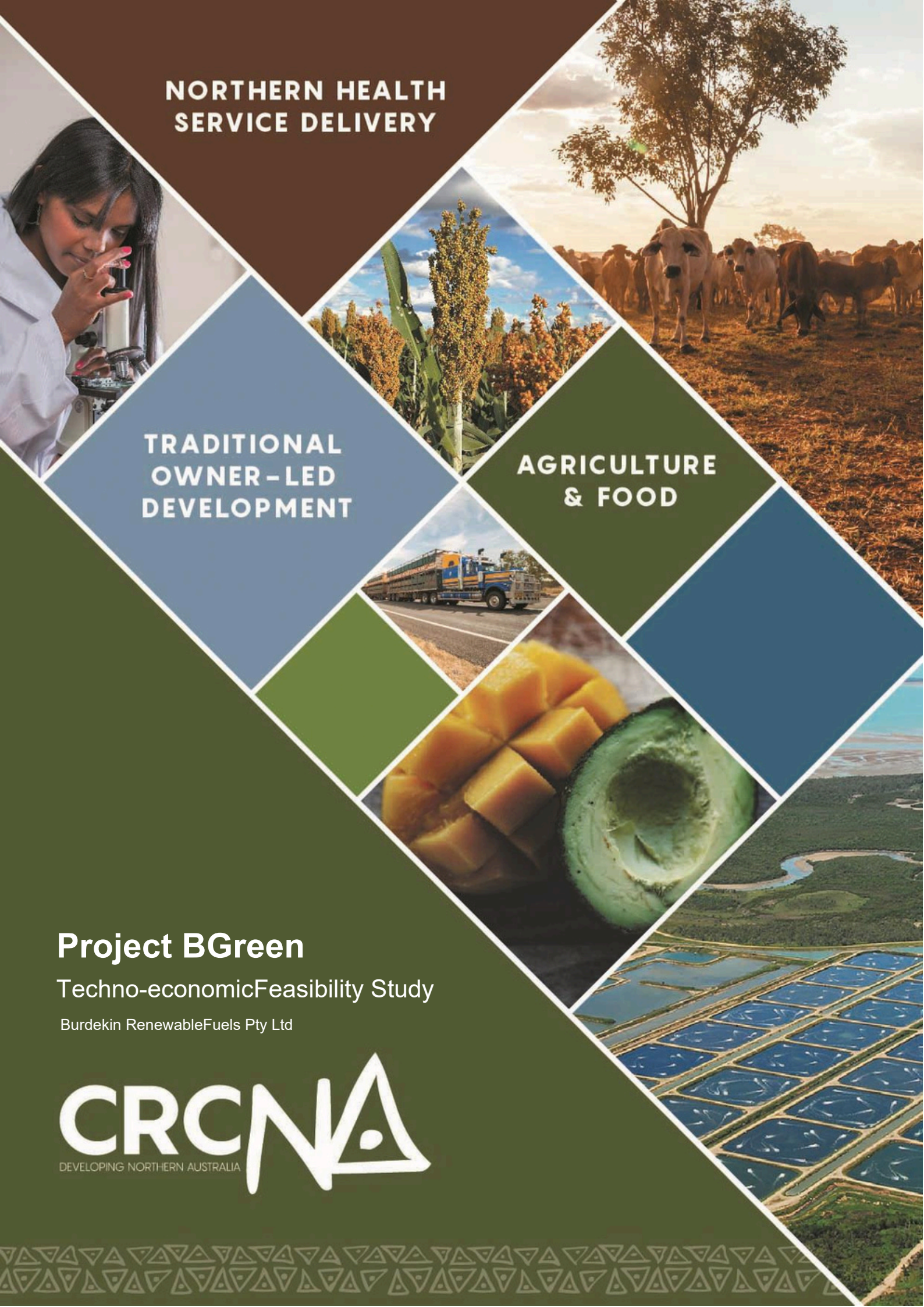


Project BGreen

Techno-economicFeasibility Study

Burdekin RenewableFuels Pty Ltd

CRCNA
DEVELOPING NORTHERN AUSTRALIA

Acknowledgements

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Project Participants

CRCNA	Project Participant
Burdekin Renewable Fuels	Participant and Stakeholder
sra Sugar Research Australia	Project Participant
QUT Queensland University of Technology	Stakeholder
PROCOM CONSULTANTS	Participant and Stakeholder
TOPSOE	Participant and Stakeholder
Sumitomo SHI FW	Stakeholder
S&L PETERS	Participant and Stakeholder

Executive Summary

This study has assessed two designs.

The original design was based on the manufacture of bioglycols from ultrapure sugars and ammonia using hydrogen from the gasification of around 175,000 tonnes per year of naturally dry sugarcane trash. The hydrogen produced was around 14,500 tonnes per year; less than the initial design expectation of around 20,000 tonnes per year. The high capital cost and poor economics for this option prompted investigation of an alternative design.

Coal mine waste gas was identified as a low to negative greenhouse gas alternative to supply energy and feedstock for hydrogen. This allowed bagasse and cane trash to be diverted from energy generation to manufacture biocrude using hydrothermal liquefaction technology from Licella or Topsoe/Stepper Energy. The scale of facilities was sufficient to install upgrading to convert biocrude to drop-in sustainable aviation fuel (SAF), naphtha and diesel.

This raised hydrogen demand to 30,000 tonnes per year including the 7,500 tonnes per year for glycol manufacture.

Resource Description and Logistics
The Inkerman District resource was used as the basis for the design. It is located south of the Burdekin River in the Burdekin Shire, south of Townsville in North Queensland. This District reliably supplies around 2.1 million tonnes per year of whole green sugarcane. The design incorporates an additional 500,000 tonnes of sweet sorghum supplied to the mill outside of the six month sugarcane crushing season.

Site Selection and Description
Arefinery site was selected on the southern edge of the existing cane district. It has a range of attributes including:

- Largeflat area
- Proximity to new cane and cropping land
- Adjacent to powerline corridors
- Proximity to the NQ Gas Pipeline

