanol per year to be used in a range of applications including printing, industrial chemicals, pharmaceuticals, surface coatings and more.

A 38MW renewable bagasse cogeneration plan at Mackay Sugar’s Racecourse Mill produces enough renewable energy to power about 30 per cent of Mackay. The plant reduces Queensland’s greenhouse gas emissions by 200,000 tonnes equivalent carbon dioxide (CO2e) annually by using bagasse from the facility’s sugar milling process.

Potential sugarcane feedstocks include:

- sugarcane and green waste for use in biochemicals, biofuels and bioplastics
- sugarcane bagasse for use in second generation biofuels or hydrocarbon replacement feedstocks
- Sugars, liquor and molasses for use in precision fermentation

Industry backed diversification is also evident in the industry roadmap, *Sugar Plus – Fuelling the Future of Food, Energy and Fabrication* released in July 2022. The roadmap states “The Sugar Plus vision represents potential for substantial long-term growth by expanding activities to address very large bioeconomy markets, which can be created with the right collaboration across the industry and the right public policy support. The scale of this opportunity is enormous, as sugarcane and sugar are attractive and sustainable hydrocarbon feedstocks”

PRECINCT DEVELOPMENT OPPORTUNITIES

In 2021, the Greater Whitsunday region invested in a research and planning investigation to determine the characteristics, attributes and competitive advantages of the region's industrial land and its suitability for co-locating biomanufacturing facilities and activities.

Five industrial precincts were identified as suitable and readily available to be occupied by a co-located biomanufacturing plant. All sites can utilise feedstocks for bioenergy including biomass co-generation and renewable energy.

Five identified industrial precincts within Greater Whitsunday can readily facilitate the development and commercialisation of environmentally sound, socially acceptable and cost-competitive biomanufacturing investment.

The five identified precincts are:

Abbot Point State Development Area (SDA)

a total of 4,143 ha of available land based around the Port of Abbot Point State Development Area north of Bowen partially owned by the Queensland Government and managed by the office of the Coordinator General and includes other freehold lots.

Feedstocks
- Grains and oil seeds
- Horticultural waste
- Aquaculture
- Algae

Port of Mackay

a total of 24.8 ha of available land based on undeveloped land at the Port of Mackay owned by North Queensland Bulk Ports Limited.

Feedstocks
- Sugarcane
- Grains and oil seeds
- Meat by-products waste

Racecourse Mill

a total of 24.8 ha of available land based on a total of 39 ha of developable land in the area based around the Racecourse Mill and Sugar Refinery, west of Mackay owned by Mackay Sugar Limited.

Feedstocks
- Sugarcane
- Grains and oil seeds
- Meat by-products waste

Rosella Industrial land site

a 211 ha site at Rosella, south of Mackay, owned by Economic Development Queensland.

Feedstocks
- Sugarcane
- Meat by-products waste

Nebo Industrial Estate

a total of 98.4 ha of available land based around the established industrial precinct east of Nebo.

Feedstocks
- Grains and oil seeds
- Meat by-products waste

Source: Aurecon Group, Mackay. More detailed profiles of each precinct can be found in Appendices

Supporting and promoting a precinct approach presents several competitive advantages for the region in attracting commercial biomanufacturing investment and scale-up, including:

- **Centralised facilities** to take advantage of existing infrastructure and energy
- **Potential energy parks** (steam and power) to support multiple processing facilities
- **Established local supply chains**
- **Anchor stakeholders** may provide access to infrastructure e.g. road, rail, electricity and water and receive payment for services
- **Sharing plant, equipment and workforce** with new enterprises
- **Co-investment with industry** to upgrade or expand existing infrastructure with an agreed investment payback period or lease of facilities arrangements

The Greater Whitsunday region, through its established METS (Mining Equipment, Technology Services), trades and manufacturing sectors, also has suitable and capable companion markets, technology support and major service centres to effectively service the construction, operation and maintenance requirements of biomanufacturing precincts and facilities.

These precinct development credentials, alongside the proximity to feedstock and transport logistics, have seen heightened international investment interest in the region in recent times.

An example of this interest is evident in the Queensland Government partnership with commercial proponent Cauldron, who are conducting a pre-feasibility business case for a precision fermentation contract manufacturing facility in the Mackay region.

