



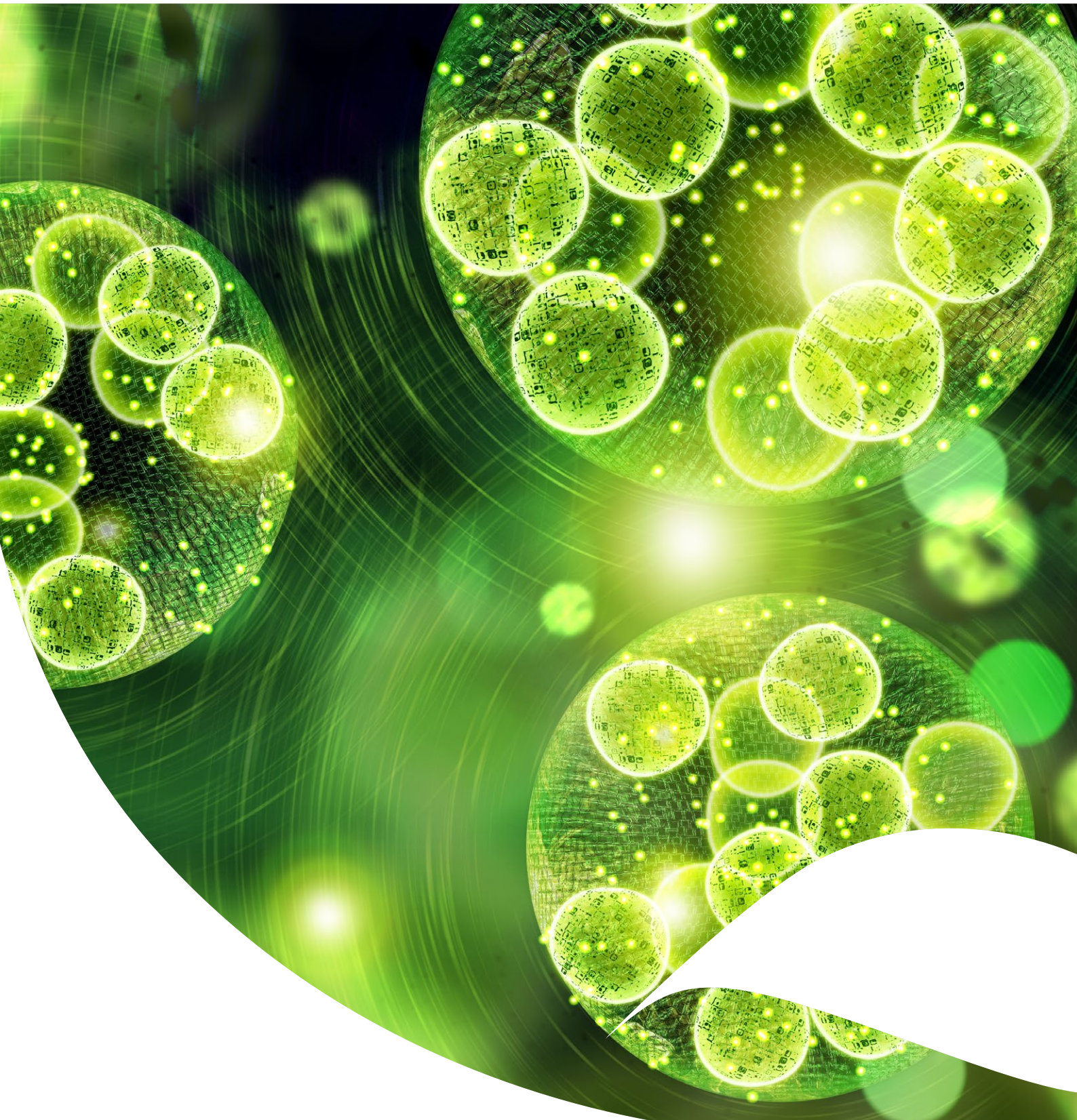
THE UNIVERSITY  
OF QUEENSLAND  
AUSTRALIA

CREATE CHANGE

# Bioeconomy Capability Statement

## Building better bioeconomies at UQ

Creating green solutions for future industries and a sustainable economy



This capability statement has been prepared for The University of Queensland (UQ) to support global university, government and industry engagement. It represents a snapshot of the research and innovation undertaken at UQ as we collaborate with partners around the world to build better bioeconomies. To review the full suite of UQ's research, commercialisation and partnership expertise, please visit the [UQ website](#).

We encourage you to learn about UQ's journey towards building better bioeconomies; understand our collective motivation to create change in this critical space; and most importantly, invite you to **partner with UQ** to create green solutions for future industries and a sustainable bioeconomy. If you'd like to access a digital copy of this statement, please scan the provided QR Code on the closing page or email [\*\*global.strategy@uq.edu.au\*\*](mailto:global.strategy@uq.edu.au).

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## UQ's vision is to deliver knowledge leadership for a better world

“At UQ, we are committed to helping solve the world’s greatest challenges. This Bioeconomy Capability Statement reflects our desire to deliver for the public good through all of our education, research and community engagement programs – both locally and globally.”

**Professor Deborah Terry AO**  
Vice-Chancellor and President



For more than a century, The University of Queensland (UQ) has educated and worked with outstanding people to deliver knowledge leadership for a better world.

With a community of more than 6600 research and professional staff and 53,600+ students, UQ is focused on delivering unparalleled teaching, learning and research excellence that creates positive change at the local, national or global level.

UQ ranks well within the world’s top 1% of universities. This is consistently highlighted by a series of key independent rankings, including the U.S. News Best Global Universities Rankings (36), the NTU Performance Ranking of Scientific Papers for World Universities (38), QS World University Rankings (47), Academic Ranking of World Universities (51), and the Times Higher Education World University Rankings (54).

Renowned as Australia’s leading institution for research reputation<sup>1</sup> and commercialisation with technologies licenced by UniQuest reaching global sales of \$32 billion, UQ has a proud reputation for creating positive change in the world through teaching, research and discovery. Our impact extends across the globe.

Located in Queensland, with campuses across Brisbane, Gatton and Herston, UQ has access to Australia’s abundant natural resources, a unique sub-tropical climate, technologically advanced research infrastructure and world-class scientific expertise.

With vast renewable solar and wind resources, and extensive land and ocean estates, Australia is rich in CO<sub>2</sub> and the nutrients essential to drive the development of sustainable bioeconomies and build an advanced, high-value manufacturing industry.

The world we live in is facing unprecedented global challenges, compelling us to seek sustainable ways to provide food for a growing population, energy to support development, clean and safe water, and reduced carbon emissions to mitigate climate change. Failure to address these challenges will contribute to a growing health crisis and diminish the potential for a green economy to emerge and prosper across the globe.

These challenges are a call to action and provide an opportunity to deliver economic prosperity in a world that is not reliant on fossil fuels and traditional energy resources. Building more resilient and sustainable bioeconomies provides an opportunity to overcome a range of challenges to deliver economic prosperity in a world that is not reliant on fossil fuels.