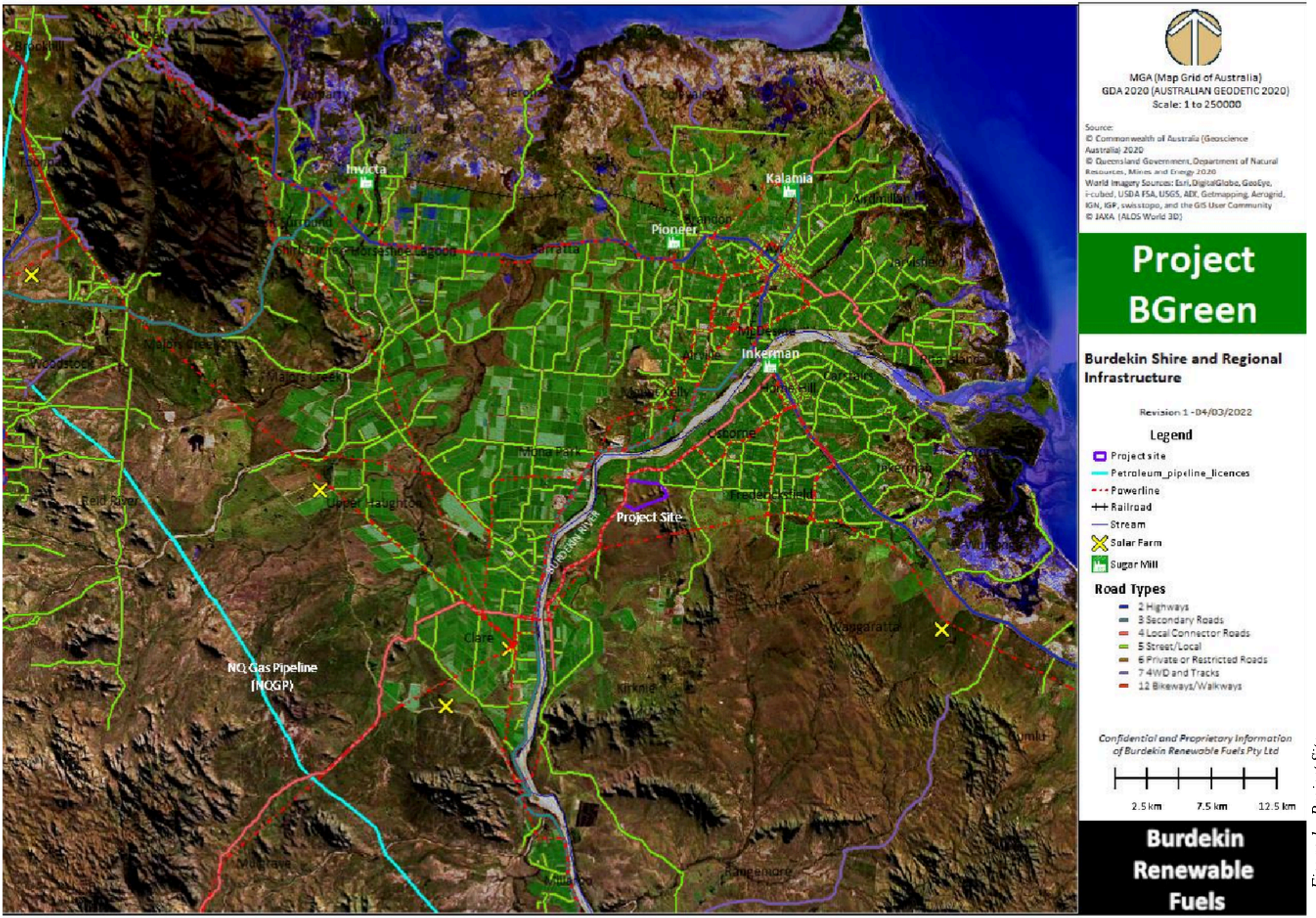


Figure 1 - Project Site

Process Technology

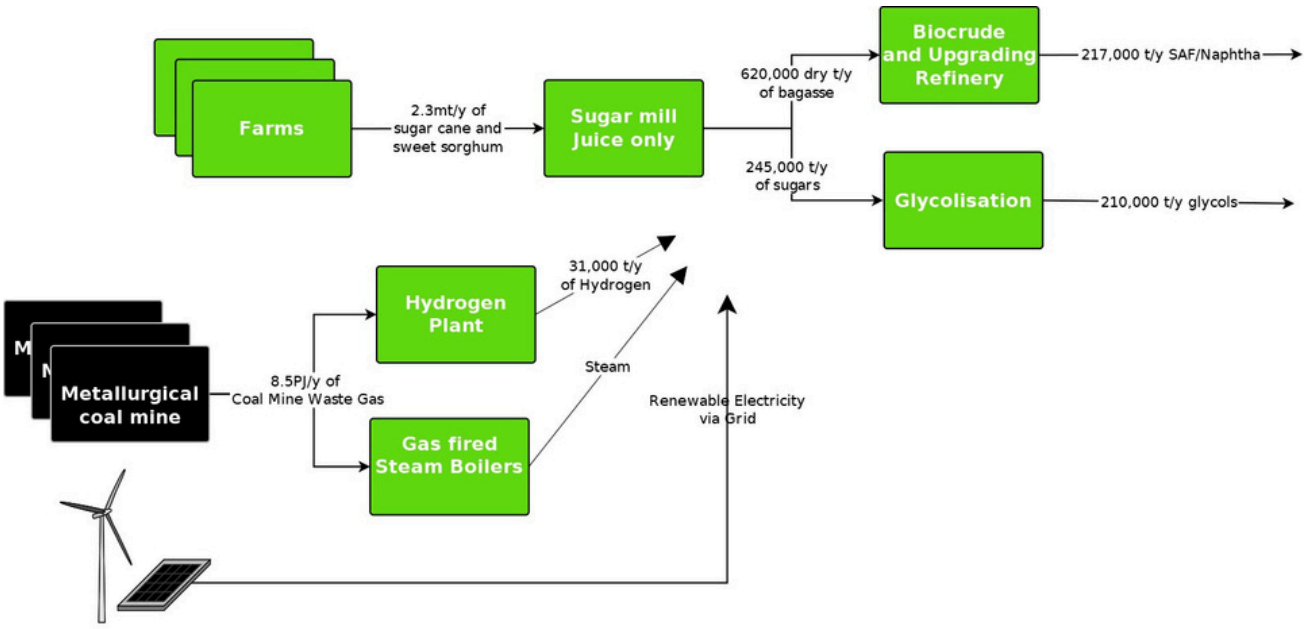


Figure 2 - Process Overview

Major project items included:

Feedstock - 2.6m tonnes per year of sugarcane and sweet sorghum feedstock

Cane Logistics - development of a road and 70km rail supply system to handle 2.6 m tonnes in an 8 month milling season

Sugar mill - modified milling process to manufacture 250,000 t/y of ultrapure sugar by QUT

Glycol refinery - Topsoe monosaccharide cracker technology to manufacture 148,000 t/y of glycols from ultrapure sugar

R-Fuels refinery - 230,000 t/y of SAF, naphtha and diesel from biomass using hydrothermal liquefaction technology from Licella or Topsoe/Steeper and upgrading from Topsoe, Shell, etc.

Ethanol refinery - Molasses (unrecovered sugars from the sugar mill) and sweet sorghum sugars used to manufacture around 50 ML of ethanol, of which 11.3 ML is used internally to manufacture ultrapure sugars.

Hydrogen plant - A conventional hydrogen plant producing 30,000 t/y of hydrogen using coal mine waste gas as feedstock. Formerly, it was planned to use biomass in a Sumitomo SHI FW gasifier to manufacture syngas. Coal mine waste gas provides a negative GHG interim solution until green hydrogen is available.

Steam plant - The original SHI FW biomass boiler concept was replaced by f5 x 100 t/h modular gas-fired boilers, four operating at low pressure, 6 bar and one at high pressure 27 bar. A 50 t/h supercritical water boiler operating at 540 °C and 260 bar is also required for hydrothermal liquefaction.

Major project items included (cont.):

AD Plant - An AD Plant capable of handling around 3 ML per day of high organic process water is installed. Treated water is used to irrigate sweet sorghum.

Utilities - Utilities include supply of:
- Water froma nearby water supply channel
- 33 km gas pipeline spur from the North Queensland Gas Pipeline
- Gas Letdown station at the project site
- 132 or 2 x 66 KV high voltage transmission lines to supply 63 MW of electricity
- Kirknie Road Upgrade
- Construction Camp

Corporate -
- Office based in Townsville
- IT systems
- Land procurement for project site
- Biomass and product certification
- Council and state charges for land and environmental approvals
- Corporate service including legal, financial, sales, technical and HR.

Environmental review

It is the intention that this Project will be a Coordinated Project assessed through preparation of an Environmental Impact Study (EIS), requiring *Environmental Protection and Biodiversity Act* (EPBC) Referral to the Commonwealth Government.

For the Project to be declared 'Coordinated,' a pre-lodgement meeting and application for declaration will need to occur. A description of the proposal is provided in the form of an Initial Advice Statement (IAS) that assists the Coordinator-General in understanding the range of potential sources of impacts and their relevant mitigation.

Using the IAS and draft Terms of Reference (TOR), the Coordinator-General seeks preliminary public feedback to formalise the TOR.

A draft EIS dealing with the ToR is subsequently drafted and publicly released to obtain further community feedback. A supplementary EIS (Final EIS) is issued and evaluated to specify development conditions and management plans which are issued by the Coordinator General. These conditions form the basis of subsequent regulatory approvals.

The final issue of conditions will also be subject to EPBC conditions from the Commonwealth Government.

Native Title

The main project site is not subject to Native Title with the exception of parts of the gas pipelines spur from the North Queensland Gas Pipeline. Relevant parties appear to be:
- Juri People - South of the Burdekin River
- Bindal People - North of the Burdekin River and west to Mulgrave
- Birriah People - adjacent to the NQ Gas Pipeline

Markets

Glycolsarea large traded market of around 15 million tonnes per year for MEG. MPG is a smaller but high value market of round 1.6 million tonnes per year.

Renewable SAF, Diesel and Naphtha are undersupplied markets. Small sales of ethanol are included.

USD products were converted to AUD at the average exchange rate since 2015, ie 0.7262 AUD/USD. The current exchange rate for the month of June 2023 was 0.6630 AUD/USD.

Full year revenue was around 1.08 bn.

Operating costs

The first full year of operations in year 4 indicate that operating costs are $700 million, including escalation. The largest costs are feedstock, followed by chemicals used in the renewable fuels refinery, gas and electricity.

Capital costs

The total capital cost – escalated over a 2.5 year construction period is $2.6bn.

Financial model

The equity internal rates of return are:
Project - 10.4%
Equity - 25.3%

Enterprise Value based on a price to earnings (PE) ratio of 15 and net profit after tax (NPAT) is positive after seven year and reaches $3.9b after ten years. This is a growth multiple of more than 4x equity.

Based on asset of this size in the rapidly growing renewables market and adjacent sugarcane for expansion in the Burdekin (>3x), a PE ratio of 15 is a conservative estimate of the organisations future value.

Risk

Risks largely relate to the early stage nature of the proposed technologies.

The region is, otherwise, a low risk construction and operation environment with a global reputation for high quality and reliable sugar.

Phase 2 Development Framework and budget

There are few places in the World where a project such as the BGreen could be contemplated and successfully delivered.

The next Phase covers the development of the project to the start of construction. The estimated development budget is $35m. It is expected to take 2 years to the start of construction and a further 2.5 years to first product.