The Queensland State Government further confirmed its focus and commitment to attracting investment and establishing the state's bioeconomy with the announcement of an investigation into a potential State Development Area (SDA) for the Mackay region in April 2023.

MACKAY STATE DEVELOPMENT AREA (SDA) INVESTIGATION ANNOUNCED

In Queensland, a State Development Area (SDA) is a designated site, area or region identified by the state government for strategic economic development and growth.

An announcement by the Queensland Government in April 2023, to investigate a SDA declaration in the Mackay area signifies the potential for the region to become home to a new Queensland biomanufacturing area.

A designated SDA will facilitate further investment attraction and certainty for businesses and investors operating within the SDA by:

- Streamlined planning, development and application processes
- Coordination of strategic infrastructure planning
- Provision of appropriate environmental management and considerations
- Collaboration, communication and stakeholder engagement

> "Mackay has enormous potential as a leader in future industries finding new ways to make the food, fuel, feed and fibre the world needs. The declaration of a SDA in Mackay could help leverage the region's traditional strengths in rural industries, such as cane growing and milling, and create new industries and jobs."
> –
> ***Deputy Premier Steven Miles***

SUPPORTING INFRASTRUCTURE, TRANSPORT, PORTS, SUPPLY CHAIN AND UTILITIES

The Greater Whitsunday region has thrived for generations on the back of strong traditional industries like agriculture, resources, manufacturing, and horticulture.

This depth of capability and resilience also positions the region to harness opportunities associated with emerging technology and shifts in global trends.

The Greater Whitsunday economy is diverse and powerful, boasting a total economic output of more than $54 billion[1].

The region's agricultural sector is one of Australia's largest sugarcane producers with 28% of the country's sugarcane grown in region alongside 5% of Australia's beef[2]. 26 operating mines in the Bowen and Galilee basins drive the region's impressive resources sector, which is underpinned by a major METS service centre in Mackay.

The size, capability and performance of industry within Greater Whitsunday is testament to the region's ability to support new and existing commercial investment with reliable and efficient infrastructure, services and supply chain.

Industry within Greater Whitsunday is supported by an established and sophisticated infrastructure network, ideal positioning to Asia-Pacific markets and a robust local supply chain. These attributes underpin the region's ability to establish and embed an emerging industrial biotechnology sector into the region's identity.

[1] REMPLAN 2023 - https://app.remplan.com.au/greaterwhitsundayalliance/economy/summary?state=Q7L6HEv65FP3NWKu8Qeg7KHElbI05Y

[2] MIW Region Biofutures Precinct Analysis and Report, 2021 Aurecon Mackay for Department of State Development, Manufacturing, Infrastructure and Planning

TRANSPORT INFRASTRUCTURE AND SERVICES

The Greater Whitsunday region's established and effective transport infrastructure and services will reduce transport costs and enable export efficiency for commercial biomanufacturing operations.

TRANSPORT INFRASTRUCTURE AND SERVICES WITHIN THE GREATER WHITSUNDAY REGION INCLUDE:

Regional Airports: located in Mackay, Proserpine and Moranbah

Sea Ports: large, established ports located in Mackay and Bowen

Bulk Shipping Terminals: located at Abbot Point, Dalrymple Bay and Hay Point

Roads: modern and efficient road networks

Rail: reliable freight service networks

Connection to integrated transport and logistics systems plus proximity to Asia-Pacific markets provide a clear advantage to commercial biomanufacturers looking to invest in Greater Whitsunday.

FACILITIES INFRASTRUCTURE, UTILITIES AND COMPANION MARKET OPPORTUNITIES

Industrial land planning has identified several sugar mills and industrial sites in Greater Whitsunday that have underutilised land.

These sites have existing zones and licences in place and could readily be utilised for co-located biomanufacturing operations. Natural synergies and companion market opportunities will deliver lower capital costs, especially in construction, and close proximity to existing infrastructure and utilities will reduce ongoing operating costs.