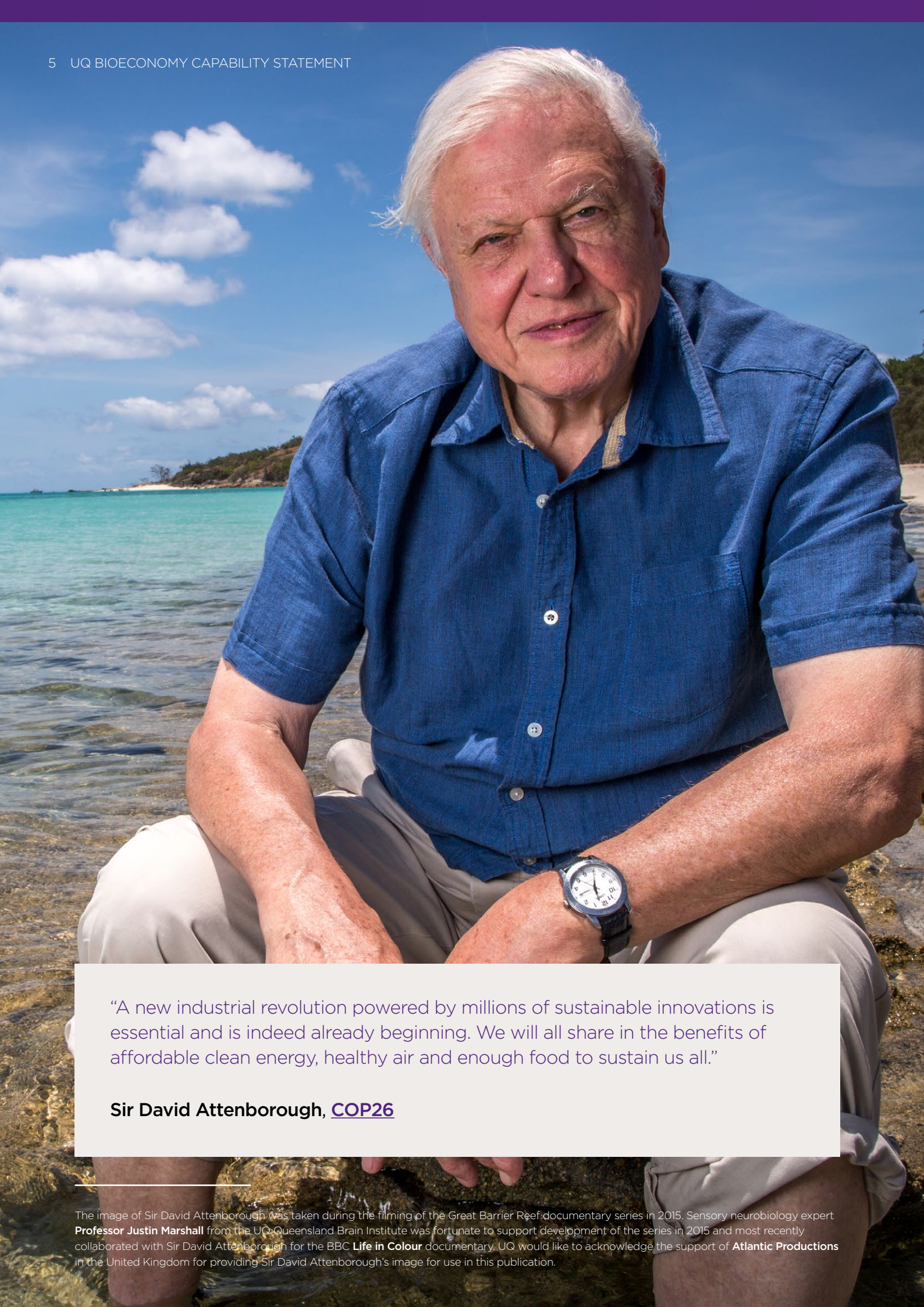
In June 2021, the G7 nations committed to 100% CO<sub>2</sub> emissions reductions by 2050 to combat dangerous climate change. Two months later, the Intergovernmental Panel on Climate Change (IPCC) declared a **code red for humanity**, confirming the unprecedented impact human activity has had on global warming and calling for rapid de-carbonisation to occur by 2035. As the world's most advanced economies mobilise strategies to support an essential transition away from a carbon-intensive economy, UQ is primed to drive rapid advances in technology to meet expanding global demand, a growing global marketplace and a pivot in consumer demand to healthy, safe and green products.

UQ is ideally positioned to invest in the production of value-added products derived from renewable biological resources and waste streams, and to develop and apply innovative industrial technologies equipped to scale up biomass conversion and the ultimate redistribution of materials to benefit the food, feed, fertiliser, fibre, and fuel sectors.



**The European Union defines bioeconomy as:** “The production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy.”

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“A new industrial revolution powered by millions of sustainable innovations is essential and is indeed already beginning. We will all share in the benefits of affordable clean energy, healthy air and enough food to sustain us all.”

**Sir David Attenborough, [COP26](#)**

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The image of Sir David Attenborough was taken during the filming of the Great Barrier Reef documentary series in 2015. Sensory neurobiology expert **Professor Justin Marshall** from the UQ Queensland Brain Institute was fortunate to support development of the series in 2015 and most recently collaborated with Sir David Attenborough for the BBC **Life in Colour** documentary. UQ would like to acknowledge the support of **Atlantic Productions** in the United Kingdom for providing Sir David Attenborough's image for use in this publication.

## Australia is solving the world's greatest challenges through the development of a truly sustainable global bioeconomy

Building a sustainable bioeconomy is increasingly central to international government policies the world over. As countries independently endeavour to address food security, water scarcity, climate change and access to affordable energy sources, they are united by a collective, global motivation to capitalise on the abundance of renewable biological resources and the need to transition away from a reliance on fossil fuels.

The capacity to invest in the production of value-added products derived from renewable biological resources and waste streams is dependent on the development and application of innovative industrial technologies equipped to scale up biomass conversion and the ultimate redistribution of materials to benefit the food, feed and fuel sectors.

As outlined in the International Advisory Council on [Global Bioeconomy 2020 Global Bioeconomy Policy Report IV](#), close to 60 countries have adopted a focus on developing policies and governance structures that will oversee a transition toward a sustainable bioeconomy.

[The United Nations 2030 Agenda for Sustainable Development](#) has also inspired a generation of global leaders to invest in a sustainable future, at the heart of which is a thriving bioeconomy.

### In Australia, we are well placed to solve the world's greatest challenges

Advances in biotechnology and biomanufacturing, with investment in sustainable bio-based industry sectors, have been significant in Australia for several decades.

As a nation we have long understood that a successful bioeconomy is dependent on the development and implementation of effective **circular economies of scale**. Australia is investing in sustainable futures with a priority focus on sustainable agriculture, bioenergy and biofuel production and has a resolute commitment to develop **environmentally centred products, services and technologies** that not only protect our natural and renewable resources, but focus on their conservation, regeneration and continued diversification.

**Australia has committed to the United Nations 2030 Agenda for Sustainable Development and with this has invited all facets of government, academia, business and community to unite and contribute to the Sustainable Development Goals.**

The global bioeconomy is large and rapidly expanding. Recent commitments by the United States, the European Union and China to implement carbon pricing is expected to accelerate the growth of the global bioeconomy to achieving net zero CO<sub>2</sub> emissions by 2050.