Introduction and body

Project intent

Project BGreen brings together industry, university and other research bodies and international partners in a collaborative industry-led R&D venture to:

- Develop enabling technology through QUT and SRA to make pure sugar feedstock from Burdekin sugarcane
- Assess performance and yield at Haldor Topsoe's MOSAIK™ demonstration facility in Denmark
- Assess hydrogen manufacture from sugar cane bagasse using gasification technology from world leading technology
- providers SHI FW – a Japanese/Finnish company
- Incorporate Licella Technology with Shell Upgrading technology to manufacture SAF and Naphtha
- Complete a preliminary design of a facility located at a representative greenfield site at Home Hill in the Burdekin Shire
- Establish the preliminary business case.

The Project will de-risk future project investment by establishing a business case to support discussions with stakeholders including potential ESG investors. The work undertaken in Phase 1 is critical to enable strategic discussions with relevant decision-makers and stakeholders.

It will demonstrate the potential for resetting NQ's sugar industry towards higher value green chemicals and will offer a pathway to transition the sugar industry from trade-restricted raw sugar. Strategic information and knowledge-building developed in this project will clarify the opportunities and challenges to be faced in regenerating the sector.

The proposal at the start of the Study was for a biorefinery to produce BioGlycol from the sucrose and green ammonia or Sustainable Aviation Fuel (SAF) using excess hydrogen from gasified sugarcane trash. Glycol is widely traded commodity used as a precursor to manufacture PET plastics and films.

Green ammonia and SAF are widely proposed as solutions to the intractable problem of maritime shipping and aviation. Despite best intent, both spheres of activity are expected to take decades to transition to liquid fuel alternatives.

All products are dependent on biomass, whilst BioGlycol uses the sugar fraction in sugarcane.

The Study also identified an alternative negative GHG pathway based on the utilisation of Coal Mine Waste Gas (CMWG) – which is equivalent to pipeline quality natural gas. Using CMWG displaces biomass as the source of energy and hydrogen for the Project. Consequently, it decouples biomass from sugar and enables both raw materials to be optimised.

This enables the Project study to focus on:
- Sugar for BioGlycols
- Bagasse for sustainable aviation fuel (SAF), renewable diesel and renewable naphtha collectively called renewable fuels or r-fuels.

Company

Burdekin Renewable Fuels Pty Ltd (BRF) was established on 12 July 2017. It was formed as a subsidiary of Inkerman Cane Growers Organisation Limited (established in 2004) – a not-for-profit entity with 120 members. It has roots as a cane growers cooperative back to the early 1900's.

BRF expanded its equity base in 2022 to raise funds to undertake the Phase 1 study. It will continue to expand its equity position to fund subsequent phases.

Sugar industry

The Australian sugarcane industry, one of the world's most efficient, has innovative growers, millers and exporters of sugar and is recognised world-wide for cutting edge technology and sustainable farming practices.

Australia's sugarcane is grown in high-rainfall and irrigated districts along coastal plains and river valleys on 2,100 kilometres of Australia's eastern shore - between Mossman in Far North Queensland and Grafton in Northern New South Wales. Queensland accounts for about 95% of Australia's raw sugar production and New South Wales around 5%.

More than 4,000 sugar growing farms operate along Australia's eastern seaboard. While the average size of a cane farm is 100 hectares, some are more than 1,000 hectares. Average farm size is increasing each year as the number of Growers' contracts and area farmed by their cane farming business expands. This consolidation is made possible primarily by advances in technology.



Figure 3 - Sugar Industry Snapshot

The Australian cane industry produces 30-35 million tonnes of cane per year which is around 4 to 4.5 million tonnes of sugar. Tops and Trash – not included above – is another 6 to 7 million tonnes of unexploited biomass, either burnt prior to harvesting, collected post-harvest or left on the field to rot.

Innovation

The industry's focus is squarely on its international competitiveness because most sugar is exported and there are no domestic support price or subsidies. Australia has maintained competitiveness by adopting innovative practices across the value chain, particularly through mechanisation, new farming techniques and diversification and new milling technology.

Cane growing and raw sugar production underpins the economic stability of many regional communities. It is the social fabric that has woven itself through the development of townships up and down the coast.

Sugar industry issues

The sugar industry is a substantial contributor to the North Queensland economy. However, its long term viability suffers from intractable trade restrictions, rising costs due to regulatory decisions and an increasingly negative perception related to health concerns about sugar as an ingredient in processed foods.

Burdekin Shire

Burdekin Shire is located between Townsville and Bowen in the delta of the Burdekin River. It covers an area of 504,000 hectares – twice the area of Luxembourg.

The Burdekin region is the largest sugar growing area in Australia. The region is unique in that 100% of sugar cane is irrigated leading to very high yields of around 120 tonnes of cane billets per hectare compared to an Australian average of around 85 tonnes per hectare.

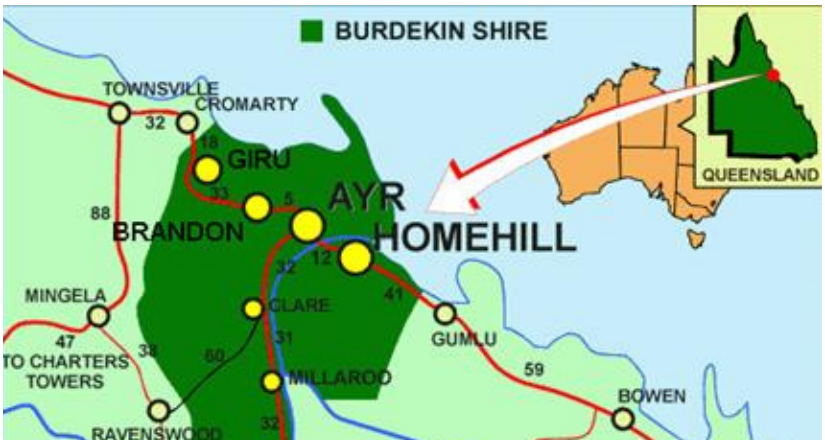


Figure 4 - Burdekin Shire (source: Burdekin Shire Council)

Burdekin resource

Burdekin sugarcane offers a highly productive source of lignocellulose and sugar with crop yields of around 140 to 150 field tonnes per hectare – whole green cane - which are equivalent to around 50 dry tonnes per hectare.

Canegrowers - under the banner of Burdekin Renewable Fuels – are proposing to harvest whole green sugarcane. This harvesting methodology will eliminate cane burning – a disliked practice due to region-specific intractable agronomic issues. These issues include blockage of irrigation furrows and bulldozing/build-up of tops and trash in front of machinery - during field operations.

Burning removes a large amount of extraneous matter, mostly dry leaf known as trash and green leaf known as tops.

Sugar is extracted from the central stalk of the sugar cane plant.

This stalk is cut into **billets** during harvesting to allow it to be efficiently transported to the sugar mill for processing.

Tops is the leafy green growing section of the plant. The moisture content of the Tops is around 75% at harvest.

Trash is the dead leaf. The plant recycles nutrient from old leaves to new leaves, as itdies. The trash falls around the plant and dries to around 8% moisture content.

Burning cane prior to harvesting will always retain some unburnt extraneous matter. This is largely separated by the cane harvester and returned to the ground.

Around 3 million field tonnes of tops and 3 million field tonnes of trash are produced in a typical year in Australia. Combined, this is equivalent to 3.5 million dry tonnes of biomass.

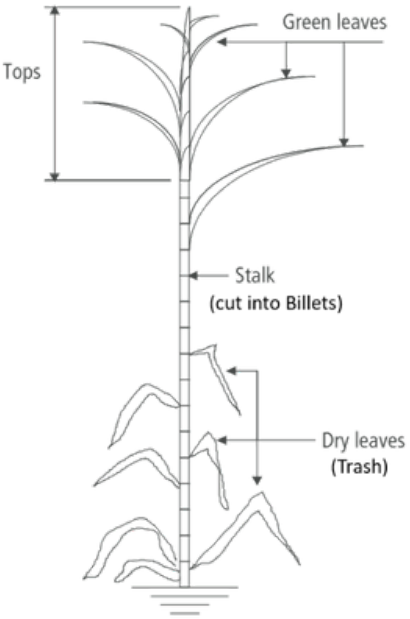


Figure 5 - Key components of Sugar Cane

Inkerman resource

BRF is responsible for the Resource Estimate which is based on more than 120 years of sugarcane growing in the District.

The Inkerman District is a cane-growing district centred around Home Hill on the southern side of the Burdekin River. Annual production is reliably around 1.75 million tonnes of sugarcane billets annually.

Sugarcane is currently burnt prior to harvesting to eliminate cane tops and trash, a ligno-cellulosic resource of around 350,000 field tonnes per year. Combined, this is a total average crop harvest potential of 2.1 million field tonnes per year. Whole green cane will be harvested over a five to six month season.

The region has substantial cleared land that is not currently cropped and would be suitable for additional sugarcane and sweet sorghum. This offers an additional resource potential of 500,000 tonnes per year which can be processed through the sugar mill or field dried to extend the cropping season by around seven to eight weeks.

It has access to:
- Cane rail
- Major Roads
- High voltage transmission lines
- Landfill
- Unexploited cropping land

The site does not have access to rail which is useful for handling bulk products like raw sugar to the Port of Townsville.