Alternate revenue streams and cost sharing opportunities from companion markets may include:

- Sharing of infrastructure, marketing and industry facilitation
- Processing of perishable foods to packageables
- Logistics, packaging and distribution
- Waste management and reduction
- Electricity retail
- Liquid fuels
- Renewable energy supply
- Animal Feeds

NORTH QUEENSLAND BULK PORTS

North Queensland Bulk Ports (NQBP) is a Queensland Government-owned corporation responsible for managing and operating multiple bulk ports in North Queensland. NQBP plays a vital role in facilitating trade, supporting regional industries, and managing the sustainable development of port facilities.

NQBP manages three major bulk ports in Greater Whitsunday:

- **Port of Mackay:** Situated in Mackay, it primarily handles commodities like sugar, grain, fuel and mineral concentrates. It is Queensland's fourth largest multi-commodity port by throughput and hosts one of the world's largest bulk sugar terminals.
- **Port of Hay Point:** Located south of Mackay, it is one of the world's largest coal export ports, handling significant volumes of coal for international markets.
- **Port of Abbot Point:** Situated near Bowen, it is a multi-cargo port that handles commodities such as coal and other bulk materials. It also serves as a base for offshore support services.

Greater Whitsunday's network of ports is an ideal integrated logistics transport solution for commercial biomanufacturing proponents, for both inbound and outbound trade.

RACECOURSE SUGAR REFINERY

Sugar Australia is the nation's leading producer of sugar products, and the Racecourse Refinery in Mackay is Australia's largest and most advanced sugar refinery. It produces a range of refined and specialty sugars for the iconic CSR Sugar brand.

Each year the Racecourse Refinery:

- **Produces 312,600 tonnes of white sugar**
- **Produces 20,200 tonnes of specialty sugars (ie, extra course white, liquid or coffee sugars)**
- **Produces 12,400 tonnes of molasses**
- **Provides 45 operational jobs**

Racecourse Refinery is located beside Mackay Sugar's Racecourse Mill, which supplies most of the raw sugar processed at the refinery during the local crushing season (June to November). Additional sugar is retrieved from the Mackay Bulk Sugar Terminal during the non-crushing season (December to June).

Significant financial and environmental benefits related to energy and transport are realised from co-location of the refinery at a working sugar mill, as well as additional efficiencies with reduced labour costs and utilising mill waste as a fuel source.

Source: Sugar Australia - https://www.sugaraustralia.com.au/files/3416/6208/9142/Wilmar_SA_A4_At-A-Glance_Racecourse_web.pdf

ACCESS TO RENEWABLE ENERGY

The Greater Whitsunday region is already home to several renewable energy sources and has significant potential for new renewable energy projects aligned to the Queensland Energy and Jobs Plan released in 2022[3].

The plan focuses on accelerating investment in renewable energy, supporting local businesses, and advancing Queensland's transition to a clean energy future.

Since 2015, the Queensland State Government has invested more than $1 billion in renewable energy projects in Greater Whitsunday, delivering more than 500 megawatts (MW) of renewable energy capacity[4].

As the world transitions to sources of renewable energy, Queensland's energy system is also shifting to clean, reliable and affordable power.

3 Queensland Energy and Jobs Plan, September 2022, Department of Energy and Public Works, www.epw.qld.gov.au/__data/assets/pdf_file/0029/32987/queensland-energy-and-jobs-plan.pdf

4 Department of Energy and Public Works, https://www.epw.qld.gov.au/energyandjobsplan/regions/mackay-isacc-whitsunday

Key renewable energy operations within Greater Whitsunday include:

- **Whitsunday Solar Farm:** 69MW capacity, 145-hectare solar farm located near Collinsville in the Whitsunday region
- **Hamilton Solar Farm:** 57.5MW capacity, over 170,000 solar panels also located near Collinsville in the Whitsunday region
- **Collinsville Solar Power Station:** 42MW capacity, generates enough energy to power 15,000 homes and built on the site of a decommissioned 180MW coal-fired power station
- **Clarke Creek Wind and Solar Farm:** 450MW capacity, approximately 100 wind turbines and solar farm capacity, located 150km south of Mackay
- **Racecourse Cogeneration Plant:** 38MW cogeneration plant located at Mackay Sugar's Racecourse Mill produces enough renewable energy to power about 30 per cent of Mackay

Several renewable energy projects earmarked for the Greater Whitsunday region have recently been announced by the Queensland Government and private investment:

- **Pioneer-Burdekin Pumped Hydro:** potential 5-gigawatt pumped hydro energy storage facility identified in western Pioneer Valley, approximately 75km west of Mackay
- **Northern Queensland Renewable Energy Zone (QREZ):** the Greater Whitsunday region is located within the Northern QREZ, an initiative of the Queensland Government to develop areas with high quality renewable resources, such as wind and solar, in a coordinated way by combining renewable generation, transmission and storage technology
- **Capricornia Energy Hub:** is one of the largest renewable energy projects in Northern Australia and encompasses a pumped-hydro electric scheme, wind farm and solar farm. Located on Widi Country, in the Mackay Hinterland, it will deliver dispatchable green energy into the grid to power over 1.5 million Queensland homes and is expected to be operational by 2028

PROVEN RESEARCH CAPABILITY

Queensland is a leader in biomanufacturing research in Australia thanks to strong research infrastructure and academic base and continued focus and investment in this capability is evident in the updated *Queensland Biofutures Roadmap and Action Plan.*

The Greater Whitsunday region has seen the growth of leading expertise in research and development, particularly through the establishment of the QUT Mackay Renewable Biocommodities Pilot Plant, located at Racecourse Mill.

The Pilot Plant provides research and development biomanufacturing capability to convert sugars and biomass into high-value biomanufactured products.

This regional capability proves a valuable resource for commercial proponents interested in bringing their technology to region with the intent to scale up or improve production and manufacturing processes.

Strong research and translational capabilities are established within Greater Whitsunday and will benefit from continued government investment, expansion of facilities and pilot programs activated through commercial investment.

MACKAY QUT RENEWABLE BIOCOMMODITIES PILOT PLANT AT MACKAY SUGAR'S RACECOURSE MILL

The Queensland University of Technology (QUT) Mackay Renewable Biocommodities Pilot Plant is pioneering biomanufacturing research and innovation from its location on site at Mackay Sugar's Racecourse Mill. The unique facility provides researchers with pilot scale infrastructure to advance research and development and provides access to biomass, like sugarcane bagasse, to convert into biofuels, green chemicals, future foods and other bioproducts.

The plant can support the development of a wide range of technologies and is available for use by industry and research partners to bridge the gap between research and commercialisation. Over the past decade, the facility has completed many projects with a wide range of regional, national and international partners.

The Pilot Plant is currently undergoing a $16 million expansion with the support of the Queensland Government through the Industry Partnership Program, the Australian Government through the Regional Recovery Partnerships Program and QUT. The upgrade will result in significant investment in new biomass processing, fermentation, separation and purification equipment, which will enhance its ability to demonstrate synthetic biology processes for regional biomanufacturing.

Upgrading the facility will make the pilot plant the first and only facility in Australia capable of demonstrating synthetic biology processes at scale. With upgraded fermentation capability, the pilot plant will demonstrate technologies for development of future foods industries, such as dietary alternative products, as well as the production of bioplastics and bio-textiles.

> "This expansion will support companies to develop new products for the future foods and other biomanufacturing industries, enabling them to rapidly demonstrate their technologies and products for market testing,"
>
> –
>
> ***Professor Ian O'Hara, Deputy Dean, Faculty of Engineering QUT & Queensland Biofutures Industry Envoy***

MERCURIUS RISING PILOT PROJECT

The Mercurius Rising Pilot Project, currently being deployed by Mercurius Biorefining at the QUT Mackay Renewable Biocommodities Pilot Plant, will showcase the versatility and efficacy of the company's REACH™ technology. Mercurius' patented and ground-breaking REACH™ technology converts a range of biomass feedstocks into renewable drop-in fuels and renewable chemicals for biobased industrial plastics.

The REACH process avoids the need for the use of pure sugars, high operating temperatures and high pressures, resulting in faster conversion rate and lower cost of production than current processes.

This world-leading technology is being trialled in Mackay, the heart of Queensland's sugar industry and strengthens the region's credentials as a leading biomanufacturing location. The trial will produce renewable chemicals, diesel and jet fuel from sugarcane waste.