This provides Australia with both a challenge, and an opportunity to supply this rapidly expanding market.



## The State of Queensland is developing a thriving bioeconomy to support its transition toward a zero-carbon future

UQ is located in Queensland, an Australian state with a history of agility and a proven track record in adaptability, resilience and innovative thinking. Recognised as a gateway to more than two thirds of the world's population and home to high-potential urban and regional economic growth centres, Queensland is widely regarded as one of the most biodiverse places on earth.

The Queensland Government is committed to developing a prosperous and resilient economy that manages the risks of climate change and harnesses the opportunities associated with transitioning to a net zero emissions global economy. Climate change poses significant risks to Queensland's economy, communities, environment and way of life.

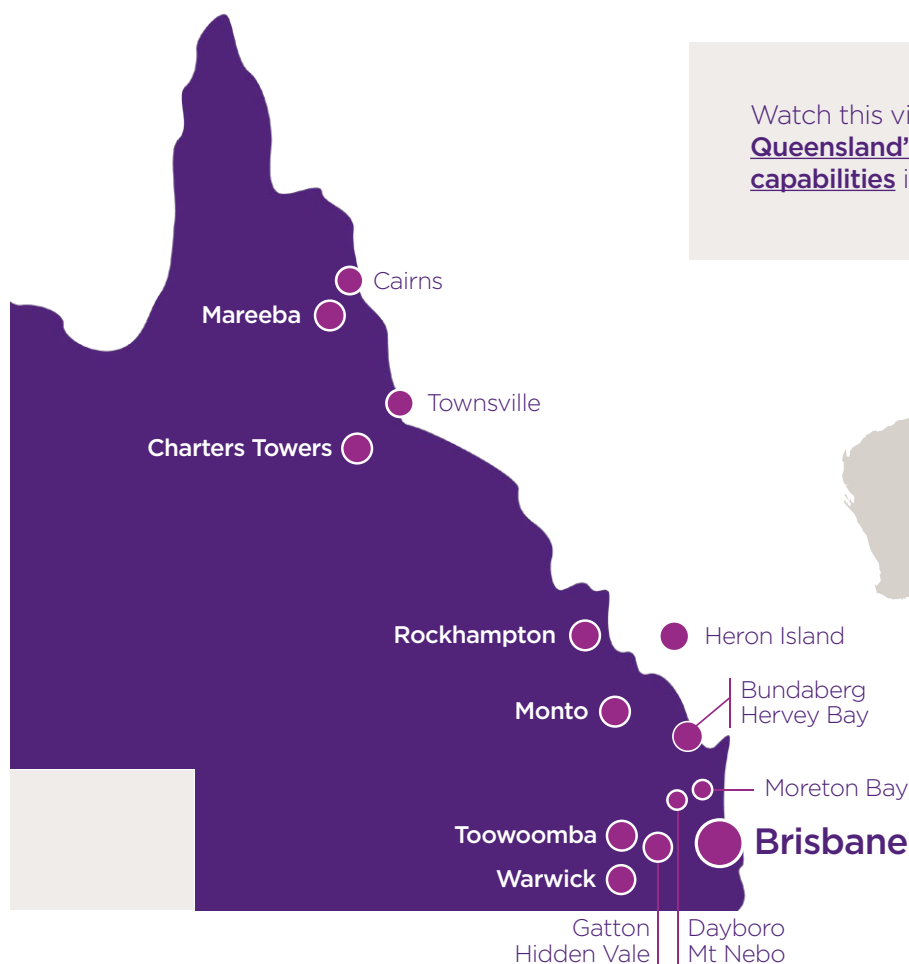
The Queensland Climate Action Plan 2030 was launched to map a pathway for the next decade to address climate change and to help reach [Queensland's targets](#) of achieving at least 30% emissions reduction below 2005

levels by 2030, powering Queensland with 50% renewable energy by 2030, and eventually reaching net zero emissions by 2050.

Underpinned by a waste-disposal levy, [Queensland's Waste Management and Resource Recovery Strategy](#) aims to increase resource recovery and reduce the amount of waste going to landfill by attracting investment and developing new jobs and industries. Transitioning Queensland towards a circular economy where materials are maintained at their maximum value for as long as possible is one avenue for delivering on climate, resource efficiency and biofutures priorities.

The development of a thriving bioeconomy is necessary to achieve this vision for Queensland. Ongoing investments in advanced manufacturing and materials, agricultural innovation, renewable energy (solar, hydrogen, etc), robotics and automation, and the development of a sustainable industrial biotechnology and bioproducts sector, complete with sustainable, innovative supply chains, is considered crucial to future-proofing the state and developing local solutions for global problems.

Progressive strategies such as the '[Advance Queensland Biofutures 10-Year Roadmap and Action Plan](#)' and the '[Queensland Hydrogen Industry Strategy](#)' support an ambitious goal to develop a AU\$1 billion biofutures sector that will support the industries of the future and secure a sustainable bioeconomy in Queensland.



Watch this video to learn about [Queensland's research strengths and capabilities](#) in emerging industries.\*

\*To view this video, access the digital copy of this statement by scanning the provided QR code on the closing page.

### Driving economic activity requires energy

The sun is by far earth's largest renewable energy resource. Every two hours, earth receives more solar energy than is required to power our total global economy for a year.

Australia alone receives about 50 times more solar energy than is consumed by humanity in an entire year. Given its vast space, huge solar energy resource and plentiful ocean estate, Australia is uniquely positioned to expand biomass production on land and sea to produce a broad range of sustainable products from high value pharmaceuticals and fine chemicals to food, feed, biopolymers, nanomaterials and beyond.



## UQ has a duty as a globally connected, socially responsible organisation to the development of a sustainable global bioeconomy

Leveraging a scientific community of more than 800 researchers engaged in bioeconomy related projects and initiatives, UQ forms partnerships with esteemed public and private partners locally and globally to deliver cutting-edge research and to transform bio-based industries.

We create sustainable global solutions to the world's largest problems. With business models now placing resource efficiency and environmental sustainability at their core, our role is to identify effective ways to harness knowledge, invest wisely and scale up our global bioeconomy. Our highly successful collaborations demonstrate that innovation is best achieved through teamwork, and that university and industry partnerships can drive excellent research to create change and bring us one step closer to a cleaner and greener future.

*By harnessing the strength of meaningful global partnerships, UQ is collaborating to create change.*

## We understand the value of inter-regional and inter-disciplinary expertise

The challenges faced in striving to achieve a sustainable bioeconomy are similar all over the world. By focusing on inter-regional collaboration, inter-disciplinary expertise and effective global partnerships, we can harness the complementary scientific knowledge necessary to fast track the industrial transition toward a global bioeconomy.

UQ is committed to the development of integrated research teams, uniting highly skilled and like-minded researchers across a range of disciplines.