Future expansion can occur by conveyor across the Burdekin River to the north side where the Pioneer and Kalamia districts intersect.

Sugar milling

Queensland University of Technology is responsible for the sugar mill and allied processes.

Sugar milling has more flexibility compared to conventional milling for food production. Consequently, QUT have introduced several innovative features. The sugar mill process will be altered to achieve twin objectives:
- Extremely high purity sugar for glycol feedstock
- Dry trash separation for gasification

Additional changes to a conventional sugar mill include:
- Bagasse drying to using waste heat
- Sweet sorghum milling capability

Whole cane green or sweet sorghum will be supplied to mill. Dry trash will be removed and stockpiled for gasification using dry separation prior to milling. A wet separation step will be used to further remove soil contamination to assist efforts to achieve the all-important first objective.

Sugar will be ultra-purified using a new multi-stage cleaning process described in this report.

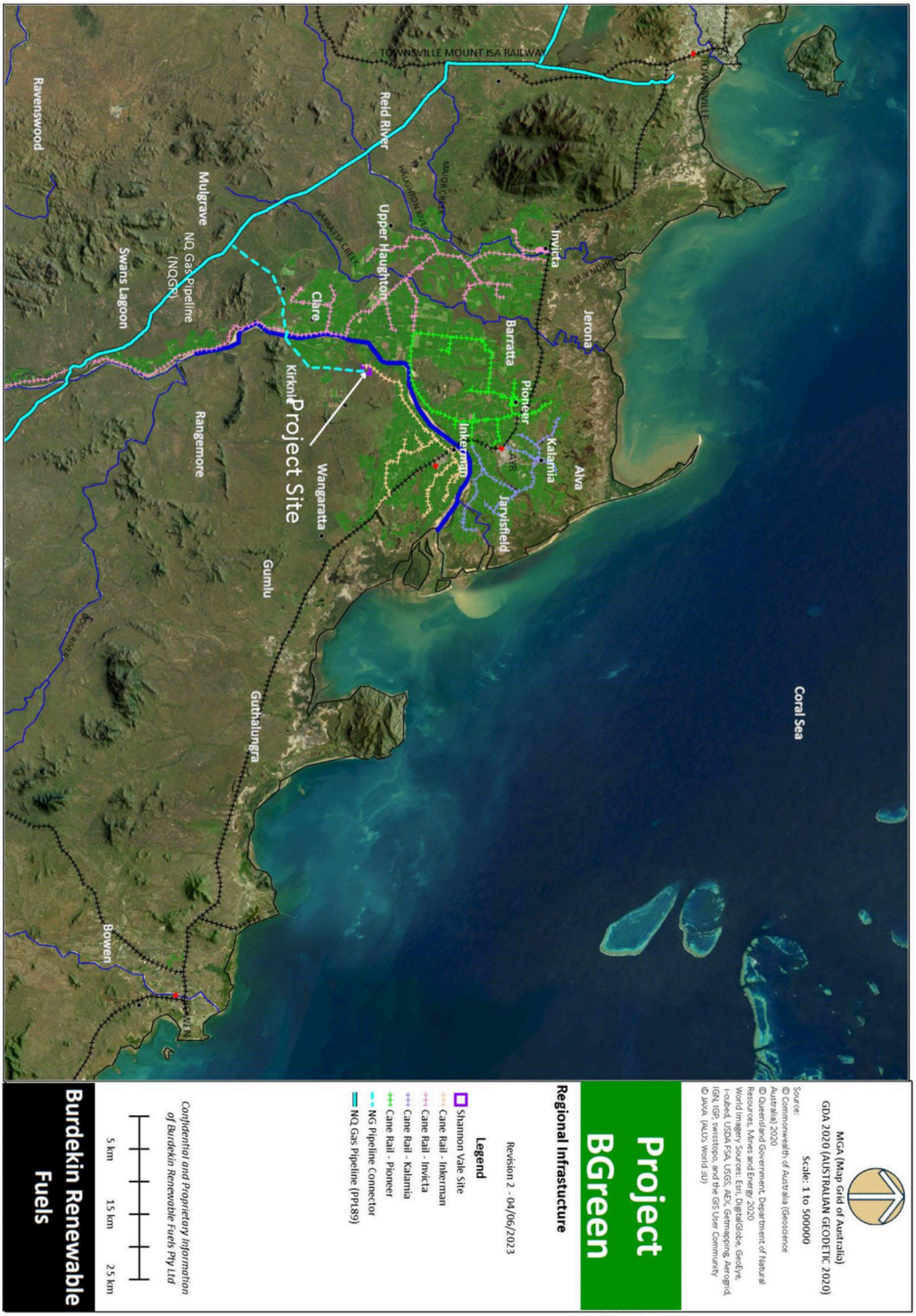


Figure 6 - Proposed Project Site and Regional Infrastructure

Process

Burdekin Renewable Fuels identified technology pathways to use sugarcane to manufacture:

- BioGlycols from sucrose using Topsoe's monosaccharide cracker technology
- Green Ammonia using excess green hydrogen derived directly from biomass and nitrogen from green electricity.

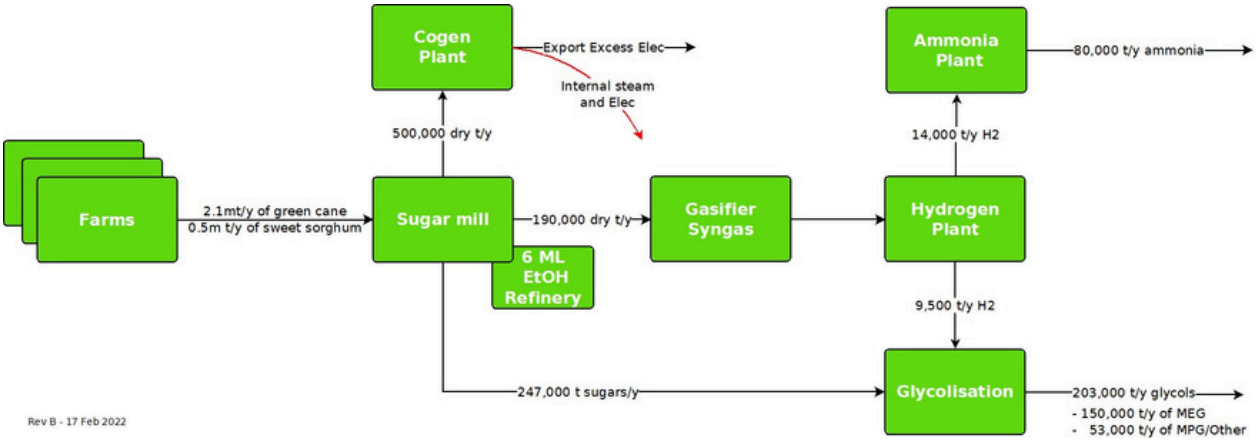


Figure 7 - Original Concept

The design was altered during the Study Phase to focus on:

- BioGlycols from sucrose
- Renewable fuels, predominantly SAF from residual biomass

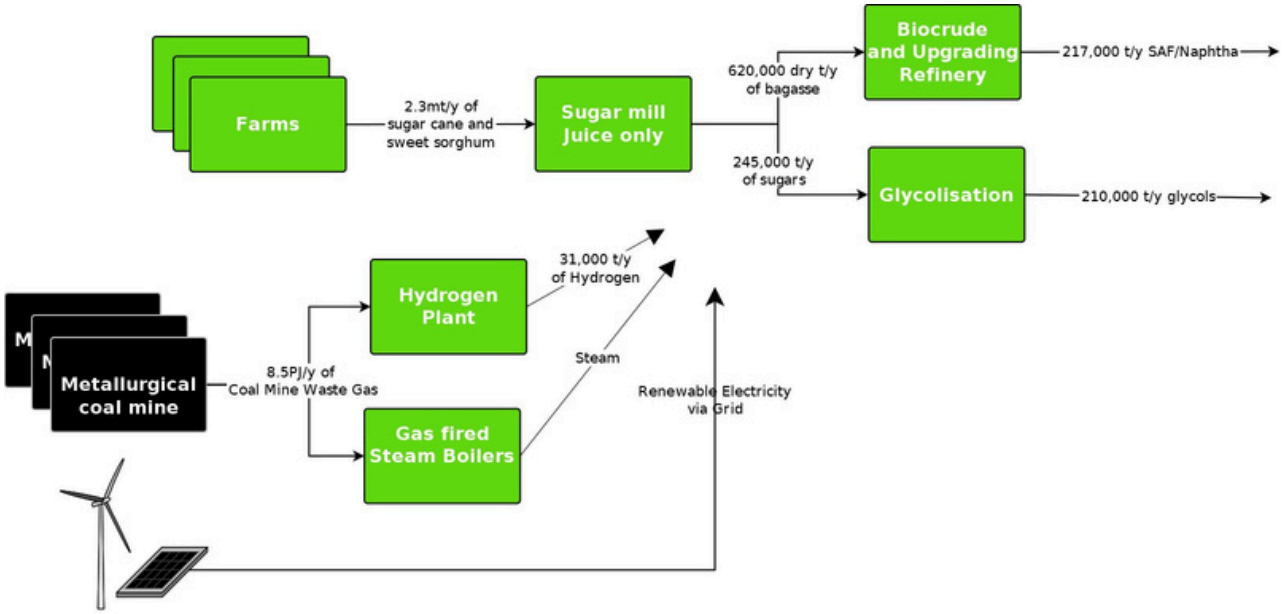


Figure 8 - Proposed concept

This transition was aided by the discovery that:

- CMWG offers a negative GHG alternative as feedstock for hydrogen, steam, process heat and electricity due to avoidance of methane emissions when flaring
- The North Queensland Gas Pipeline (NQGP) from Moranbah to Townsville has capacity to the supply the Project
- QPM Energy is developing additional gas processing capacity at Wards Well in the Northern Bowen basin to supply CMWG.