Representatives from QUT will work alongside Mercurius to examine the technology and by-products to enhance commercialisation opportunities in Queensland. If successful, Mercurius will also prepare studies for another demonstration facility to be based in regional Queensland which would scale up production leading to growth of more biomanufacturing jobs and opportunities.

DYNAMIC WORKFORCE DEVELOPMENT

Collaboration, coordination and planning for new economies and workforce transformation is well underway in Greater Whitsunday.

Workforce partnerships will be critical to the region's ability to deliver the necessary training capacity, at the right time, and to the standard needed to operate major biomanufacturing facilities.

The Mining and METS industries are the region's largest employers with many in the workforce qualified across a range of trades including boiler making, electrical and fitter mechanics and technically skilled in design, engineering and manufacturing.

A real opportunity exists to leverage and extend these workforce skills and experience with METS businesses being encouraged to explore opportunities for diversification.

In 2022, GW3 developed a model for harnessing transferable skills, recognising the increasing importance of cross job and cross industry skilling in a world where the nature of industries is evolving.

This model provides a framework that can be used to support existing regional workforces to transition into the emerging sectors, such as biomanufacturing.

More specifically, this model:

- Validated cross industry skilling pathways
- Developed a clear cross industry pathway framework
- Identified pathway tools to support transitions

The strength and proven capability of the region's Vocational Education and Training (VET) programs demonstrate an ability to quickly respond to the workforce needs of an emerging biomanufacturing sector.

Given the region's dynamic workforce development plans there is great confidence that an established and capable workforce pipeline could be realised within two years from time of commercial investment[5].

The Greater Whitsunday region is rapidly deploying workforce development strategies to ensure future skilling needs of established and emerging industries are met.

5 Exploring US Parallels for Biomanufacturing Training, 2023, California Biomanufacturing Center for Department of State Development, Manufacturing, Infrastructure and Planning

As a region, Greater Whitsunday is committed to:

Growing our own workforce

- Stackable Career Education Program
- Educator Professional Learning Program
- Activate Program

Preparing an emerging sector workforce

- Regional Jobs Committee Project
- Cross Industry Skilling Project
- Queensland Future Skills Partnership
- Development of digital assets

Evolving our current workforce

- Agriculture and Aquaculture Tech and Skills Hub
- Greater Whitsunday AgTech Hub
- CQU/BMA Digital Innovation Skills Hive
- Advanced Apprenticeship Program co-design

QUEENSLAND FUTURE SKILLS PARTNERSHIP

The Queensland Future Skills Partnership Pilot Program fast-tracks development and delivers automated technology pathways, skillsets and qualifications to Queensland's resources sector.

The Queensland Future Skills (QFS) Partnership is a three-way partnership between BHP Mitsubishi Alliance (BMA), TAFE Queensland and CQUniversity.

The Pilot Program partners have worked with industry experts, community experts and government to co-design and deliver training to support the implementation of autonomous technology in mining. The training enables existing workers, particularly in regional areas, to acquire new skills by completing micro-credentials and skill set qualifications.

Although initially targeted at the resources sector, a similar partnership model, the Aquaculture and Agriculture Tech Skills Hub, is being delivered in the Greater Whitsunday region to fast-track training programs aligned to new career pathways and future occupations within the agribusiness sector.

This partnership model could also benefit the rapid development of career pathways and skilling solutions for an emerging biomanufacturing sector.

APPENDICES

CASE STUDIES

NOVUM ENERGY AUSTRALIA & BHP PARTNERSHIP

Novum Energy Australia has entered into a long-term agreement with BHP to facilitate the disposal of end-of-life OTR (Off The Road / mining truck) tyres creating a new Mining Truck Tyre reclamation facility in Nebo.

To improve the environmental sustainability and reduce emissions of the Queensland coal operations, the process used by Novum Energy Australia produces minimal emissions and recovers re-usable products that can be utilised locally, creating a circular economy and jobs growth.

A senior BHP representative said recycling the tyres would create new jobs for the community, increase sustainability and reduce emissions at BHP's Queensland operations.

BHP's agreement with Novum Energy Australia leverages a relationship with Isaac Regional Council and Department of State Development to build a facility in Nebo.

The plant when operational, will process up to 19,000 tonnes of waste material annually, employing 25-30 staff on a full-time basis.

