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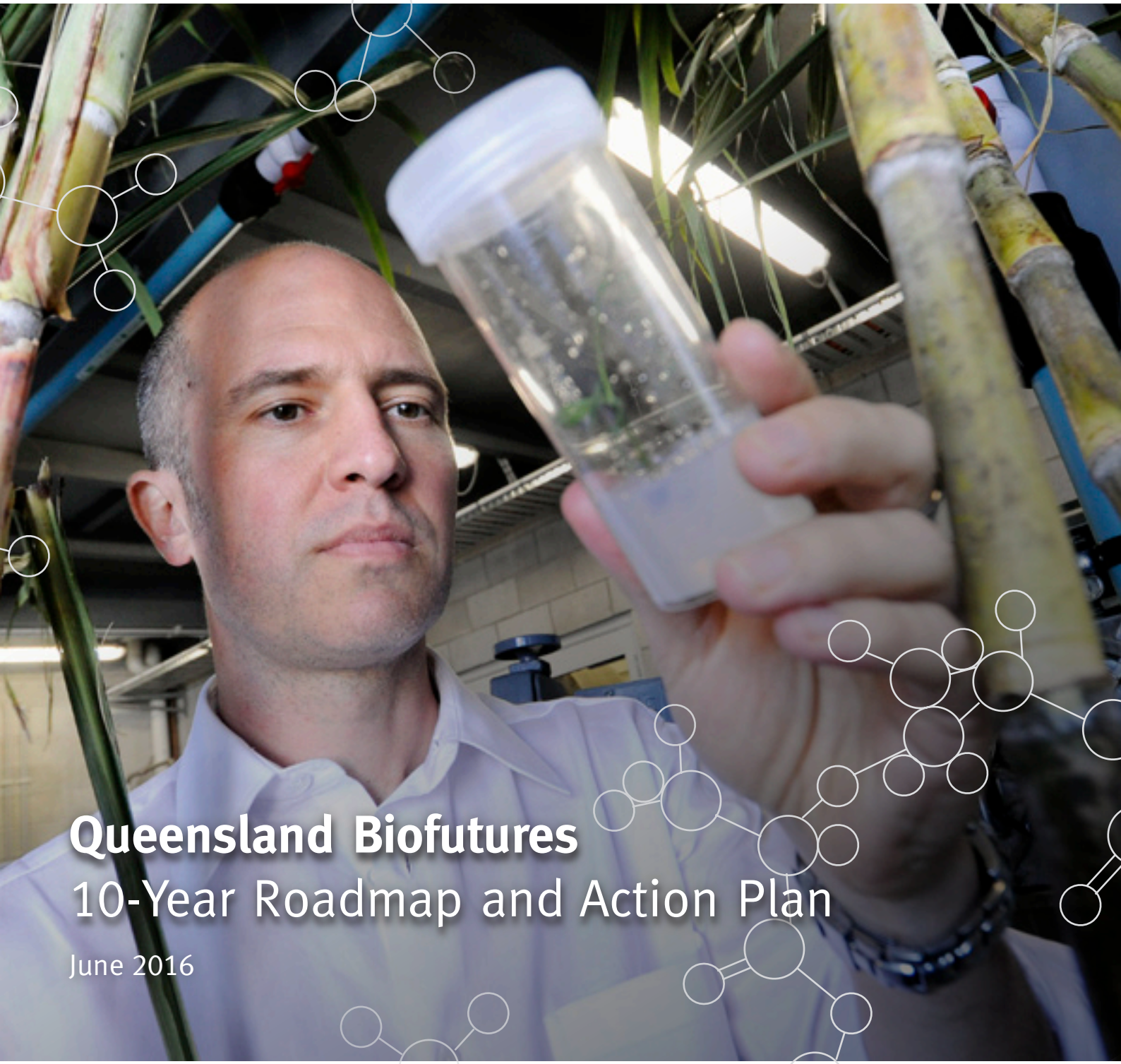

Queensland Biofutures

10-Year Roadmap and Action Plan

June 2016

Queensland Government

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Department of State Development
PO Box 15009, City East, Queensland 4002

Phone: 13QGOV (13 74 68)
Email: info@dsd.qld.gov.au
Web: www.statedevelopment.qld.gov.au

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Foreword

The world is changing rapidly and the traditional industries that have supported us and been the backbone of our state are strong but our economy is transitioning. Queensland is in the fortunate position to have a broad range of internationally competitive industries that contribute to our diversified economy.
The Queensland Government is committed to meeting the challenges of the future head-on and is driving innovation to secure Queensland's future.

Our Advance Queensland program is providing the support to further diversify the economy by developing new industries that have global growth potential, and in turn create the knowledge-based jobs of the future. Advance Queensland will foster new industry and research collaborations that will tackle the big innovation challenges.

Biofutures is one of the opportunities that will support future economic development, open the door to new investment and grow employment in regional Queensland. Opening our eyes to new possibilities ultimately means jobs and a more secure future for Queensland.

The biofutures industry could have a transformative effect on Queensland's economy, but it won't happen without government commitment. We are determined to see a strong and sustainable industrial biotechnology and bioproducts sector become a reality.