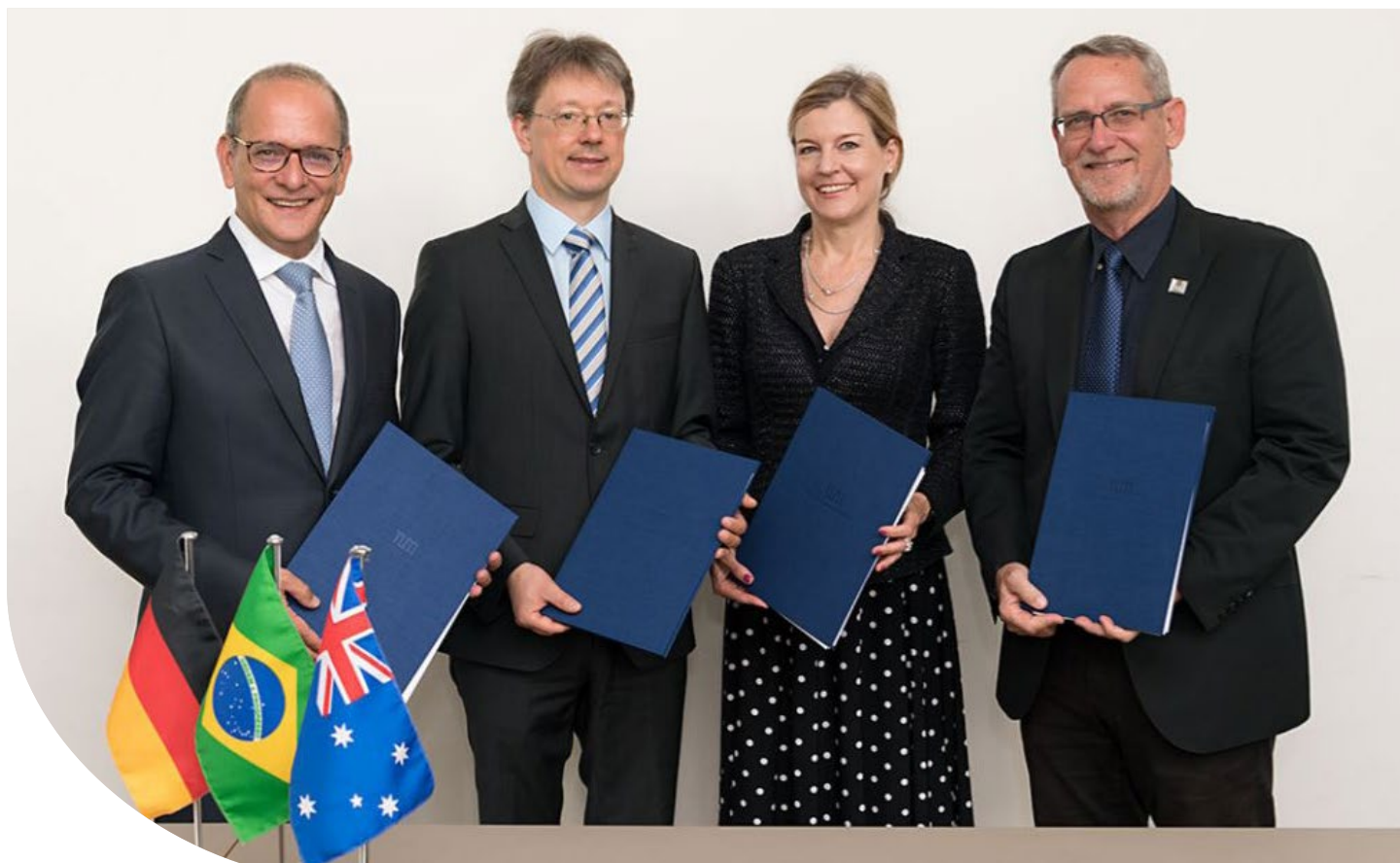
UQ researchers are committed to securing green solutions that will nurture robust circular economies and ensure the provision of essential environmental services and sustainability driven technologies to bring us closer to a carbon-neutral future.

## Knowledge Leadership - Global Bioeconomy Alliance

At UQ, we recognise that delivering true knowledge leadership requires a highly effective partnership network across all sectors and regions of the world. **The Global Bioeconomy Alliance** (GBA) was established in 2018 between the Technical University of Munich (TUM), The University of Queensland (UQ) and Sao Paulo State University (UNESP).

The alliance provides a clear strategic focus and unites institutions with the common goal of achieving a sustainable bioeconomy with a focus on the production of bio-pharmaceuticals, healthy and safe foods, sustainable agricultural products, renewable resources and biomaterials for industry (e.g. bioplastics and nanomaterials), biotechnology and bioprocesses, along with the development of biomass-based energy centres.

UQ and TUM embarked on a landmark **flagship partnership** in 2021 cementing a commitment to strategic engagement focused on sustainability and the delivery of innovative solutions to address global challenges and further global impact.



## Knowledge Exchange - The UQ Global Bioeconomy Community

As a founding member of the Global Bioeconomy Alliance, UQ has assumed a leadership position committed to addressing global challenges and creating change with the common goal of achieving a sustainable global bioeconomy. There is no better place to nurture the local and global impact we know our bioeconomy expertise can offer than right here at UQ.

**Connect with the UQ Global Bioeconomy Community**  
[global.strategy@uq.edu.au](mailto:global.strategy@uq.edu.au)

# Bioeconomy at UQ - Fast Facts

## UQ is creating sustainable global solutions to the world's largest problems

Our community of expert researchers are developing more environmentally sustainable, economically viable, and community supported biological production systems that will support the essential transition toward a carbon-neutral future. Responsible, high-impact bioeconomic innovation is being built on successful partnerships between university, industry, government and community stakeholders.

### A top 50 university

QS and ARWU global rankings rate UQ among the world's best universities for:

- Food Science & Technology
- Agriculture Sciences
- Environmental Sciences
- Ecology
- Agriculture & Forestry
- Biological Sciences
- Life & Earth Sciences
- Civil & Structural Engineering
- Law
- Medicine
- Pharmacy & Pharmacology
- Earth & Marine Science
- Public Health
- Mining & Mineral Engineering

### #1 in Australia

- Biotechnology (ARWU)
- Food & Science Technology (ARWU)
- Environmental Sciences (QS)
- Agriculture & Forestry (QS)
- Commercialisation & Research Reputation (Nature Index Tables)



436

UQ global partners in  
**54 countries**



821

**UQ affiliated** bioeconomy  
researchers at UQ



\$410M+

**Externally funded**  
bioeconomy projects



85+

**Bioeconomy patents**



600

**UQ bioeconomy**  
research projects



354

Partly funded bioeconomy  
industry projects valued at  
**\$115 million+**



12,107

UQ bioeconomy related  
publications with a **Field  
Weighted Citation Rate  
(FWCI) of 2.24**