Novum's Managing Director Rowan Kendall said: "Our focus is on the economical reclamation of waste rubber to address OTR tyres, and conveyor belting.

"With minimal use of energy, Novum converts waste rubber to re-usable products – oils, recovered carbon black, gas and waste steel".

WILMAR BIOREFINERY

Wilmar operates an integrated biorefinery precinct at Sarina with the BioEthanol distillery and the Plane Creek Sugar Mill. The distillery manufactures ethanol to meet the demands of a wide range of applications: the printing industry, cosmetics, toiletries, aerosols, industrial chemicals, household cleaners, pharmaceutical, medical and biological products, food and beverages, flavours, fragrances and surface coatings.

Wilmar BioEthanol is a leading Australian producer and importer of ethanol products, supplying a significant share to the food, beverage, pharmaceutical, printing and general industrial markets as well as supplying the growing fuel market in Australia.

Wilmar AgServices operates a liquid fertiliser and stock-feed business based at the Wilmar BioEthanol plant at Sarina which converts the co-product from the distillery known as Bio Dunder® into a highly valued liquid fertiliser. This is marketed back into the sugarcane, horticulture and stock-feed markets in the Central and Northern Queensland region. Nineteen cartage and application contractors transport and apply the products using state of the art variable rate and GPS controlled truck and tractor applicators.

Wilmar AgServices is leading the way in the efficient delivery of environmentally friendly nutrient solutions in some of the most sensitive Great Barrier Reef Catchments. They have been recognised for their innovative approach with numerous industry and environmental awards.

QUEENSLAND SUSTAINABLE AVIATION FUEL INITIATIVE

The ultimate goal of the Queensland Sustainable Aviation Fuel Initiative is to help enable construction and operation of a sustainable biofuel manufacturing facility in Queensland.

The project started in 2010 at The University of Queensland and a second project is now evaluating the specific business case for a biofuel production plant in Mackay.

The Queensland Sustainable Aviation Fuel Initiative was born out of an aviation industry desire for genuinely sustainable aviation fuels that will match current performance standards. The initiative was established through a Queensland Government National and International Research Alliances Program grant that brought together a consortium of university biofuel experts and industry for the AU$6.5 million first stage of the program.

The second phase to evaluate the business case is funded through the Queensland Government's Research Partnerships Program.

TRANSFORMATION OF SURPLUS TOMATO AND CAPSICUM PRODUCE – Bowen Gumlu Growers Association & Fight Food Waste Cooperative Research Centre Project Partnership

The Bowen Gumlu Growers Association (BGGA) has a significant contribution to the Australian horticulture industry with about $190m worth of tomatoes and $77m worth of capsicums (~42% of national production) produced each year. About 30-40% of the total produce worth ~$300m is lost or wasted due to various reasons and is currently discarded.

The project aims to value add to more than 40,000 tonnes of tomato and 10,000 tonnes of capsicum waste generated every year in the Bowen & Gumlu region. The Bowen Gumlu Growers Association want to utilise surplus/waste tomato and capsicum produce by processing the raw material and creating high-value nutrition and bioactive rich powders, and liquid extracts that can find applications in food, health and feed industries.

The Queensland Government's Department of Agriculture and Fisheries (DAF) is partnering with BGGA and the Whitsunday Regional Council for this project. Stage one will establish proof of concept protocols that will allow scale-up and commercialisation of technologies in stages two and three, if stage 1 desired results are achieved.

New and existing processing technologies will be employed to produce high-value human and animal food/nutritional products.

Use of appropriate technologies to process surplus/waste produce into higher-value products can help to reduce the waste in this sector by at least 70%. This will not only mitigate the crop wastage but also saves resources utilised in the production and will reduce carbon footprint.

PRECINCT OPPORTUNITIES

Abbot Point State Development Area (SDA)

A total of 4,143 ha of available land based around the Port of Abbot Point State Development Area north of Bowen partially owned by the Queensland Government and managed by the office of the Coordinator General and includes other freehold lots.