There is a global boom happening right now in this sector and Queensland has the competitive advantages to be a national frontrunner in this exciting industry.

The Queensland Biofutures 10-Year Roadmap and Action Plan articulates our vision for the state's biofutures industry in 2026. The roadmap clarifies how we will capitalise on our competitive advantages and realise the opportunities for growth, as well as how we will overcome the challenges in the development of a competitive industrial biotechnology and bioproducts sector in Queensland. The roadmap will also provide the necessary assurance to strengthen existing Queensland operations, and give them the confidence for continued investment and expansion.

Queensland is fortunate to have all the right advantages to make biofutures happen. We have the people. We have the ideas. We have the infrastructure. We have world-class research in both agricultural and bioindustrial product development. We have the climate and a lifestyle that is the envy of the world. Located at the gateway to the Asia-Pacific, Queensland is ideally neighboured with some of the fastest growing economies in the world.

However, there are missing links. We need greater collaboration and movement between the science base and business community; we need a bigger pipeline of world-leading, investment-ready business opportunities; and we need the private sector capital and skills to turn these opportunities into products, profits and jobs.

Internationally, biofutures is in a rapid phase of development, driven by government support and strategic alliances between technology providers, research institutions and raw material suppliers. As a government we are ready to implement the actions necessary to drive this industry forward.

If you want to be a global innovation leader, you have to articulate to the world a long-term plan. We cannot wait for the world to come to us, we must tell the world we are ready.

The Honourable Annastacia Palaszczuk MP
Premier of Queensland,
Minister for the Arts

The Honourable Dr Anthony Lynham MP
Minister for State Development,
Minister for Natural Resources and Mines

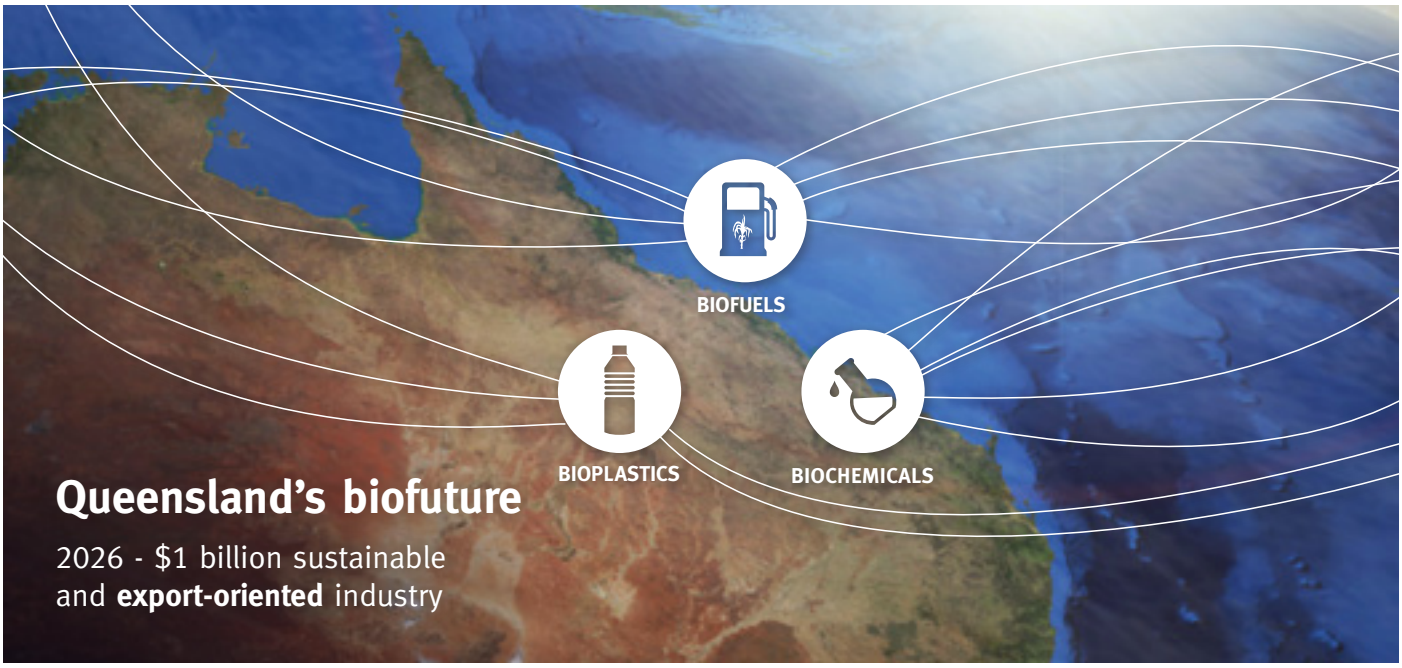
Vision

Our vision is for a $1 billion sustainable and export-oriented industrial biotechnology and bioproducts sector attracting significant international investment, and creating regional, high-value and knowledge-intensive jobs.