This approach enables the carbon backbone available in biomass to be available for value-adding to support key transition sectors like aviation. It also reduces the GHG impact from metallurgical coal and, ultimately, provides a transition pathway to green hydrogen.

Importantly, it creates a sustainable manufacturing centre in Australia to deliver strategic security around the supply of renewable military grade fuel and aviation fuel – of which greater than 90% is currently imported.

BioGlycol and Topsoe Monosaccharide Cracker Technology

Danish company - Topsoe - has developed a ground-breaking MoSAIK™ solution that forms the basis for bio-based chemicals. The MOSAIK™ monosaccharide industrial cracker is a pyrolysis/hyrdogeprocess for the preparation of ethylene glycol comprising the steps of pyrolysing a monosaccharide and hydrogenating the product composition in the presence of a catalyst. It enables sugars to be broken down into an intermediary product that can be converted further into a number of bio-chemicals using patented Topsoe catalysts and processes. See Annexure 1.

The alternative bio-pathway to glycols is via a five step ethanol fermentation route which is has relatively low theoretical yield. More than 50% of the mass of sugar is lost in the initial fermentation step.

The pathway assessed in this report is hydrogenation and separation to yield monoethylene glycol (MEG), monopropylene glycol (MPG) and a mix of glycols. Hydrogen is used to complete the glycolisation reaction.

Glycol represents a 15 million tonne per year traded product with over 30 million tonnes per year used to manufacture films and fibres. It is a rapidly growing and freely traded commodity driven by increasing demand for freshly prepared food and convenient packaging.

Biomass to biocrude and upgrading to Sustainable Aviation Fuel (SAF), Naphtha and Diesel

Australian technology company, Licella Technologies, has developed world leading catalytic hydrothermal liquefaction technology – CAAT-HTR™ - which can utilise bagasse to manufacture stable, low oxygen biocrude capable of upgrading to sustainable aviation fuels, renewable diesel (r-diesel) and naphtha (r-naphtha). Naphtha is a key feedstock in refineries to manufacture polymers and plastics.

Sustainable Aviation Fuel (SAF) and r-naphtha are unlikely to be replaced by electricity for decades to come. Current and projected demand substantially exceeds demand.

The CAT-HTR™ platform uses supercritical water (SCW) to convert biomass to biocrude. The biocrude is upgraded using hydrotreating to a range of products including SAF, r-naphtha and r-diesel.

Licella Technologies has investigated the conversion of Burdekin cane tops and trash to manufacture biocrude and demonstrated that itcan be converted to conventional drop-in fuels.

The Federal Government has indicated further support for Licella with a grant of $5million to support development and certification of fuels to military and aviation fuel standards. Qantas and Airbus [1] have established the Australian Sustainable Aviation Fuel Partnership to invest up to US$200 million to accelerate the establishment of a sustainable aviation fuel (SAF) industry in Australia.

[1] https://www.qantas.com/agencyconnect/au/en/agency-news/agency-news-june-22/qantas-and-airbus-joint-investment-to-kickstart-australian-biofuels-industry.html

Other process facilities

Ultrapure sugar manufacture

Liberation of sugar and biomass requires a modified sugar milling process to produce:

- Ultra-pure glucose solution at around 70% Brix
- Dry biomass at around 20% solids

Topsoe's catalytic process requires extremely pure sugar in the form of glucose and fructose as feedstock to optimise the process and to avoid catalyst poisoning. To this end, QUT was contracted to modify existing sugar milling/refining technology to produce a suitable syrup sample and production process.

Alongside standardised processes, novel ethanol/sugar crystallisation was employed. The sugar mill is intended to produce partially processed crystal sugar to enable storage to be used to enable all year round operation of the BioGlycol Refinery. Excess bagasse will also be dried and stockpiled for the Renewable Fuels Refinery to operate all year round.

Hydrogen

Both BioGlycol and renewable fuels use large amounts of hydrogen:

- hydrogenation to convert thermally cracked sucrose to BioGlycols
- hydrotreating to remove oxygen (predominantly) to convert biocrude to SAF.

The original intent of the study was based on green hydrogen manufacture from dry biomass, specifically, cane trash. Using GHG- negative CMWG provides a low carbon intensity alternative, although it is not green.

This option is not effective and consumes a significant amount of biomass which could be better used to provide a carbon backbone for biocrude. Consequently, two options were assessed:

1. Gasification to manufacture syngas and conversion of syngas to hydrogen
2. CMWG to syngas and conversion of syngas to hydrogen

Gasification, Syngas Clean-up and Cogeneration

Sumitomo Heavy Industries (SHI FW) assessed the gasification, gas clean-up and cogeneration system to achieve high efficiency performance from the available biomass resource. The ligno-cellulosic feed is estimated to be around 630,000 dry tonnes per year of which 170,000 dry tonnes per year of cane trash is available to gasify.

SHI FW role is to assess:

- Gasification - Steam and oxygen will be used in a fluidised bed to gasify cane trash to produce a syngas
- Syngas cleaning - Syngas will be cleaned to remove particulates, char, tars and other contaminants.

Preliminary studies and feedback from Sumitomo Heavy Industries (SHI FW) indicated that production of ammonia from sugarcane trash was only sufficient for the production of BioGlycols - which negates the potential for ammonia.

Coal mine waste gas containing methane was identified during the study as a low GHG alternative to hydrogen from biomass and can also be used to generate steam and retain biomass for conversion to biofuels, including aviation fuel.

Coal Mine Waste Gas as alternative hydrogen supply option

Coal mine waste gas (CMWG) is methane from pre-mine drainage of coking coal mines in the Northern Bowen Basin. It is produced from coal mining. Capture and beneficial use of the gas eliminates fugitive emissions of methane which have a GHG intensity of 84 times carbon dioxide over the first 20 years and 27 times carbon dioxide over 100 years.

Consequently, industrial use of CMWG is GHG negative. It reduces global emissions of GHG by converting it to carbon dioxide and using the gas to displace other forms of fossil fuel derived energy to manufacture products.

Negative GHG emissions from CMWG come about through several mechanisms:
- venting of methane during open cut coal mining
- venting and flaring of methane from underground mining
- flaring to lower GHG emissions by burning methane to produce carbon dioxide typically loses around 7 to 9%[2] of the methane to at atmosphere.

Recovery of CMWG by proper pre-mine drainage techniques and subsequent beneficial use by industry or generators reduced GHG emissions, including displacing other fossil fuels.

Using Coal Mine Waste Gas enables the valuable carbon backbone contained within biomass to be used to manufacture carbon-based chemicals or sustainable fuels to replace fossil derived products which cannot be manufactured from electricity.

Its use will be:
- Steam - Boiler modules (LP 4 x 100 t/hour and HP 1 x 100 t/hour), 1 x 50 t/hour SCW
- Hydrogen - Hydrogen plant for supply of hydrogen to:
  - Glycol Refinery
  - Biocrude upgrading facility

Infrastructure and utilities

Infrastructure and utilities include:
- Road and Rail upgrades
- Gas pipeline from the North Queensland Gas Pipeline (NQGP)
- High voltage transmission line connection
- Water supply and water discharge to irrigation
- AD plant to treat process water and create biogas used to manufacture hydrogen
- Product storage and handling

Site selection

A greenfield site is located above 100 year flood levels in the Kirknie District in the western side of a cattle station surrounded by cropping land. The landowners have agreed to permit development of the proposed site (eg, easement/sub-divide) the site. The area has several key features including:
- Surrounded by cane land
- Main roads connection via Kirknie Road to the Bruce Highway
- Adjacent 66KV power line
- Cane rail adjacent to the site
- Adjacent to Kirknie Landfill which receives most of the waste in the Burdekin Shire
- Proximity to the NQ gas pipeline

The site is attractive in respect of proximity to existing cleared land that is suitable for expansion of cropping. The Leichardt – Inkerman sections to the south and east are constrained by sodic soils which will favour cropping of sweet sorghum over sugarcane. Alternatively, the surrounding areas are amenable to solar using non-arable, cleared flat land and wind along Stokes and Inkerman Range.

