

Economic impact of a future tropical biorefinery industry in Queensland

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Key points

- The commercial production of replacements for chemicals, plastics, and fuels from biobased feedstocks, using technologies such as fermentation and thermochemical conversion, is now established globally, with annual production of hundreds of thousands of tonnes.
- Queensland has a comparative advantage in bio-refining – the climate and agriculture sector ensure a large supply of biomass material that can be used to produce chemicals, plastics and fuels. The production of biobased products was identified as an area of increased focus in *Queensland's agriculture strategy*.
- This study estimates the economic impact of a sample of potentially viable new manufacturing facilities using several arid, tropical and sub-tropical crops. By 2035, the annual impact of the modelled biorefineries is estimated to be over \$1.8 billion. The net present value of their contribution over the modelled period is \$21.5 billion. By 2035, they support over 6,640 FTE employees, many of which are in regional Queensland.
- Biorefineries in Queensland are likely to be a viable source of economic growth and diversification. Their output can be used as inputs to domestic industries as well as generate export earnings. In addition, biorefinery industries can significantly value-add agricultural outputs, diversifying agricultural producers' revenue base.
- The economic impact analysis assumes that the biorefineries operate without government subsidisation. While production is viable without ongoing subsidies, some government facilitation would assist in industry establishment.
- There is a potential role for government in facilitating investment in the sector and ensuring policy settings do not impede private investment, for example through streamlining processes for environmental approvals. In addition, any potential biorefinery investors could make use of the services of Queensland Government agencies (including the Department of Agriculture, Fisheries and Forestry and Trade and Investment Queensland).
- International experience shows that governments can make an important contribution to attracting investment, for example through developing technology precincts and facilitating relationships between international companies and domestic industry.
- For commercial investors, this analysis supports the case for investing in the next phase of detailed design, engineering, construction cost estimation and due diligence.

Summary Report

Introduction

This report is a joint production by Deloitte Access Economics and Corelli Consulting.

qutbluebox engaged Corelli Consulting to provide the scientific information on industrial biotechnology, the case studies and potential bioproducts, presented in Chapters 2 and 3 and Appendix A of the full report.

qutbluebox engaged Deloitte Access Economics to estimate the potential economic impacts of a future tropical biorefinery industry in Queensland. This includes report content relating to economic impact analysis (including regional socioeconomic profiles, regions included in the economic impact analysis, economic characteristics of projects and discussion of computable general equilibrium modelling).

Biorefining is the process of converting biomass (organic matter) into value-added chemicals, plastics and fuels. Research into biorefineries has escalated in recent years, with a push to transition to renewable and sustainable feedstocks and reduce reliance on petrochemicals.

There are significant opportunities from biorefining for Australia, and regional Queensland in particular, including export revenues, economic growth, diversification of the agricultural sector, stimulating Australian manufacturing and climate change mitigation. Many of the potential feedstocks are the by-products of agricultural processes, or waste products that would otherwise require disposal or combustion. The various climates of Queensland (ranging from tropical to sub-tropical to arid zones) provide a diverse range of potential biological feedstocks for the production of chemicals, plastics and fuels.

Over the last decade, the ambition to secure an industrial future based on renewable resources has built significant momentum globally. The movement to sustainable chemicals and plastics manufacture has been supported by the major chemical and technology-based companies.

International experiences

Two case studies (Malaysia and Brazil) highlight key issues of the international experience in the industrial biotechnology sector. In Malaysia, a clear government vision for technology precincts has paid dividends, by attracting international businesses to Malaysia. The success of this strategy can now be measured in gross national income and new jobs generated as a direct outcome of precinct development. This success is expected to continue as Malaysia revives failing national industries and brings additional value to existing agricultural production.

As is the case with the Malaysia, the Brazil case study is built upon a national vision for the development of a new industrial sector. In Brazil, government has played a role in attracting international companies and facilitating collaboration of those companies with national industries, particularly those that supply feedstock for chemicals and plastics production.

Malaysia

Malaysia is home to two major biorefinery precincts, each based on key local feedstocks, designed to attract international chemical and polymer manufacturers. Kertih Biopolymer Park, reportedly Asia's largest biorefinery complex, was launched as a collaboration between Malaysia's national, regional, and state governments. This biorefinery precinct is planned to initiate a cellulosic feedstock-based chemical manufacturing sector that could generate US\$6.14 billion in income and create 2,500 new jobs by 2020. Two keystone participants are the joint venture between South Korea's CJ CheilJedang Corporation and France's Arkema for the feed additive methionine (80,000 tonnes per annum, or tpa) and the US-based technology company Gevo, which will be producing the solvents bio-isobutanol, butanediol and ethanol at the 60,000-tpa scale by 2015.