The Queensland Government stands committed to the biofutures industry and sees it as a major opportunity for diversification of the Queensland economy. It will help create thousands of jobs and a new high-value, knowledge-intensive industry in Queensland, particularly in rural areas and regional centres. Through Advance Queensland, the government has set itself an ambitious 10–year vision for the sector.

While there are challenges for expanding this industry in Queensland, such as strong international competition from overseas governments and an underdeveloped venture capital market in Australia, there is real potential for catalytic growth of this industry in Queensland. Between our strong competitive advantages—such as a subtropical and tropical climate and world-class agricultural and research sectors supported by the strategies and actions we are implementing—we are confident this vision will become a reality and Queensland will become renowned both nationally and internationally as a place to invest, research and commercialise biofutures projects. In partnership with our researchers and industrial sector, the Queensland Government will forge a biofuture for the state.

It is likely that Queensland's early biofutures success stories will come from biofuels and its associated supply chain given the mature market for transport fuels in Queensland. However, the Queensland Government acknowledges that this is only an early platform for diversification into other biobased products, as the industry matures and associated technologies and processes advance. There may also be other factors that influence development of Queensland's biofutures industry, such as changes to world markets, consumer demand and international responses to rising carbon emissions. Our vision is deliberately broad and our strategies and supporting actions are flexible to ensure we are able to capitalise on a wide range of future opportunities as the sector develops.



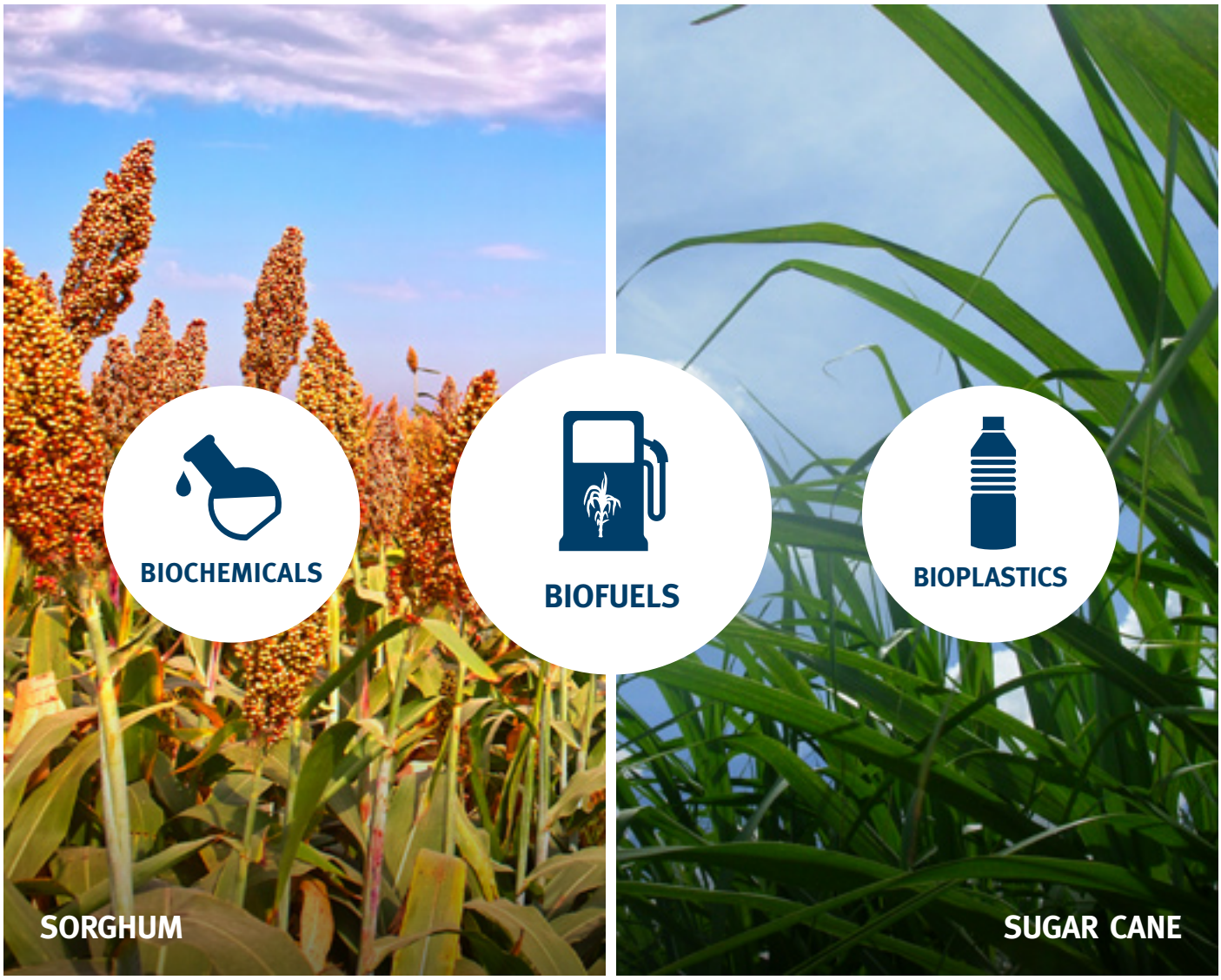
What is ‘biofutures’?