2 https://www.iea.org/reports/flaring-emissions

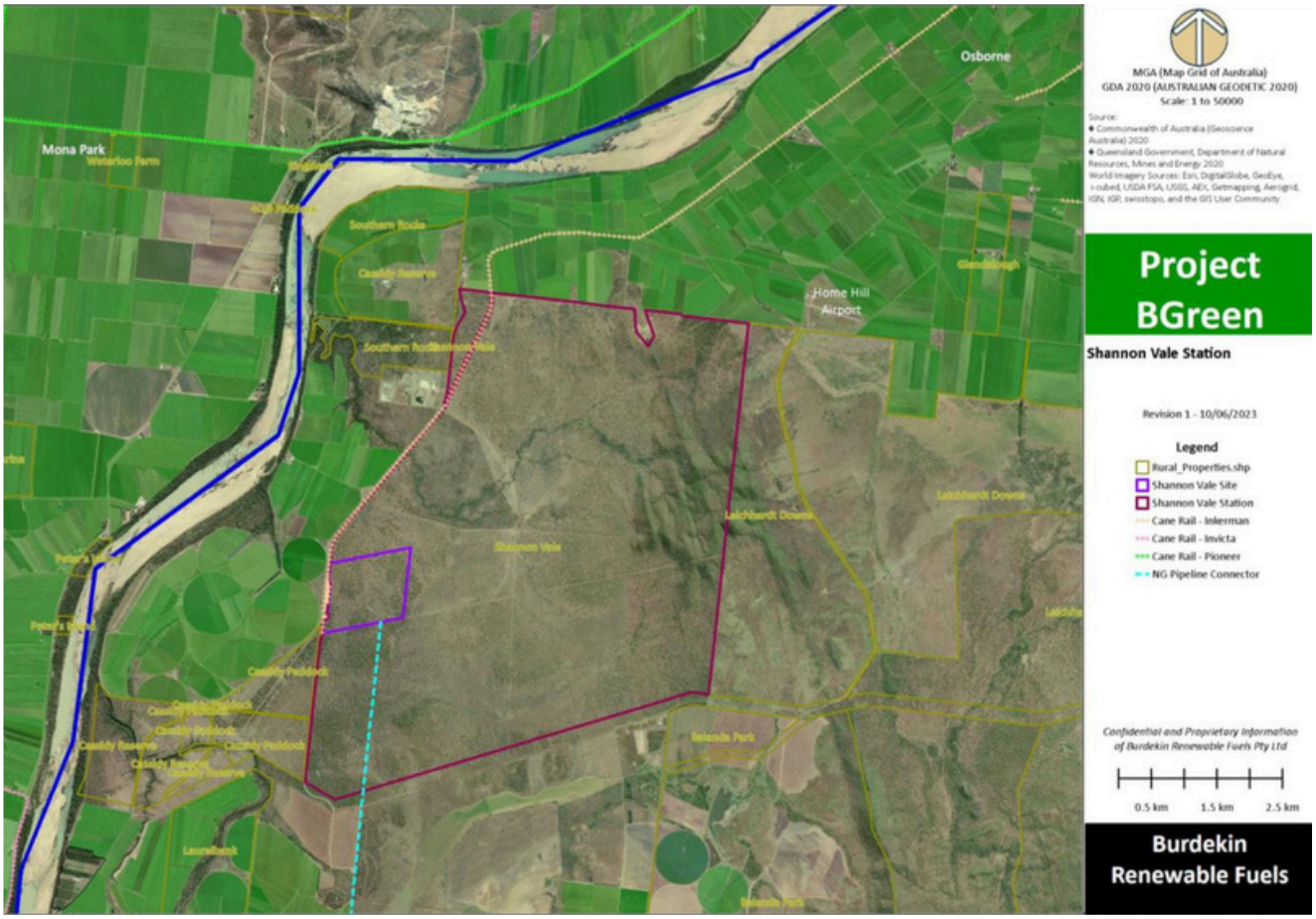


Figure 9 – Indicative site location

Sugarcan logistics

Sugarcane harvesting and delivery are tightly integrated with milling operations. Handling 2.3 million tonnes per year of sugarcane and sweet sorghum in a six month harvesting period implies an annualised movement of around 4.6 million tonnes per year. Whole green cane is bulkier than sugarcane billets, approximately doubling the volume to be handled.

In-field transporters are used to transfer sugarcane to the existing cane rail system. The existing rail system is owned and operated by Wilmar Sugar.

Itis,therefore, necessary to develop an alternative truck and/or rail system to the proposed site.

Excluding existing sugarcane sourcing potential from the North of the Burdekin River, increased opportunities for cropping exist to thesouth and east of the site. Consequently, the design of road and rail systems have focussed on developing new rail infrastructure inthese regions whilst being compatible with road infrastructure in the existing regions.

Market and Product Logistics

BRF has investigated market opportunities for:

- MEG
- MPG
- Sustainable Aviation Fuel (SAF)
- Renewable Naphtha (r-naphtha)
- Renewable Diesel (r-diesel)

Logistics handling requirements have also been assessed based on exports of liquids from the Port of Townsville. Storage facilities are proposed to utilise the capabilities of Sugar Terminal Limited – a grower and miller owned port facilities operator.

MEG markets

The demand for MEG exceeds 30 million tonnes per year and is growing in Asia at more than 4% per year. It is largely used to manufacture PET which is used in plastic bottles and fibres for textiles along with a myriad of industrial uses.

Considerable interest in bioMEG is driven by corporate mandates by food and beverage, cosmetics and other consumer-facing manufacturers to use sustainable packaging.

MPG markets

There are many uses for monopropylene glycol across many different industries.

Consumer markets

The first grade is used in the food industry for food colourings and flavourings and is also a classified humectant food additive (E1520). There are also many applications in the cosmetics industry that use this solvent, specifically personal care products including shampoos, bubble baths, baby wipes and as a moisturiser in make-up.

Industrial markets

The second is industrial grade MPG which has a variety of uses but the main application is as an antifreeze and aircraft wing and runway de-icer which is because its freezing point lowers upon mixing with water. It is also used in heat transfer liquids such as engine coolants.

Monopropylene glycol is used a chemical intermediate in the production of high-performance unsaturated polyester resins used in paints and varnishes and as an excellent solvent utilised in printing inks. It is also used in the manufacturing of non-ionic detergents which are used in the petroleum, sugar-refining, and papermaking industries, the cryonics industry and as an additive in pipe tobacco, preventing dehydration.

Sustainable Aviation Fuel

Heavy, long distance aircraft face a difficult future as it is expected that liquid fuels will be required beyond 2050. The airline industry has committed to zero carbon emissions.

Fly Net Zero is the commitment of airlines to achieve net zero carbon by 2050.

> At the 77th IATA Annual General Meeting in Boston, USA, on 4 October 2021, a resolution was passed by IATA member airlines committing them to achieving net-zero carbon emissions from their operations by 2050. This pledge brings air transport in line with the objectives of the Paris agreement to limit global warming to 1.5°C.[3]

An estimated 65% of the reduction is derived from displacing fossil aviation turbine fuel with sustainable aviation fuel. By way of example, Australia consumes around 10,000 megalitres of aviation fuel. Assuming no further growth, this implies an annual demand of around 6,500 megalitres of SAF. Project BGreen has the potential to produce around 200 megalitres per year.

Displacing fossil aviation turbine fuel is an enormous task.

3 https://www.iata.org/en/programs/environment/flynetzero/

Construction methodology

A construction methodology for the Project is based on expansion of the existing Participant structure and associated large scale vendor/technology packages.

Key packages include:
- Sugar mill
- Glycolisation
- Biocrude from Biomass
- Biocrude upgrading
- Hydrogen plant
- AD plant
- Steam Boilers
- HV Electricity connection
- Gas pipeline and letdown station
- On-site infrastructure
- Off-site infrastructure

A tier one contractor will be selected in Phase 2 to provide an EPC/M contract for the facility.

Environmental review

An environmental assessment of the site indicates that the Project is expected to adhere to the Queensland government's *State Development and Public Works Organisation Act 1971 (SDPWO 1971*) and federal government's *Environmental Protection and Biodiversity Conservation Act (EPBC).*

This process will take an extended period of time due to multi-seasonal ecological studies.

A specialist environmental consultant will be appointed to undertake the scope of services.

Native Title

The refinery site is not covered by Native Title or has an underlying Native Title claim. Claims exist and determinations exist on the Northern side of the Burdekin River. Relevant Native Title Parties include:

- Juru People – South side of the Burdekin River
- Bindal People - North side of the river to the boundary of Beckers Station and into Woodhouse Station
- Birriah People - Part of Woodhouse Station, sharing a boundary with the Bindal People

Alongside cultural heritage surveys and a cultural heritage management plan with each party, an Indigenous Land use Agreement (ILUA) will be negotiated with:

- Bindal People #2
- Birriah People

Further research may identify Native Title Areas that relate to the Juru People or other Native Title parties.