101

Current bioeconomy  
related projects with a  
value of **\$158 million+**



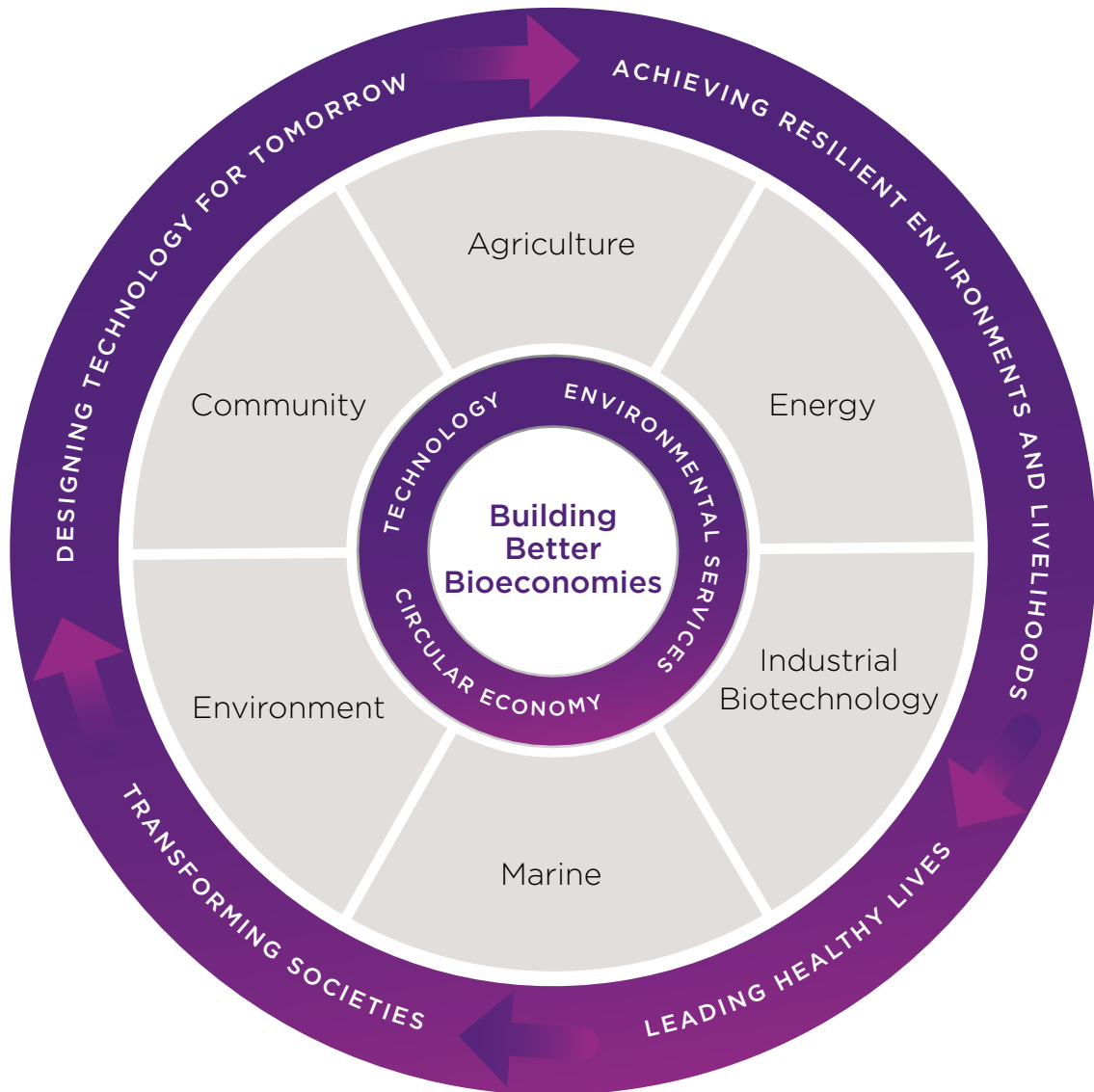
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**Higher Degree  
Research completions**  
in bioeconomy

## The comprehensive bioeconomy ecosystem at UQ

Developing successful bioeconomies is dependent on safeguarding environmental sustainability and nurturing a well-developed circular economy. These critical touchpoints have, for the longer term, influenced the development of enabling technologies, which will now impact the six major interconnected themes of significance and support the crucial industrial transition toward a sustainable bioeconomy.

### UQ bioeconomy themes:\*



### UQ is building better bioeconomies by prioritising:



Advanced manufacturing



High-value biopharmaceuticals



Sustainable agricultural products



Renewable resources for industry



Biotechnology and bioprocesses



Biomass-based energy centres

\*Our focus on six major themes does not preclude emerging or expanding opportunities or limit engagement within any given area across the broad definition of bioeconomy.

## Sustainability is central to UQ's corporate mindset

### UQ is making a contribution toward achieving the United Nations Sustainable Development Goals

The bioeconomy is central to over half of the 17 United Nations Sustainable Development Goals. At UQ, we align our focus closely with the UN SDGs and strive for research impact that will develop solutions to major global challenges. Through our commitment to building better bioeconomies, achieving resilient environments and livelihoods, transforming societies, leading healthy lives and designing technology for tomorrow, UQ researchers are striving to ensure we make an important contribution to these global goals.

### The science and practice of sustainable development

We all have a role to play in sustainable futures and at UQ, we invite students from across the world to take the [free UQx online course](#) 'The Science and Practice of Sustainable Development' delivered by edX. The course is part of a broader suite of leading global development and sustainability programs offered by UQ and teaches the critical foundations of sustainable development and how to achieve the UN's Sustainable Development Goals, which are deeply interconnected in this field.

### UQ's Global Development Hub

For 25 years, UQ has partnered on projects in the international development space with the aim of improving outcomes in human development and environmental sustainability.

Harnessing the broad expertise of a world-class research community and a willingness to partner for global change and impact, UQ has operationalised a Global Development Hub that provides a central consolidated platform and entry point for engagement with key stakeholders eager to leverage UQ's proven development-sector expertise and experience. In 2021, UQ Vice-Chancellor Professor Deborah Terry AO officially launched the Global Development Impact Plan (2021-2025) and inaugural Global Development Dialogue Series.

The Global Development Impact Plan sets out a whole-of-UQ vision to deliver significant global impact within the development sector through drawing upon combined efforts and expertise of UQ International Development and the broader Global Engagement team, schools, faculties, institutes, and central units. Prioritising development-sector themes of environment, agriculture, health, governance and public policy, energy and resources and innovation and entrepreneurship, UQ invites you to explore our networks and capabilities to create opportunities and achieve impact through partnered innovation.



**Partner with us** [global.development@uq.edu.au](mailto:global.development@uq.edu.au)

## UQ is building better bioeconomies with a global network of research, industry and government partners

Global connectivity is at the heart of UQ's vision to create knowledge leadership for a better world. With more than **436 global partners in 54 countries**, UQ is engaged to meet the challenge of building better bioeconomies by nurturing its effective global partnerships. UQ sees the need to drive future-focused regional and global development opportunities to secure economic growth, upskill a sustainably minded workforce and secure evolution in a new generation of jobs - all while reducing the environmental impact on our planet.

## At UQ, we are committed to bringing a sustainable mindset to all that we do

From renewable energy technologies and sustainable mining practices, to disease control and policy regulation, the UQ community is working towards a cleaner, healthier, and happier future. **The UQ Sustainability Strategy 2021-2025** endorses a roadmap closely aligned to the United Nations Sustainable Development Goals and an institutional blueprint committed to building and operating a more sustainable university.