The term ‘biofutures’ broadly refers to the industrial biotechnology and bioproducts sector. This sector focuses on the development and manufacturing of products from sustainable organic and/or waste resources, rather than fossil fuels. It encompasses a spectrum of innovative scientific and industrial technologies designed to convert sustainable feedstocks or waste into a diverse range of bioproducts.

Agriculture, plantation forestry, algae, organic and carbon-rich ‘waste’ streams could all be used as feedstocks in the future to generate a wide range of sustainable chemicals, fuels, synthetic rubber, cosmetics, detergents and textiles.

Bioproducts offer a renewable and environmentally beneficial alternative to existing conventional chemical and fossil fuel refining processes. Many of the potential feedstocks are the by-products of agricultural processes, or waste products that would otherwise require disposal or combustion.

Biofutures is seen internationally as the next wave of economic development, providing major opportunties for innovation, jobs and growth. The Queensland Biofutures 10–year Roadmap and Action Plan sets us on a path to ride this wave.



Industry drivers

Development of the biofutures industry is being driven by the triple bottom line: economic, environmental and social issues.

Economically, development of the sector has been driven by the increasing instability in crude oil markets. While world oil and coal prices have been dropping in recent years, the long-term trend projections are for increasing prices.

Environmentally, industrial biotechnology and biobased products decrease reliance on fossil fuels while also reducing the environmental footprint of manufacturing. There is potential to manufacture products with significantly fewer carbon emissions with some biobased chemicals produced with up to 45% less carbon emissions, and some consuming carbon in their production and manufacture. There is also capacity to reduce non-renewable energy and resources used during manufacture.

Socially, suppliers and consumers are increasingly choosing products that are considered sustainable and environmentally friendly. Sustainable, renewable feedstocks that reduce the environmental footprint of manufacturing are increasing market demand and providing suppliers with a 'social licence to operate'. Emerging technologies and research and development into plastics, aviation fuels, fibre products and animal feeds made from sustainable or waste feedstocks are all opportunities driving the triple bottom line.

The global picture

According to the World Economic Forum (WEF), converting biomass into fuels, energy, and chemicals has the potential to generate upwards of US$230 billion to the global economy by 2020. By 2020, revenue from biofuels is forecast to reach US$80 billion, plastics and chemicals are forecast to reach US$15 billion.

Since the 2010 WEF report, the market has expanded rapidly. In 2014, the global biorefinery products market reached almost US$438 billion. The sector is expected to reach US$1128 billion by 2022.

A review of the industrial biotechnology and bioproducts sectors globally show they all have benefited from strong government leadership and support including tax relief, loans, subsidies and grants, co-investment, investment attraction and designating suitable land for development.

Over 64 countries and subnational governments demonstrate strong leadership and support for their biofuels sectors including subsidies, targets and mandated use of biofuels.

Globally, Brazil and the United States are well known for their strong mandates combined with research and investment in industrial biotechnology, particularly in regards to biotechnology and bioproducts including advanced biofuels.

All European Union countries, as well as Iceland and Norway, have in place national action plans on how they will support biofuels and the wider bioeconomy.

Alberta, Canada is a practical example of combined state, multi-industry, and research effort to build on existing economic strengths in agriculture, and expand their bioindustrial sector. Facing similar challenges to Queensland, Alberta is supporting the growth of their biofutures industry through grants and government-facilitated industry, research and investment hubs such as Alberta Innovates Bio Solutions (Al Bio).

Queensland's industry snapshot

In contrast to the more mature sectors in other countries, Queensland has an emerging industrial biotechnology and bioproducts sector, largely characterised by three biorefinery plants located in the state. These plants are capable of producing more than 160 million litres of ethanol and biodiesel for domestic transport using conventional production technologies.

These plants are:

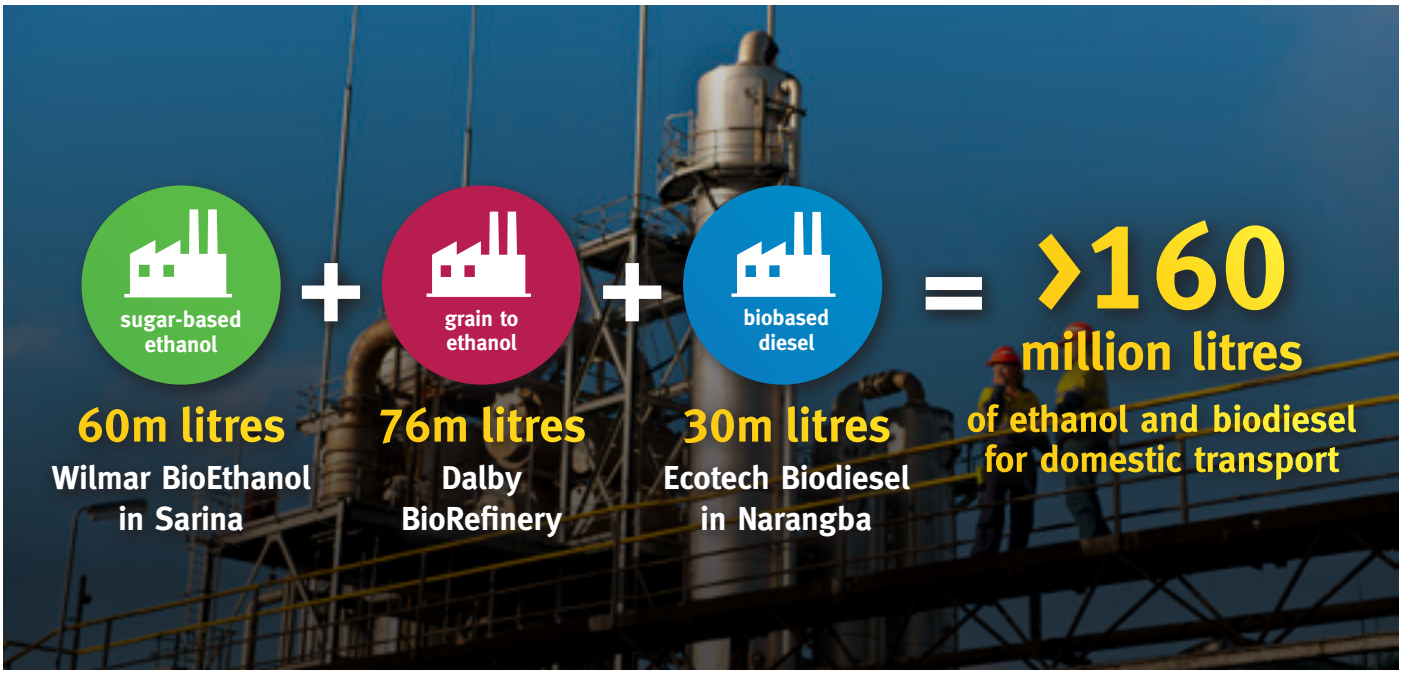
- Wilmar BioEthanol in Sarina, Australia's largest producer of molasses-based ethanol with the capacity to produce 60 million litres of ethanol per year
- Dalby BioRefinery (United Petroleum), Australia's first grain to ethanol plant with capacity to produce 76 million litres of ethanol per year from red sorghum
- Ecotech Biodiesel in Narangba, which has the capacity to produce 30 million litres of biobased diesel from used cooking oil and tallow.

It is estimated that the three plants in Queensland directly employ up to 120 people and are worth up to $100 million in annual revenue and $10–20 million in value added terms per annum.

The University of Queensland, James Cook University and Queensland University of Technology are providing leading research and development on advanced biofuels, bioplastics, biochemicals, emerging specialised energy crops and high yield cultivars, and germplasm improvement. They have key partnerships with global companies including Dow, Pacific Northwest National Laboratory, Joint BioEnergy Institute, and Clemson University, all in the United States, and Syngenta in Switzerland, Novozymes in Denmark, Asahi in Japan, and Bioindustrial Innovation Canada.

Queensland is also home to:

- The Mackay Renewable Biocommodities Pilot Plant, a pilot scale research and development integrated biorefinery for the conversion of cellulosic biomass into bioethanol and high-value biocommodities.
- The Solar BioFuels Research Centre, a research hub facilitating collaborative and contract research projects based on photobioreactors and raceway systems. Services are provided in systems design and testing.
- The Macroalgal Biofuels and Bioproducts Project, a research, development and demonstration plant of macroalgal biomass as a feedstock for renewable fuels and bioproducts.



Opportunities for Queensland

Growing the industrial biotechnology and bioproducts sector in Queensland has many advantages. It would unlock our state's potential to commercially produce advanced biofuels, biochemicals, bioplastics and other biomaterials.

In 2014, a joint Deloitte Access Economics and Queensland University of Technology (QUT) study—*Economic Impact of a Future Tropical Biorefinery Industry in Queensland*—projected that:

By 2035, an industrial biotechnology and bioproducts sector could contribute $1.8 billion to Queensland's annual Gross State Product and support 6640 full-time jobs in Queensland.

While this alone is a significant benefit, these jobs are likely to include knowledge-intensive jobs that command higher wages and are likely to be created in regional Queensland given the location of current and likely future feedstocks.

Queensland's highly-productive agricultural industry annually produces large quantities of potential non-food feedstocks required for the bioproducts sector. Access to competitively priced feedstocks in commercially viable quantities is an essential component of the supply chain. An industrial biotechnology and bioproducts sector could assist the agricultural sector to diversify by creating markets for existing and new products including cropping waste.

Potential feedstocks already identified across the state include:

- sugarcane and green waste in North Queensland for use in polyethylene and resins
- sugarcane bagasse in the Whitsunday region for use in succinic acid
- sweet sorghum in Wide Bay-Burnett for use in ethanol
- sorghum stover in Darling Downs and South West for use in ethanol.

Modelling in the QUT study forecasts that potential output from integrated biorefineries could directly and indirectly increase output and employment in a number of industries in Queensland. To 2025, it is estimated that integrated biorefineries could increase equivalent full-time jobs by 996 in the manufacturing sector; 583 in agriculture; 110 in transport; 951 trade jobs and 1489 in the services sector. Most of the employment would be in regional Queensland.