Financial model

A financial model was developed to gather revenue, operating and capital costs to assess the financial performance of the Project. This forms the basis of subsequent capital raisings to develop the project.

Phase 2 Development

This Techno-economic Feasibility Report addresses Phase 1. It will provide supporting documentation for BRF to raise $35m to complete Phase 2 which is intended to take the $2.75bn project to the start of construction.

Phase 2 will expand upon the CRC NA strategic objectives including capacity building and wealth creation in NA. For example, Phase 2 which will build strategic research capacity at the QUT's Biocommodities Pilot Plant to demonstrate Phase 1 research into sugar purification.

The impact from the successful conclusion of the $2.75bn Phase 3 Construction will be an entity with a regional multiplier of more than 3x the value-add which comprises wages + depreciation + profit. Value added is a higher portion of revenue for integrated companies like Project BGreen which adds significant value to sugarcane beyond existing sugar milling operations.

Phase 2 proposes a development spend of around $35m to complete further pilot testing, regulatory approvals, bankable feasibility and contractual negotiations to fund the construction of the project.

Project risks

The project is exposed to predominantly technology risks and commercial volatility due to pre-existing commercial arrangements and commitments between Growers and Wilmar – a regional sugar milling monopsonist.

The risk assessment has been undertaken in accordance with the likelihood, consequence and risk matrices.

Subsequent stages of the project will undertake a risk assessment consistent with the requirements of Australian Standards (AS) ISO31000 (2018) Risk Management – Guidelines.

Strategic recommendations

This Techno-economic Feasibility Study has refined the project concept to an integrated biorefinery that uses sugar and bagasse to manufacture bioglycols and renewable fuels. Other key inputs are coal mine waste gas as interim feedstock to generate steam and hydrogen and renewable electricity via a grid connection.

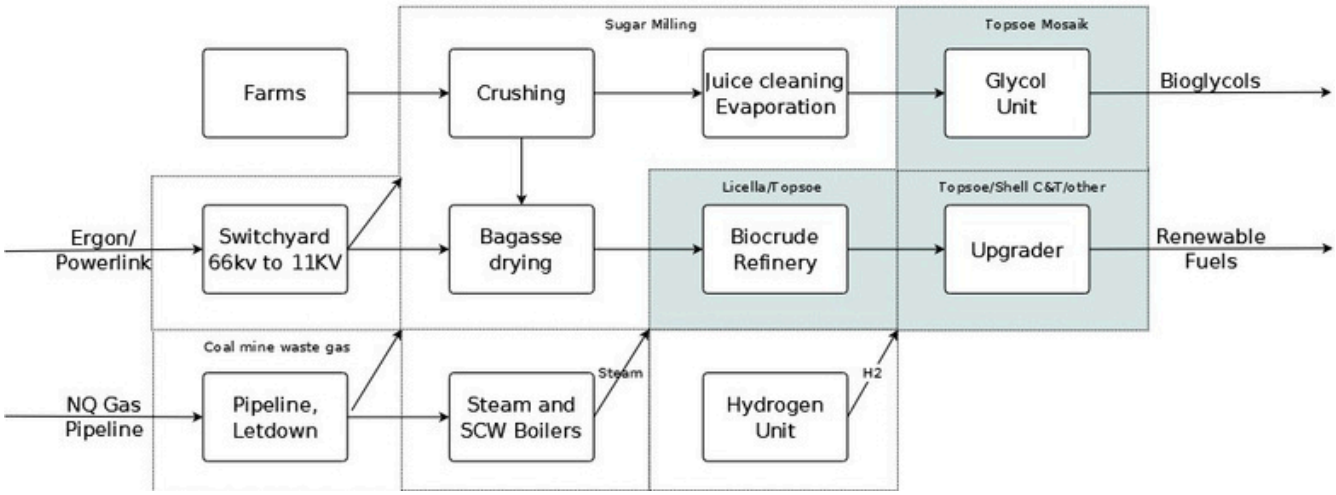


Figure 10 - Major Project Facilities

Project BGreen will be developed in three phases prior to ongoing Operations. The development phases are:

1. **Establishment phase -** largely a Scoping Study which included the first stage of process development for the manufacture of ultra-pure sugar and the definition of project options including an assessment of ammonia versus sustainable aviation fuel. This – in essence - the basis for this document.

2. **Pre-construction phase**, which will include a Definitive Feasibility Study to:
   - Identify and secure suitable land (size and appropriate land use) for each of the facilities
   - Pilot the manufacture of ultra-pure sugar, Bioglycols and Biocrude/r-fuels
   - Complete a definitive feasibility to support financier due diligence
   - Secure statutory approvals
   - Finalise contracts for sugarcane, construction, market off-take and financing
   - Engage with funding partners and secure project finance.

3. **Execution phase** for the engineering, procurement, construction and commissioning phase of the capital works.

4. **Operations phase** - includes a ramp-up to progressively increased production. This will be conducted in parallel with an extended period of capital works in authorised phases to progressively add further production capacity.

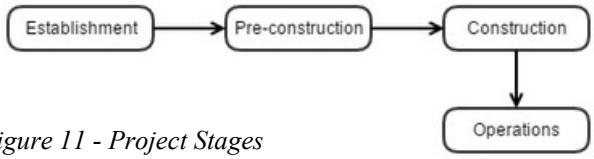


Figure 11 - Project Stages

The Project will be delivered as an integrated production system, providing reliable, long-term, high quality and large-scale production of biocrude.

Proposed Project Structure

The proposed project structure is based on Burdekin Renewable Fuels being the development vehicle for the enterprise. It will expand the team to provide commercial and technical support to contractors to undertake the pre-construction phase and subsequent construction phase.

Underpinning each phase is a suite of agreements leading to Financial Close. The items in the diagram below focus on high level agreements.

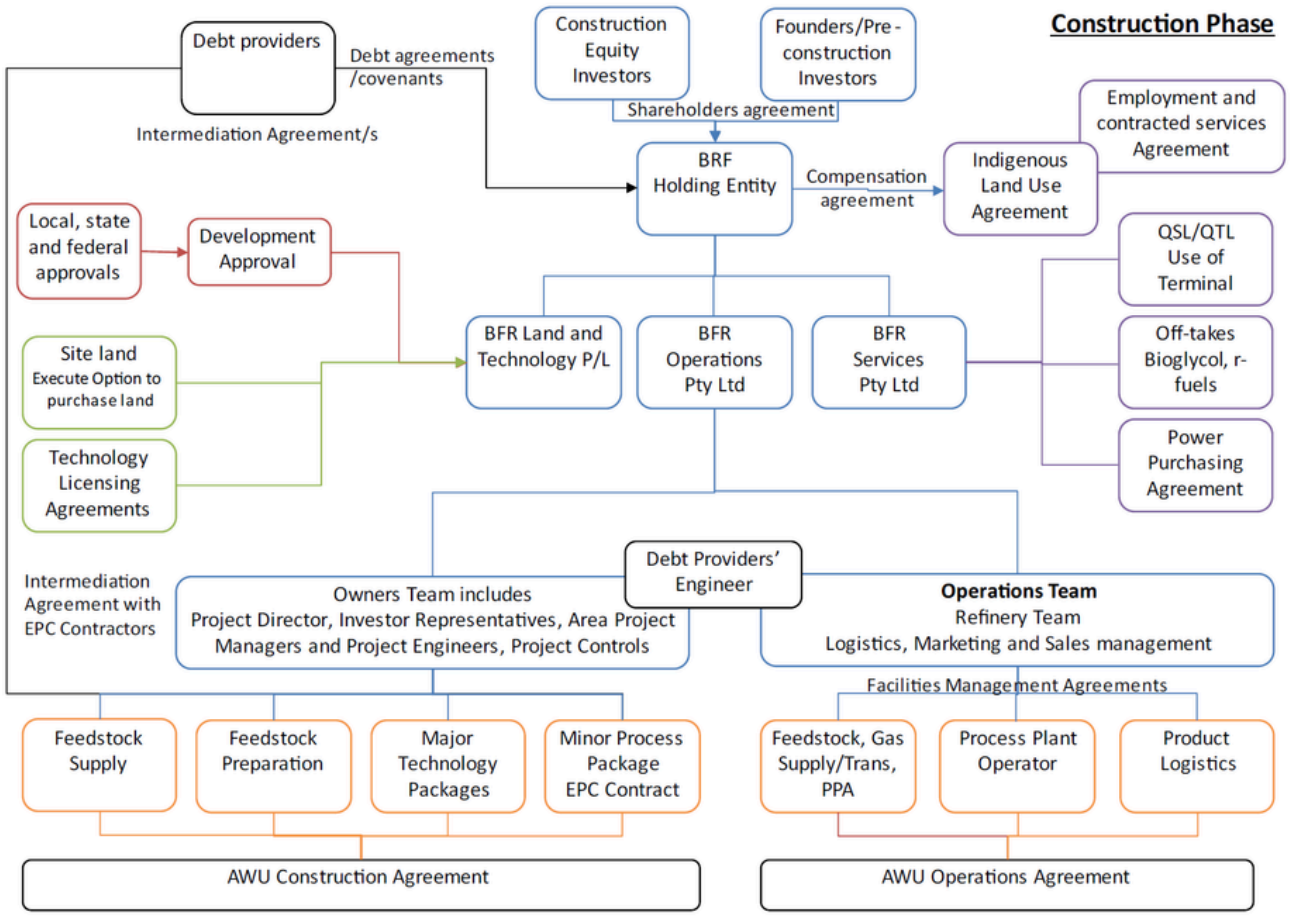


Figure 12 - Indicative Project Agreements

Pre-construction phase

Following the completion of the current Establishment Phase and securing funding to carry out the next phase, the Pre-construction Stage will commence.