**UQ will be the world's first major university to offset 100% of its electricity use with renewable power produced from our own assets with the completion of the \$125 million [Warwick Solar Farm](#).**

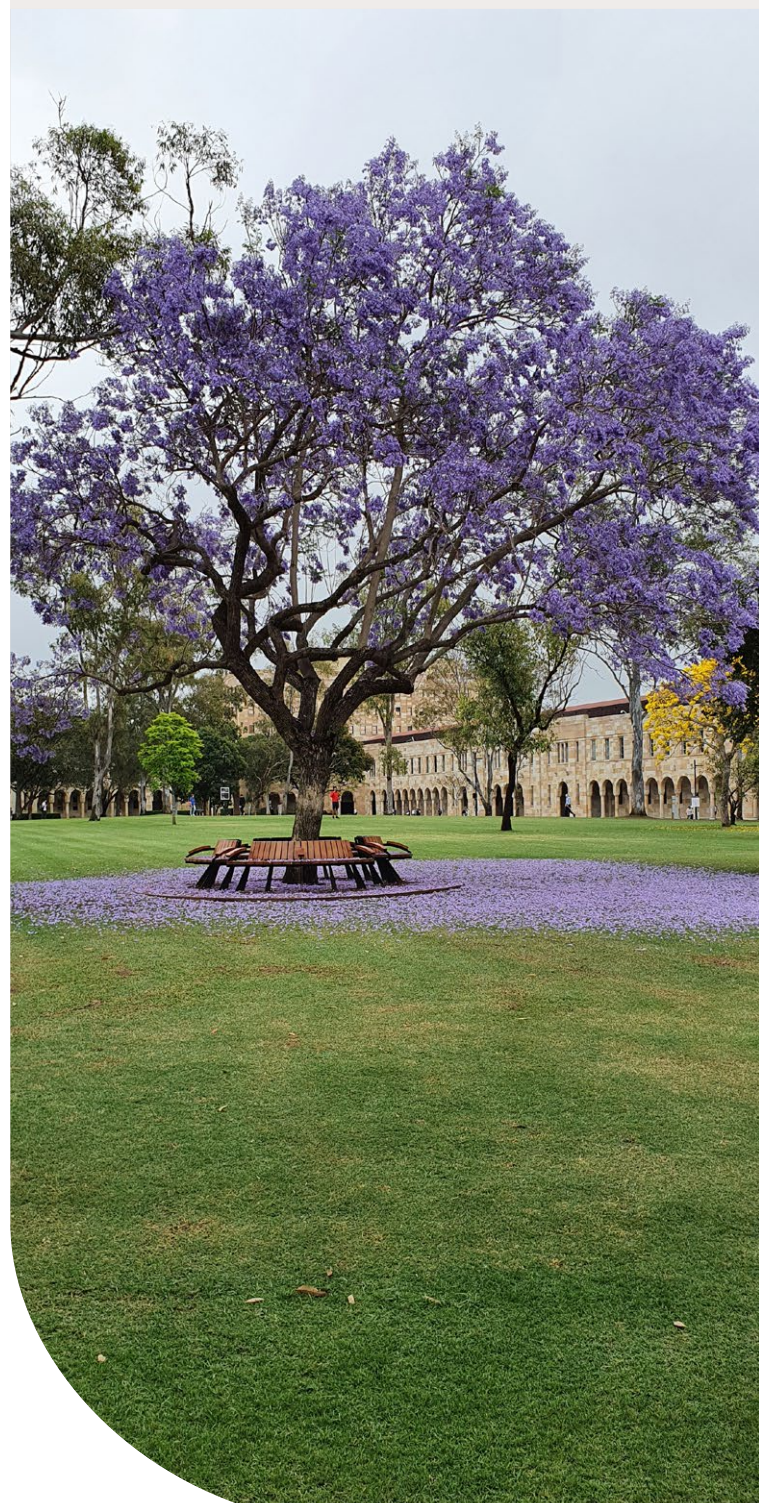
In 2021, UQ became a formal signatory to the Sustainable Development Solutions Network [University Commitment to the Sustainable Development Goals](#).

## Complete your carbon literacy training with UQ

UQ recently became an accredited partner with the UK-based [Carbon Literacy Project](#) to help individuals and organisations tackle the climate crisis by delivering an [Australian-first training program](#).

The UQ Carbon Literacy Project is an initiative led by the [Carbon Literacy Trust](#), an entity established as a Charitable Incorporated Organisation in 2014. The aim of the trust is "to advance the education of the public in the conservation, protection and improvement of the physical and natural environment" through the dissemination of Carbon Literacy.

UQ has responded to the United Nations Principles of Responsible Management Education (UN PRME) by measuring its **[carbon footprint](#)** and implementing change that will ensure **["Business for Better"](#)**





## Human and planetary health is a priority for UQ

### Case Study India - Energy and Poverty Research Group (EPRG): Improving the lives of millions

UQ researchers are working collaboratively to solve crucial energy challenges in developing countries through the [EPRG](#), a collective as committed to delivering environmental benefits as they are to reducing poverty and improving the lives of millions in our region.

Most of us take electricity and clean cooking fuels for granted, but across the world almost three billion people continue to live without reliable modern energy services.

In large parts of the developing world, families use unclean, solid fuels such as wood, charcoal, and agriculture and animal waste to meet their daily cooking and heating requirements. The indoor air pollution this creates can significantly affect human health, and the use of these fuels also has high environmental and social costs. For example, the use and sale of firewood is a leading cause of deforestation and irreversible environmental degradation

in parts of Africa, and the burden of collecting and transporting cooking fuel is often left to women and girls, furthering gender inequality. Modern, clean and efficient energy services are crucial for human wellbeing. They facilitate social and economic development, bring shared prosperity, and foster equity and gender empowerment.

UQ's EPRG is working on extending these services to impoverished regions, collaborating with partners across the globe to develop sustainable, reliable and affordable energy solutions tailored to different contexts and needs. Involving people across UQ, the group brings together PhD students, research fellows and academic research leaders with diverse skills working in a wide range of disciplines, including social science, psychology, business, communication and social change, and chemical and mechanical engineering.

With 12 projects already underway in India, and with plans to expand further, the group's work has the potential to drive changes that will improve and even save the lives of millions of people around the world, while also delivering many environmental benefits.

## With high-impact regulatory, governance and policy contributions, UQ is striving to improve local, regional, and global security

As the global community works toward scaling up development and production of renewable resources, we must be ready to embrace the economic potential and societal impacts a truly sustainable bioeconomy will generate. From education and training in the areas of industrial biotechnology, synthetic biology or biomass sustainability, UQ has the expertise to contribute to the development of new and innovative policies, which will capitalise on the many social, economic and environmental benefits that accompany a sustainable bioeconomy.

UQ is committed to best-practice approaches in the regulation of technology with researchers striving to assess the impact emerging technologies will have across sectors relative to a burgeoning global bioeconomy.

From [fighting food insecurity](#) in Indigenous communities, to developing [pesticide management programs](#) to protect the Great Barrier Reef or informing regulation and policy development in the area of [blue carbon and environmental toxicology](#) UQ is contributing to local, national and global policy frameworks that not only mitigate the impact of climate change, but work toward improved regional security.