Growth in this sector however requires the commercialisation of a broad spectrum of scientific and industrial technologies for the conversion of sustainable feedstocks and wastes into a diverse range of bioproducts. These innovative technologies will allow for greater resource use efficiency by creating more value from a given feedstock with less environmental impact.

Existing facilities and potential opportunities

Potential opportunities	
North Queensland	Polyethylene from sugarcane (bioplastic) Resins from green waste (biochemical)
Whitsundays	Succinic acid from sugarcane bagasse (biochemical)
Darling Downs / South West	Ethanol from sorghum stover (biofuel)
Wide Bay / Burnett	Ethanol from sweet sorghum (biofuel) Levulinic acid from forestry waste (biochemical)

Under the Biofutures Acceleration Program we are taking an integrated approach to biofuel production, which takes advantage of our access to agricultural production, good quality land and export hubs. Land will need to be identified with access to key infrastructure such as water and power, transport routes, available crops or other waste feedstocks.

Source: Adapted from Deloittes/QUT Study (2014)

Queensland's strengths

Queensland is well-positioned to develop and grow the industrial biotechnology and bioproducts sector.

Queensland has a number of competitive advantages that place the state in a favourable position to capitalise on the growing international demand for industrial biotechnology and biobased products.

- A **subtropical and tropical climate** providing ideal conditions to produce strong yields and high-quality feedstock products all-year-round.
- Access to millions of hectares of **suitable growing land** to support the cultivation and management of crops and plantation forestry.
- The ability to competitively produce some of the world's most **energy-dense and productive feedstock** such as sugarcane, eucalypts and algae. Additional feedstock includes red and sweet sorghum, native grasses, crop stubble, cassava, agave, and pongamia.
- A **mature and modern agricultural industry** with well-established supply chains from farm gate to markets.
- Connection to international markets through **reliable and efficient infrastructure** including:
  - four international airports and 56 certified airports
  - 177,000 kilometres of modern and efficient road network
  - 10,000 kilometres of reliable freight service rail network
  - 15 seaports and seven bulk shipping terminals
  - advanced sugarcane and forestry processing facilities—21 sugar mills and more than 75 wood processing facilities.
- Ideal positioning at the **gateway to the Asia-Pacific** and close economic ties with expanding Asia-Pacific markets—a clear advantage as an investment destination and export point.
- An **emerging industrial biotechnology sector** and world-class expertise in research and development. Queensland has nine universities and three commercial biofuel refineries capable of producing more than 160 million litres of ethanol and biodiesel.

Challenges

While the opportunities are significant and there is great determination to realise our vision, there are some challenges that will need to be addressed. Despite strong investor interest in Queensland's industrial biotechnology and bioproducts sector, and the increasing global demand, the local sector currently remains limited to conventional biofuel technologies.

Feedback from industry indicates their key challenges include:

Access to government programs and funding

Limited access to risk capital in Australia to support promising start-up companies through the research and pre-commercial stages requires government to consider providing financial incentives assisting companies to scale up to manufacture. Globally, successful industrial biotechnology sectors tend to be supported by strong government programs and subsidies prior to becoming self-sustaining.

In order for Queensland to be competitive in this market, strong government support, including financial, is considered necessary. Suggested government incentives include loans, partial funding, production subsidies and/or tax credits.

Leveraged funding could be provided to assist industry to commercialise research, develop a business case and assist in achieving bankable feasibility.

Approval processes

The capacity to locate processing facilities close to both feedstock and supply chain infrastructure will assist to minimise start-up and operation costs. Setting aside development areas, and streamlining approval processes, including the beneficial use of waste streams, will assist to reduce costs associated with time delays resulting from development and environmental approval processes.

Linkages between industry, government and researchers

Industry called for greater government-industry-research collaboration through the use of hubs or precincts to provide a strong focus on research outcomes and commercialisation. Government supported hubs, precincts and incubators are also considered important for supporting early-stage technology development when investors are difficult to attract due to risk. This approach has had positive results internationally.

Other enablers include improving public awareness, exploiting existing research, and inspiring new research activities and international collaborations.

Economic access to feedstocks

Economic access to key bioenergy feedstocks and products can be challenging. The issue is often gaps in supply chains and lack of access to information about feedstock availability. Assistance to complete the value chain will assist the industry to access economic volumes of feedstock.

Southern Oil Refining's Advanced Biofuels Pilot Plant in Gladstone

On 29 March 2016, Premier Annastacia Palaszczuk announced that Southern Oil Refining will build a $16 million Advanced Biofuels Pilot Plant in Gladstone.

The successful attraction of this project to Queensland signified the first catalytic step towards securing a large-scale advanced biofuels industry in the state.

Tim Rose, Managing Director of Southern Oil Refining, said the decision to co-locate the new pilot plant with one of their existing facilities in Gladstone was made much easier with the Queensland Government's biofutures commitment.

The 100% Australian-owned Southern Oil Refining currently operates a waste lube oil re-refining plant at Yarwun in the Gladstone State Development Area as a joint venture with JJ Richards & Sons.