Local government	Whitsunday
Location	• 170 km north of Mackay • 25 km north of Bowen
Total available land	4,143 ha
Land owner	Multiple State Government owners
Access	• Bruce Highway • North Coast Rail Line • Carmichael Rail Network
Potential industries	• Horticultural waste processing • Processes using aquaculture products, by-products and algae • Biomass co-generation facility

Why develop at the Port of Abbot Point precinct?

- Large parcels and variety of available greenfield land
- Large separation distance from urban areas
- Access to the Bruce Highway
- Close proximity to the Port of Abbot Point facilities
- Access to a diverse skilled workforce within the town of Bowen

Freight and logistics

Road

- Direct access to the Bruce Highway.
- Potential for feedstock transport from Burdekin and Isaac via the Bowen Developmental Road.

Rail

- Direct access to the North Coast Rail Line.
- Approvals are in place for rail link from the Galilee Basin.

Port

- Close proximity to the Port of Abbot Point.
- The precinct is 193 km by road south of the Port of Townsville and 225 km north of the Port of Mackay.

Utilities

Electricity

Serviced by 11HV network with more than 1 MVA available.

Water & wastewater

Dependent on the location, size, scale and infrastructure requirements, there is an opportunity for smaller-scale upgrades and/or on-site solutions.

Telco

Fixed wireless NBN services are available.

Source: Aurecon Group, Mackay

Port of Mackay

A total of 68 ha of available land based on undeveloped land at the Port of Mackay owned by North Queensland Bulk Ports Limited.

Local government	Mackay
Location	5 km north of Mackay CBD
Total available land	68 ha
Land owner	North Queensland Bulk Ports
Access	• Mackay Port Access Road • North Coast Rail Line
Potential industries	• Sugar cane processing • Grains and oil seed processing and biodiesel production facility • Processes using meat by-products • Biomass co-generation and renewable energy

Why develop at the Port of Mackay precinct?

- Single landowner, landlord and planning authority
- Established industrial precinct
- Close proximity to the Port of Mackay facilities
- Access to a diverse skilled workforce within Mackay

Freight and logistics

Road

- A second link to the port - Gudyara Road - was opened in 2020 and the future Mackay Port Access Road will improve heavy vehicle access from the Bruce Highway.
- Spiller Avenue / Edmund Casey Drive / Ken White Avenue are designated as 23 and 25 m B-Doubles routes.
- Overweight and oversize freight can be transported on port roads as approved by the National Heavy Vehicle Regulator.

Rail

The Erakala to Mackay Port line off the North Coast line services the port.

Port

Direct access to Port of Mackay facilities.

Utilities

Electricity

The Mount Bassett 33kV/11kV substation services the port.

Water & wastewater

Water and wastewater services are available.

Telco

Fixed wireless NBN services are available.

Source: Aurecon Group, Mackay

Racecourse Mill

A total of 39 ha of developable land in the area based around the Racecourse Mill and Sugar Refinery, west of Mackay owned by Mackay Sugar Limited.

Local government	Mackay
Location	10 km south-west of Mackay CBD
Land owners	• Mackay Sugar Limited • Multiple private owners
Total available land potential	39 ha (orange border) plus 60 ha of expansion area (yellow border)
Access	Peak Downs Highway
Potential industries	• Processes using sugar cane feedstock • Processes using meat by-products • Biomass co-generation and renewable energy

Why develop at the Racecourse Mill precinct?

- Available greenfield and brownfield land
- Co-location opportunities within an established biofutures precinct
- Behind-the-meter power and steam options
- Access to a diverse skilled workforce within Mackay

Freight and logistics

Road

- Direct access to the Peak Downs Highway - a designated 23 and 25 m B-Doubles route.
- Future development of the Bowen Basin Services Link/Walkerston Bypass presents improved options for freight connectivity.

Port

21 km south-west of the Port of Mackay linked via a designated heavy vehicle route.

Utilities

Electricity

- Mackay Sugar 38MW co-generation plant providing green energy.
- There is potential for a behind-the-meter and renewable energy solution to service the Racecourse Mill precinct.
- Ergon Energy's Racecourse sub-station is within the precinct and it is feasible to run extra feeders to an external customer from the 40MVA transformer at 11KV supply.