Researchers at UQ are working to [drought-proof rural communities](#), address regional climate change induced impacts on health, food and water scarcity through the [Pacific Health Governance Research Network](#) and support enhanced profitability and sustainability in the global agricultural sector by developing next generation technology to optimise integrated waste and waste-water treatment and resource recovery across the production chain through the [Advanced Water Management Centre](#). These endeavours all play a role in promoting environmentally sustainable practices and securing improved regional development and security.

## Fighting food waste

Through the Fight Food Waste Cooperative Research Centre's TRANSFORM program, **UQ is leading a national program** to transform food waste into valuable products.

Secured through investments totalling \$121 million over a 10-year period, the [Fight Food Waste CRC](#) is hosted by the [UQ Dow Centre for Sustainable Engineering Innovation](#). It specifically targets programs that will reduce supply-chain losses and supports community and industry engagement set to generate rural employment opportunities, transform the management and cost of food waste, and thereby improving competitiveness, productivity and sustainability.

The mission of the UQ Dow Centre is to provide thought leadership and to facilitate innovation in the sustainable production and use of energy and materials.





## Make a trusted investment in green futures with UQ's proven economic-modelling techniques

The application of advanced, integrated techno-economic and life-cycle modelling designed to fast track systems optimisation, de-risk scale up and deliver robust technologies with economic, social and environmental benefits is key to supporting industry partners to advance circular economy and advanced manufacturing opportunities.

From the research expertise of the [Energy Economics and Management Group](#) to the software capabilities of the [Agricultural Production Systems Simulator](#) or the opportunity to maximise genetic gain through projects partly funded by the Bill and Melinda Gates Foundation such as the [Breeding Program Assessment Tool](#) or [Hy-Gain for Smallholders](#), UQ is at the forefront of modelling that will increase economic, agricultural and food-production yields necessary to address the growing global health and environmental challenges of our time.

### Modelling Case Study: Predictive agriculture boosts production and reduces operational inefficiencies

While drawing upon precision data, [predictive agriculture](#) also integrates a vast array of agricultural, biological, climate, and hydrological data and sources into a full future facing system model – using artificial intelligence and algorithms to predict outcomes, manage inputs, and plan for system shocks and changes decades into the future. Rapid advances in the area of AI and the application of digital technologies in agriculture have enabled UQ researchers to develop a suite of tools intended to help plant breeders and producers make better predictions, apply genetic modelling frameworks, improve remote mapping capabilities and improve on operational inefficiencies using technologies such as automated

planting and harvesting technology. Many new predictive technologies for crop improvement are being developed in the new [ARC Centre of Excellence for Plant Success](#). The [INVITA](#) innovations in plant testing in Australia project funded by the Grains Research and Development Corporation (GRDC) is supporting growers to get better variety recommendations faster.

With a goal to increase [on-farm productivity](#), profitability and sustainability, the [Centre for Animal Science](#) leads a variety of tropical livestock research and development programs at UQ. Building tools to support the needs of industry, a number of initiatives include the [Precision Beef](#) integrated research strategy that pinpoints ways to maximise beef production and value by capturing and combining some of the key drivers of beef prices: genetics, rearing, environment, pasture and a unique approach to meat quality. Aligning with projects relative to digital sensor systems for breeding businesses, [improving milk delivery and calf survival](#) or enabling the selection of genetics and pastures that can enhance reproductive efficiency over a lifetime, UQ offers industry leaders with a variety of new techniques guaranteed to improve outputs, capture greater value across the supply chain and enhance returns to producers.

Techno-economic Analysis (TEA) plays an important role in determining which processes and projects are economically competitive and scalable as well as environmentally and socially acceptable. From pharmaceuticals to industrial chemicals, to fuels and fuel additives, the [UQ Dow Centre for Sustainable Engineering Innovation](#) is committed to delivering solutions to globally significant challenges by generating and communicating new knowledge and analysis. We bring together cutting-edge science, multidisciplinary research and systems analysis, along with world-class education to deliver innovations, which have a significant impact on both sustainability and the economy.

### Modelling Case Study: The Centre for Solar Biotechnology has a mission to accelerate the innovation and translation of light driven biotechnologies and industries

As projected by the United Nations (UN) and the Organisation for Economic Co-operation and Development (OECD), the global human population is forecast to expand from 7.9 to 9.8 billion people by 2050, it will require about 70% more food, 50% more fuel, 50% more fresh water than in 2005, and CO<sub>2</sub> emissions reductions of over 80% to maintain economic, social, political and climate security.

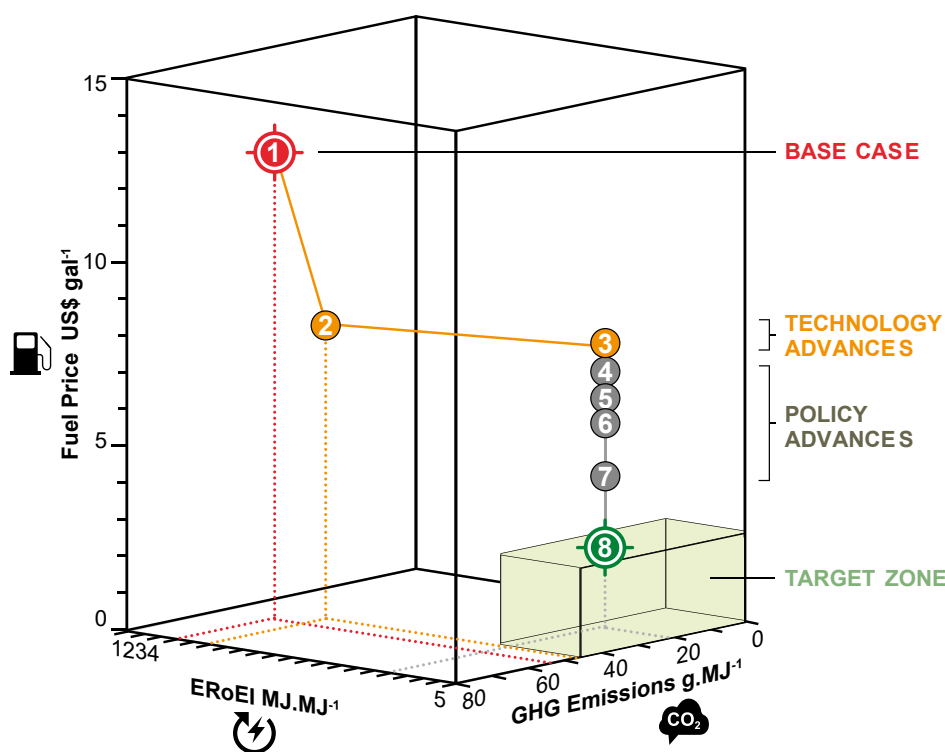
To address the 'planetary boundary' constraints of fresh water, arable land, finite nutrients (e.g. phosphate), and waste limitations, 'closed-loop production models' and circular bioeconomy systems are rapidly increasing in importance to expand sustainable primary production, ensure food security and enable greater GDP and export potential.