The second precinct, Bio-Xcell, was initiated as a partnership between two palm oil plantation firms (Felda Global Ventures Holdings and Sime Darby Bhd) and Malaysia's national government. The keystone participant is US technology firm GlycosBio, to manufacture isoprene, used in synthetic rubber, to support Malaysia's rubber industry. Bio-Xcell could be the basis of a biorefinery model that would revitalise the biodiesel industry by transforming 20 palm oil-based biodiesel plants into economically viable biochemical plants.

Brazil

Brazil has leveraged its highly-developed sugarcane industry and 30 years of investment in the ethanol industry to build a global centre for bio-based plastics. The chemical giants Dow, Cargill, Evonik and Braskem have reportedly invested over US\$2 billion in Brazil to date. Dow has already established a global-scale, 240,000 tpa ethanol plant (2011), and, more recently in a joint venture with Japan's Mitsui, is planning on value-adding that ethanol by converting it to ethylene and polyethylene in a biopolymers facility, worth around US\$1.5 billion. Brazil's emerging global-scale biorefinery industry is established on sites selected based on access to raw material supplies, logistical connections (road and port), and proximity to local markets.

A Queensland biorefinery industry

This report examines a potential future biorefinery industry in Queensland. The projects included for discussion involve the manufacture of both fine and commodity compounds, and polymers for the global chemical and pharmaceutical sectors, derived from green or bio-based feedstocks.

This Queensland initiative is defined by multiple biorefinery facilities across the state, co-located with their agricultural, forestry and green waste feedstocks. The regional biorefineries included for discussion would generate a portfolio of fine and platform chemicals for domestic use or export: platform chemicals like succinic and levulinic acids,

speciality chemicals like xylitol, the aromatic chemical furfural, phenolic resins, and biobased aviation fuel, as well as ethanol, electricity and animal feeds for local consumption.

Seven biorefinery projects were shortlisted for discussion and economic impact analysis. These include:

- Polyethylene production using greenfield sugarcane (project A)
- Resin production using green waste (project B)
- Succinic acid production using sugarcane bagasse (project C)
- Aviation fuel production using Brigalow regrowth (project D)
- Levulinic acid production using forestry residue (project E)
- Xylitol and ethanol production using sweet sorghum (project F)
- Ethanol production using sorghum stover (project G)

This set of projects does not represent the entirety of the possible future biorefinery industry in QLD, but a shortlist identified through an iterative process involving workshops with **qutbluebox**, QUT scientists, Corelli Consulting and Deloitte Access Economics. Inclusion was based on a range of factors including commercial viability, data availability, published research, export markets, feedstock availability, overseas experience and commercial scale suitability. Future advances in biotechnology will likely bring forth previously unforeseen commercial biorefining opportunities, potentially in addition to those modelled here.

As well as replacements for existing petroleum-based chemicals and plastics, the biological feedstocks suited to cultivation in Queensland, or available as by-products or waste, offer the opportunity to manufacture new chemicals not available (or not easily derived) from existing petroleum-based feedstocks. Importantly, this study demonstrates the potential for economically viable new manufacturing facilities using several arid, tropical and sub-tropical crops. The manufacturing processes largely do not compete with feedstocks used in food manufacturing or stock feed production (in some cases the bio-refinery actually increases production of stock feed as a co-output of the refinery), thus avoiding some of the issues experienced in other countries from increased competition for existing agricultural feedstocks.

The projects modelled would leverage Queensland's strengths in agriculture and industrial biotechnology, and provide benefits such as value-adding agricultural commodities. A range of different technologies suited to different climates and feedstocks suggest bio-based refineries could lay the groundwork for a state-wide industrial future. The technologies which underpin the conversion of biomass to valuable products are all well-established and suited for development into commercial-scale refineries, and provide the opportunity for Queensland to capture value from earlier publicly-funded research.

Economic impact analysis

Deloitte Access Economics has used a customised version of our in-house regional general equilibrium model (DAE-RGEM) to model the estimated impacts of biorefinery construction in Queensland. The economic impact analysis compares the 'project scenario', which

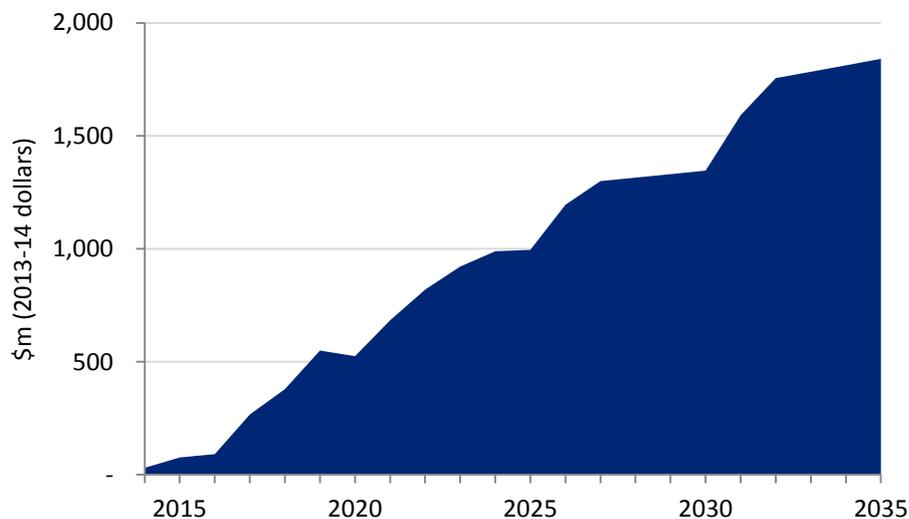
incorporates the proposed biorefinery construction, against a ‘baseline’ where the proposed construction does not proceed.