Water & wastewater

- There are trunk water mains along Gibsons Road, Te Kowai Foulden Road and the Peak Downs Highway.
- Mackay Sugar could potentially supply raw water, supplied from Racecourse Mill.
- The closest sewer pump station is the Crowleys Road facility 1.8 km east of the precinct.

Telco

Fixed wireless NBN services are available.

Source: Aurecon Group, Mackay

Rosella Industrial land site

A 211 ha site at Rosella, south of Mackay, owned by Economic Development Queensland.

Local government	Mackay
Location	10 km south of Mackay CBD
Total available land	211 ha
Land owner	Economic Development Queensland
Access	Bruce Highway
Potential industries	• Processes using sugar cane feedstock • Biomass co-generation facility • Processes using meat by-products

Why develop at the Rosella Industrial Land precinct?

- Large parcels and variety of available greenfield land
- Access to the Bruce Highway
- Access to a diverse skilled workforce within Mackay

Freight and logistics

Road

- Direct access to the Bruce Highway, road designated as 23 and 25 m B-Doubles route.
- Future development of the Bowen Basin Services Link/Walkerston Bypass presents improved options for freight connectivity.

Port

The precinct is approximately 15 km south-west of the Port of Mackay.

Utilities

Electricity

An Ergon Energy substation is located within the precinct, opposite the intersection of Homebush Road and the Bruce Highway, allowing grid network access.

Water & wastewater

- A 450 mm diameter trunk water main runs along the Bruce Highway.
- Wastewater will need to be managed via an onsite treatment system.
- There are several options available for upgrades for the ultimate development.

Telco

Fixed wireless NBN services are available.

Source: Aurecon Group, Mackay

Nebo Industrial Estate

A total of 98.4 ha of available land based around the established industrial precinct an established industrial precinct east of Nebo

Local government	Isaac
Location	95 km south-west of Mackay
Total available land	98.4 ha
Land owners	Various freehold owners including Isaac Regional Council
Access	Peak Downs Highway
Potential industries	• Grains and oil seed processing and biodiesel production facility • Processes using meat by-products • Biomass co-generation facility

Why develop at the Nebo Industrial Land precinct?

- Large parcels and variety of available greenfield land
- Established industrial precinct
- Access to the Peak Downs Highway
- Access to a skilled staff, equipment suppliers and accommodation

Freight and logistics

Road

Direct access to the Peak Downs Highway, a designated 23 and 25m B-Doubles route.

Utilities

Electricity

Located within the boundaries of Ergon Energy's distribution network.

Water & wastewater

Water and wastewater services are available.

Telco

Fixed wireless NBN services are available to the study area.

Source: Aurecon Group, Mackay

GLOSSARY

BIOMANUFACTURING

Biomanufacturing refers to the industrial biotechnology and bioproducts sector. This sector focuses on developing and manufacturing products from sustainable organic or waste resources, rather than fossil fuels. This term can be used interchangeably with **Biofutures**.

For the purpose of this Blueprint, the term biomanufacturing is utilised in reference to concepts featured in the *Queensland Biofutures 10-Year Roadmap and Action Plan* that are specifically relevant to the opportunities available to Greater Whitsunday.

CONTRACT MANUFACTURING FACILITY

An organisation with the owner and operator making all fermentation capacity available for customers. Typically equipped with necessary infrastructure, facilities and expertise to handle various stages of biomanufacturing process. May also be referred to as a Contract Manufacturing Organisation (CMO).

FEEDSTOCK

Feedstock refers to the raw materials or substances that are used as input in an industrial process, particularly in the production of energy, chemicals, or other products. It is the initial material from which a manufacturing or conversion process begins (ie, sugar to fuel fermentation). The terms feedstock and **biomass** can be used interchangeably.

PRECISION FERMENTATION

Precision fermentation also known as precision biomanufacturing, involves optimising the fermentation process to enhance the production of desired products while minimising waste and maximising yields. It is a specific application within synthetic biology that involves the targeted cultivation and manipulation of microorganisms for the precise production of desired compounds.

SYNTHETIC BIOLOGY

Synthetic biology involves the engineering of biological components, such as DNA sequences, proteins, and cells, to create artificial biological systems or modify existing ones. Synthetic biologists aim to reprogram living organisms or create entirely new ones to perform specific tasks or produce desired products.

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