Key elements to be addressed include:

1. Secure Land under an Option to Purchase
2. Engineering design including further pilot trials
3. Definitive Feasibility Study
4. Regulatory approvals
5. Logistics arrangements
6. Construction contracts
7. Feedstock agreements
8. Off-take agreements for bioglycols and r-fuels.
9. Financial modelling
10. Investor/Financier due diligence
11. Equity and debt agreements

Secure Land under an Option to Purchase

BRF will negotiate an option over the land for a period of 36 months to undertake the Pre-construction Phase. The Option will be executable on Financial Close with 30 days to settlement.

Engineering design including further pilot trials

Pilot testing will continue during the Pre-construction Phase and include production of bioglycol and biocrude samples for customer evaluation. Accreditation of SAF using the hydrothermal liquefaction pathway and Burdekin sugarcane is expected to occur in parallel under funding provided to Licella by the Department of Defence for that purpose.

Definitive Feasibility Study

The Definitive Feasibility Study will be conducted on the preferred development case, studying and establishing:

- All the project risks including agreed mitigation measures to control any critical risks
- The detailed engineering scope of the project
- A detailed estimate of capital and operating costs, developed to a Class 3[4]methodology and an accuracy of nominally ±10-15%
- The project schedule and detailed plans necessary to meet the schedule
- The organisational development of Burdekin Biocrude Refinery and its partners required to deliver a project of this size and complexity
- The basis for the bankability assessment of the project, leading to Financial Close

Table 1 - AACE International (AACE) Recommended Practice No. 18R-97 outlines the Cost Estimate Classification System

	Primary Characteristic	***Secondary Characteristic***			
ESTIMATE CLASS	**LEVEL OF PROJECT DEFINITION** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]	**PREPARATION EFFORT** Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

4 AACE International (AACE) Recommended Practice No. 18R-97 outlines the Cost Estimate Classification System in the process industry. There are 5 classes defined by AACE.

Regulatory approvals

It is expected that the Project will be a coordinated project under the *SWDPO Act 1971*. Commonwealth (*EPBC Act*) and State approvals will be assessed bilaterally via and Environmental Impact Statement (EIS) process.

Matters to be addressed will be:
- Traffic
- Air Quality
- Water emissions
- Noise emissions
- Contaminated land and waste
- Matters of State Environmental Significance (predominantly flora and fauna)
- Matters of National Environmental Significance (predominantly flora and fauna)
- Hazard and risk
- Flooding
- Groundwater
- GHG
- Offsets

Offsets (approximately 4 x impacted habitat) may be required for state and federal approvals subject to impacts on flora and fauna. State offsets are typically subservient to federal offsets to avoid double counting. Potential exists to locate offsets adjacent to the site.

Additional approvals include:
- Various agreements with Council for road upgrades and utilities (water, sewage, legal advice required) and interface with plant design and layout
- Agreement with Main Roads for highway crossings
- Building approvals (through council)

Logistics arrangements

Logistics arrangements will be required for:
- Whole green cane from farms to the refinery incorporating new rail lines and upgrade road access including Highway crossing.
- Raw material supplies including lime, chemicals, etc
- Replacement parts to maintain the facility
- Construction camp

Construction contracts

The construction model is based on the development of Project Management Service Team reporting to BRF. The team will coordinate tendering for equipment and construction contracts and recommend an appropriate contractor/s to build the facility.

This will occur during the Bankable Feasibility Study to bring to the Study cost estimate a construction-driven focus.

Secure Feedstock agreements

Sugarcane supply agreements are typically rolling three year contracts between Growers and Wilmar. This has worked well in an environment where there is only one milling entity. It does permit Growers to plan ahead and opt out to grow other crops at the expiration of the contract period.

The three year timeframe is – more or less – linked to a foreseeable timeframe for securing prices for Raw Sugar which each Grower is required to do for their 2/3rd share of the raw sugar produced by the Miller.
A long term fixed price contract would be a favourable alternative to Growers as it secures future planning and permits long term investment in farm and equipment.

The contract negotiation will predominantly take place with representative district Grower groups like Inkerman Cane Growers Organisation Limited. Larger Growers and funds-backed farming entities will negotiate separately.

The negotiation is a protracted process and will require considerable time and securities.

Off-take agreements

Off-take Agreements are valuable. It is likely that offtake will be constrained to party in return for early stage investment to underpin the financing of the Pre-construction Phase.

	Name	Duration	Start	Finish	Predecessors
1	Project Start	1 day?	31/07/23...	31/07/23...	
2	Phase 2 Funding	132 days	1/08/23 ...	31/01/24...	1
3	**Phase 2 - Preconstruction**	**403 days**	**1/02/24..**	**18/08/2...**	**2**
4	Option over land	80 days	1/02/24 ...	22/05/24...	2
5	**Pilot Plant testwork**	**280 days**	**1/02/24..**	**26/02/2...**	**2**
6	Pure Sugar Testwork	200 days	1/02/24 ...	6/11/24 ...	2
7	Glycol pilot trial	120 days	12/09/24...	26/02/25...	2;6FS-40 ...
8	Biocrude testwork	260 days	1/02/24 ...	29/01/25...	2
9	Upgrading testwork	130 days	1/08/24 ...	29/01/25...	2;8FS-13...
10	Regulatory Approvals	400 days	1/02/24 ...	13/08/25...	2
11	Native Title ILUA /CHMP	200 days	23/05/24...	26/02/25...	2;4
12	Bankable Feasibility Study	280 days	1/02/24 ...	26/02/25...	2
13	Contracts	160 days	2/01/25 ...	13/08/25...	12FS-40 d...
14	Financing	123 days	27/02/25...	18/08/25...	10FF;12
15	Phase 3 - Construction	650 days	19/08/25...	14/02/28...	3
16	Phase 4 - Operations	1 day?	15/02/28...	15/02/28...	15

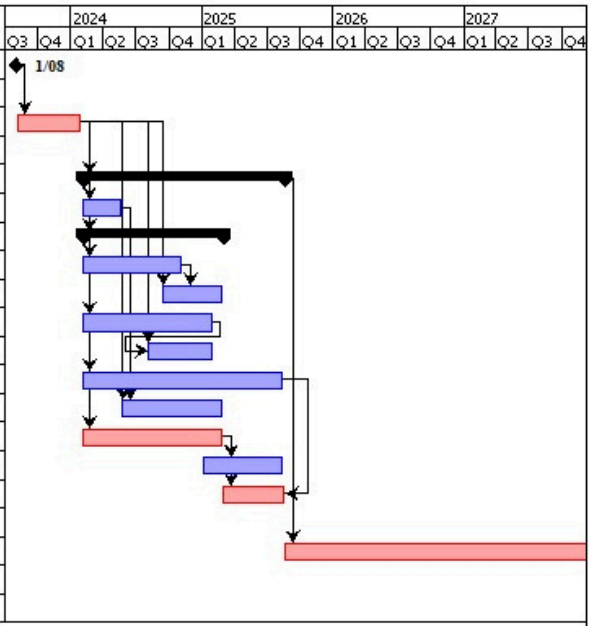


Figure 13 - Planned Schedule, Feasibility and Execution phases

Financial modelling

Financial modelling will be validated by an external corporate adviser.

Due diligence will commence when the financial model is advanced and the BFS is reaching conclusion.

Equity and debt agreements

Corporate advisory support will be contracted to support equity and debt arrangements. Alongside conventional and non- conventional (green bond issuance, debt will be sought from Australian and offshore Export Credit Agencies such as:

- CEFC
- NAIF
- ARENA
- EFIC (vendor finance support)

Project schedule

The planned schedule for biocrude production is 24 months from the end of the Pre-construction Phase. This is expected to be finalised in late 2023 resulting in biocrude production occurring in 2028 using stockpiled bagasse.

Based on the current management plan for the studies, the schedule is shown in the Figure 20.3 below.

The key event between now and the start of the Pre-construction Phase is investment attraction to fund the Pre-construction tasks.

Pre-construction budget

The Pre-construction budget identifies the estimated costs to complete all the tasks required to move the Project to Financial Close which signals the start of the Construction Phase. The total amount budgeted to be spent during the Pre-construction Phase is $35 million.