Preliminary assessment of commercial returns for each project suggests the returns are sufficient to attract private investment (however, detailed financial modelling and a full feasibility study would be needed before making any investment decisions). Thus, the only government support assumed in our economic modelling is general in nature – that government provides a stable economy that is ‘open for business’, with streamlined processes to minimise regulatory red tape and provide efficient environmental approvals. It is assumed that the biorefinery sector operates without explicit government subsidies, tax concessions or mandates.

The biorefinery opportunities modelled are expected to increase Queensland’s gross state product (GSP) by more than \$1.8 billion annually by 2035 (in today’s dollars). In net present value terms, the industry’s contribution over the modelled period is \$21.5 billion.

This does not represent the full extent of the future size of the industry in Queensland, but rather is based on the seven prospective bio-refinery projects modelled. If these projects are successful, it is possible that Queensland could eventually be home to more biorefineries than are modelled here.

Figure 1.1 Deviation of GSP from base scenario



Source: Deloitte Access Economics

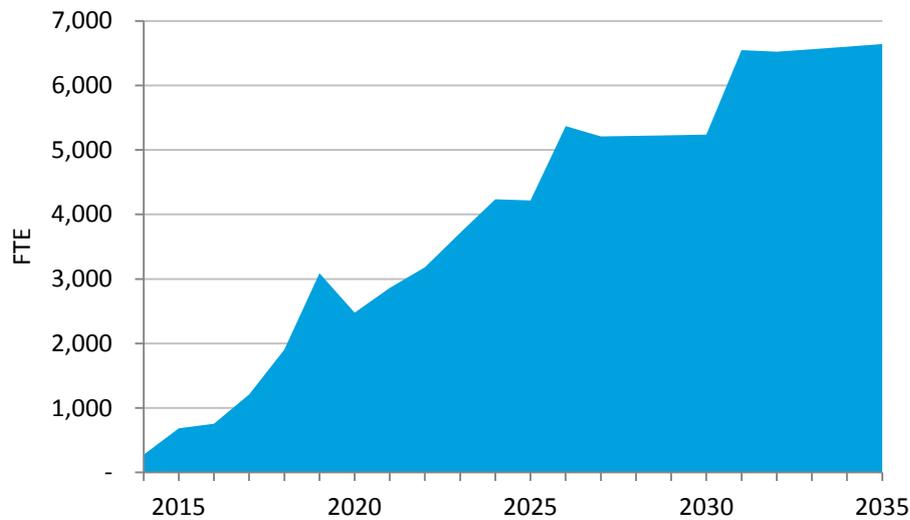
The biorefinery investment modelled is projected to increase employment across the state by 6,640 FTEs by 2035 (see Figure 1.2).

For Queensland as a whole, output and employment are expected to increase in the manufacturing, services, trade, agriculture, transport, electricity and water industries in the period to 2025. At the same time, both output and employment in the mining industry are expected to decline relative to the baseline.

In this analysis, project establishment and operations are modelled out to 2035-36. In reality, projects would very likely operate beyond 2035-36, with ongoing economic impacts.

Further, potential industry upsides have been excluded from the modelling. For example, the players in the soft drink manufacturing industry have indicated that they would pay a premium for polyethylene produced using biobased feedstocks. Also, the United States Navy, one of the major users of oil in the United States, aims to significantly increase its use of non-fossil fuel sources. Along with other applications, these higher prices for specific outputs could add to the overall economic impact of the industry, and suggests that the estimates presented in this report are conservative

Figure 1.2.Deviation of employment from base scenario



Source: Deloitte Access Economics

Conclusion

Queensland’s tropical climate and large agriculture sector produces significant volumes of biological material as by-products – often waste material available at little or no cost. This preliminary assessment indicates an opportunity to profitably convert these into chemicals, plastics, and fuels. There are technologies and feedstocks available for viable refineries to be developed in several regions – including the south west, central, coastal and tropical climate zones – each producing different bio-based products.

The development of a tropical bio-refinery industry could have a significant economic impact on the Queensland economy. The seven modelled projects alone could contribute around \$1.8 billion and 6,640 FTEs over the next two decades.

This report provides sufficient proof of concept to proceed with further due diligence and a full feasibility study of the future potential and viability of these bio-refineries. Combined with government policy settings that are conducive to investment and ‘open for business’, a tropical bio-refinery industry could be an important future source of economic growth in Queensland.

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