The pilot plant is expected to be operational by late 2016, and within the next three years, aims to have produced one million litres of fuel for use in field trials by the United States Navy as part of their Great Green Fleet initiative.

If successful, the pilot plant will be expanded to become Australia's first, commercial-scale advanced biorefinery capable of producing 200 million litres of advanced biofuels annually. This biofuel will be suitable for military, marine and aviation use.

This could bode well for local airlines who have recently sought proposals to meet a combined annual volume goal of 200 million litres of locally-produced biojet fuel for a period of up to 10 years commencing in 2020.

The Southern Oil Advanced Biofuels Pilot Plant is a great example of how Queensland is committed to diversifying the economy, building on the state's competitive strengths, and creating the knowledge-based jobs of the future.

Actions to date

Queensland already has a number of programs in place to encourage innovation, promote business attraction, drive industry growth and minimise investment risk.

Advance Queensland

The Queensland Government's $180 million Advance Queensland initiative is investing in our future by harnessing innovation to strengthen and diversify the economy and create jobs.

Advance Queensland is building an environment where collaboration between industry and research bodies successfully translates ideas and research into commercial outcomes, new and growing business, and jobs. Of particular interest to the industrial biotechnology and bioproducts sector:

- **Innovation Partnerships** positioning Queensland as a global innovation hub with grants to Queensland research organisations to collaborate on research projects with industry.
- **Research Fellowships** supporting post-PhD researchers with matched funding over three years to undertake research with industry that addresses Queensland's science and research priorities.
- **Business Development Fund** designed to turn ideas into reality with co-investment in emerging and high-growth Queensland businesses at the forefront of commercialising innovative research or ideas.

These grant programs specifically target innovative, knowledge-intensive Queensland growth industries, including the industrial biotechnology and bioproducts sector.

Queensland Biofuel Mandate

Queensland has a **biofuel mandate** designed to provide certainty to the biofuels sector to encourage investment and growth, leading to more jobs. It will also help create the foundation for a new high-value, knowledge-based biofutures industry in Queensland.

The mandate sets minimum sales of ethanol-blended regular unleaded petrol and biobased diesel. The ethanol mandate requires that 3% of regular unleaded petrol sales must be ethanol, while the biobased diesel mandate requires that 0.5% of all diesel fuel sold be biobased.

Both mandates will start on 1 January 2017 with the ethanol mandate increasing to 4% from 1 July 2018.

Australian Biomass for Bioenergy Assessment

Queensland is also supporting the **Australian Biomass for Bioenergy Assessment**. The project aims to catalyse investment by providing detailed information and interactive tools about Australian biomass resources. It is undertaking a detailed analysis of the types, volumes and locations of potential bioenergy and biofuel feedstocks in each state and is considering other supply chain factors such as existing electricity networks and transport infrastructure, land use capability and demographic data. This project is an initiative of the Rural Industries Research and Development Corporation and jointly funded by the Australian Government.

Future actions

The actions being undertaken now provide a stable platform for future growth. However, the Queensland Government will implement further specific actions to achieve our vision and secure Queensland's biofuture.

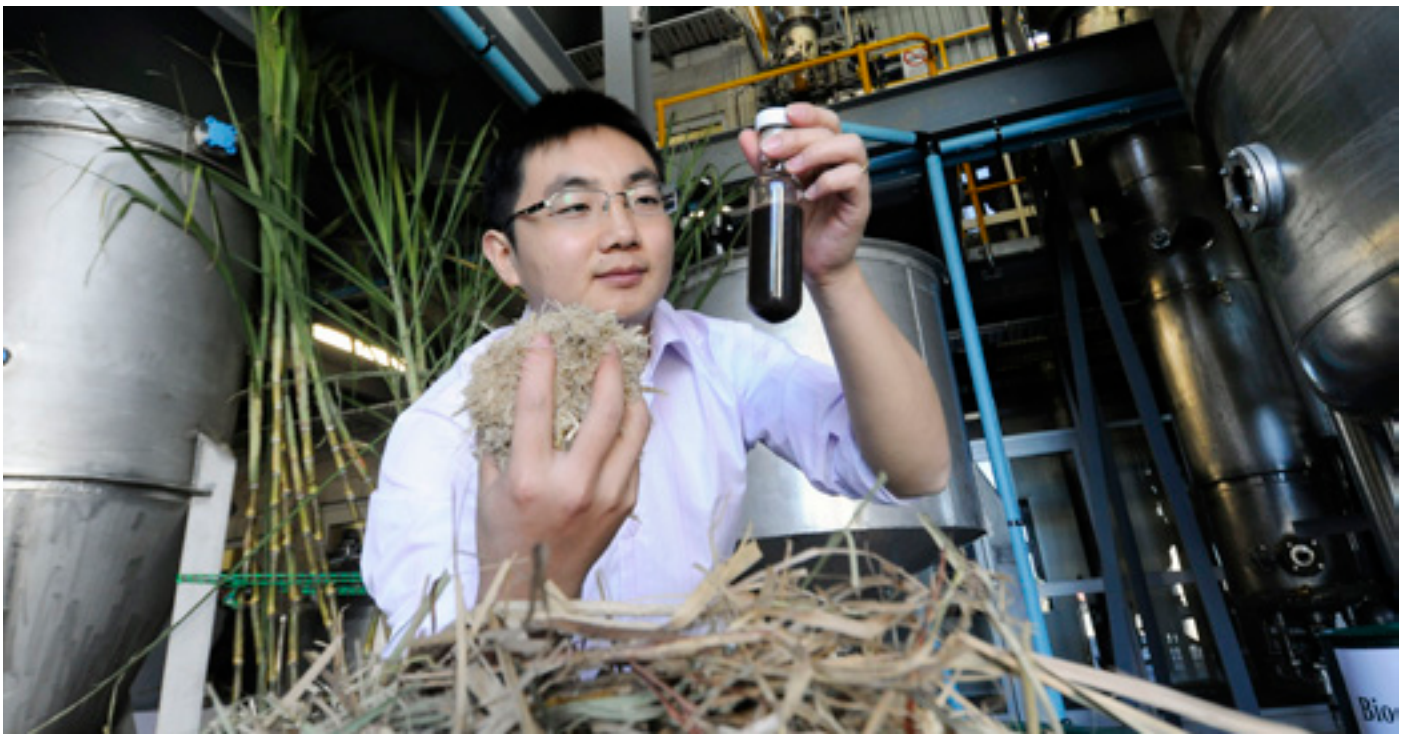
Consultation with industry and analysis of the success factors for the current global leaders, has identified three key strategies to further capitalise on our strong competitive advantages and respond to the sector's challenges.

1 Provide direct support for specific industry development initiatives

- Establish a Biofutures Industry Development Fund, a competitive funding pool to assist companies with reaching bankable feasibility.
- Provide new targeted research commercialisation or translational grants for SMEs and start-ups through Advance Queensland to increase commercialisation of biofutures projects.
- Design and support an Advance Queensland Innovation Challenge to enhance Queensland's industrial biotechnology capacity and raise awareness of the state's potential.
- Proactively chase strategic catalytic investment opportunities to attract a signature company or companies.
- Provide industrial biotechnology-focused industry development project facilitation support.
- Jointly fund a Research Chair for Advanced Biofuels with a Queensland university to enhance Queensland's research capacity and reputation as a developer of advanced biofuels and novel biorefining technologies.
- Establish a Biofutures Acceleration Program to drive the attraction of a number of advanced biofuture developments to Queensland.

2 Identify and promote the opportunities available for investment in Queensland

- Develop a marketing and communication campaign to raise awareness and promote opportunities for the sector.
- Appoint a high-profile person as Queensland's first Biofutures Industry Envoy to actively promote and raise the profile of Queensland as an investment destination, nationally and internationally.
- Identify suitably zoned land to help create industrial biotechnology precincts



to increase Queensland's attractiveness as an investment destination.

- Identify opportunities to streamline the development assessment process to encourage investment.
- Promote agricultural biomass supply chain opportunities and identify supply chain gaps in order to complement and enhance the work of the Australian Biomass for Bioenergy Assessment.
- Accelerate delivery of the Australian Biomass for Bioenergy Assessment data-sets.

3 Provide strong government leadership to create and maintain an attractive environment for investment

- Maintain a strong government sectoral focus through the Biofutures Cabinet Committee and Biofutures Interdepartmental Committee.
- Establish Biofutures Queensland within the Department of State Development, to work across government, industry and research to increase commercialisation of research and investment ready projects.
- Undertake a review of wastes in Queensland that may be suitable for diversion from disposal to higher-order and more sustainable uses.
- Investigate policy and market development opportunities to encourage re-use of waste currently going to landfill.
- Investigate a Queensland Government bioproduct procurement policy to increase local consumption and improve the market for new investors.
- Work with the Australian Government on fuel quality standards as well as excise and taxation treatment of advanced biofuels including biobased aviation and maritime fuels.

The Queensland Government is confident that this strategy will drive the growth of the biofutures industry.

Queensland Biofutures 10–Year Roadmap and Action Plan

Vision

A $1 billion sustainable and export-oriented industrial biotechnology and bioproducts sector attracting significant international investment, and creating regional, high-value and knowledge-intensive jobs.

Strengths

- Subtropical and tropical climate with year-round growing season
- Plentiful natural resources
- Productive and energy-dense biomass feedstock
- A mature and modern agricultural industry
- Connection to markets through reliable and efficient infrastructure
- Gateway to the Asia-Pacific
- World-class expertise in research and development

Challenges

- Access to government programs and funding
- Development approvals processes
- Linkages between industry, government and researchers
- Economic access to feedstock supply chains

Strategy 1

Provide direct support for specific industry development initiatives

Actions

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Strategy 2

Identify and promote the opportunities available for investment in Queensland

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Virgin
virgin australia

Department of State Development
PO Box 15009 City East Qld 4002 Australia
tel 13 QGOV (13 74 68)
biofutures@dsd.qld.gov.au

www.statedevelopment.qld.gov.au/biofutures