To harness the enormous power of the sun, the [Centre for Solar Biotechnology](#) is designing next generation light driven biotechnologies to produce high-value pharmaceuticals, bio-actives and medicated feeds, and is working on expanding into the production of biopolymers and nanomaterials, foods, fuels and clean water. Due to growing concerns over national fuel security and the consequences of anthropogenic climate change, renewable solar fuel-production technologies. Such technologies may harness higher plants, algae, cyanobacteria, artificial photosynthetic systems or combinations of these to supplement the current reliance on photovoltaic energy.

### Optimise resources with UQ's powerful Techno-Economic and Life Cycle Analysis (TELCA) platform

To optimise future bioeconomy systems for maximum economic, social and environmental benefit, the Centre for Solar Biotechnology has developed a powerful integrated **Techno-Economic and Life Cycle Analysis (TELCA)** platform.

The application of TELCA enables researchers to model protected cropping systems (low, medium and high tech), as well as land and ocean based micro and macro algae biomanufacturing systems. Using TELCA, systems can be developed to deliver **economic, social and environmental benefits**, which will be increasingly important to scale sustainable low CO<sub>2</sub> emissions technologies.



#### TELCA Development Pathway. Simulation guided design.

The development path (1-8) shows the effect of technology and policy settings on economic (Fuel Price), social (energy efficiency - EROEI), and environmental (GHG Emissions) parameters. The green box represents the target zone. Point 1 (red) is the starting point for optimisation. Orange (Points 2-3) and grey (Points 4-7) represent technology and policy improvements respectively. Point 8 (green) is the optimised end point.

## UQ will help your organisation to deliver beneficial outcomes

TELCA's integrated triple bottom line strategy is designed to fast track systems optimisation, de-risk scale up and support development of profitable business models of crop, and algae based production systems.

Using TELCA, these systems can be optimised for specific geographic locations, different crop/production species and local policy environments. Its modular design supports industry in the development of demonstration and full-scale industrial processes. It also assists in the development of industry value chains in the areas of bioeconomy, bio-manufacture and advanced manufacture, supports regional job creation, and the development of resilient industries to expand export markets.

## Realising the full potential of microalgae systems

In parallel with commercial microalgae systems development, the use of [innovative policy](#) approaches can be used to expand the bioeconomy and tackle important challenges such as fuel security. For example, the use of cost neutral utility models can significantly reduce the cost of microalgae fuels towards cost competitiveness with fossil fuels, helping nations to meet their CO<sub>2</sub> emissions reduction commitments while increasing fuel security.

This approach can also significantly expand critical mass of developing bioeconomies and give countries focused on developing their bioeconomy, a first mover advantage.

## Delivering on cost competitive algae-based fuels

Microalgae production systems can be expanded into next generation cell factories within bioeconomy precincts, onto non-arable land, mine sites and into the oceans.

Collectively these systems can significantly increase global photosynthetic capacity and so increase biomass productivity to supply a rapidly expanding circular bioeconomy.

They also expand Earth's CO<sub>2</sub> capturing capacity, which is critical if the international community is to stay within a 1.5°C global warming 'safe zone'. Microalgae systems can use saline and/or wastewater to recycle nutrients and reduce eutrophication, and energy-intensive chemical fertiliser use. Microalgae systems also have the capacity to provide distributed rather than centralised fuel production systems in regional areas, to support self-sufficiency and employment in regional communities.

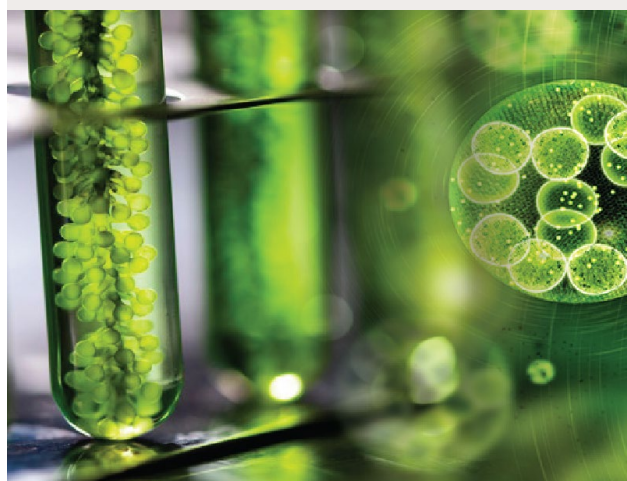
## Scale-up examples



Scaled-up microalgae production



Solar factory, solar bio-refinery, solar-biomanufacture



Macroalgae production



## Harness the power of digitisation, automation and artificial intelligence to expand your business

The increased automation and digitisation of key industrial sectors presents an ideal opportunity to harness the power of data sciences and artificial intelligence enabling remote sensing and earth observations to have an increasingly powerful impact on bioeconomy development.

At all scales, from research plots to fields, to regional yield forecasting, many aspects of the disciplines of plant breeding and crop production are being targeted by 'AgTech'. The tech ranges from mobile apps for breeders or farmers to scout and document their trials, through to integrated imaging systems mounted on farm vehicles or drones. One such example includes [The Information Engineering Lab](#) 'AgAsk' project.

Cloud computing, [machine learning](#) and connection of data with weather records, real-time satellite imagery and cropping systems models are all featured in these technologies. UQ has a long history of providing undergraduate and postgraduate training in plant breeding and crop production, and is actively extending this training to incorporate the digital technologies that are being applied in our production systems.

### Case Study: Drone developments

Though drone technology is a relatively recent development in aviation, these unmanned aerial vehicles have already made a great impact on areas of industry, agriculture and more. However, current drone technology does not allow them to operate safely in windy conditions.

At UQ, we are developing multirotor drones with force sensors that detect and measure wind velocity so they are able to react and avoid being blown off course. This will have wide-reaching effects, including making the use of drones in agricultural industries and search-and-rescue efforts safer.

## UQ offers world-leading capabilities in digital agriculture

The digital revolution continues to [transform agriculture](#), in the way it has transformed other key industries, such as telecommunications, banking and mining.

Digital agriculture makes use of integrated and connected computerised tools and information to improve decision-making and productivity across all stages of food production – from genetics to farm management or transport to the consumer.

Agriculture is yet to experience the full effect of digital technology, but leads the way in some of the frontier digital sciences, such as linking remote-sensing and predictive systems with genetics and genomics.

### [Digital Agriculture](#) capabilities include:

- Crop modelling and decision support
- Crop forecasting
- Genomics and genetics
- Sensors and automation
- Supply chain and markets
- Protected cropping and controlled environments

Learn more about  
['Innovations in Agriculture'](#)

## Future proof your investments by developing sustainable, integrated value chains

UQ's **Growing Roads project** explores the power of integrating sustainable green algae production systems into transport infrastructure. The Growing Roads initiative is designed to advance cutting-edge green technologies based on microalgae that can be integrated aesthetically into evolving transport infrastructure.

Our vision is to re-green our cities to reduce CO<sub>2</sub> emissions, open up new economic opportunities and sustainable services, offset infrastructure and vegetation management costs, and visually innovate rail and roadsides. Microalgae and plants can capture sunlight and CO<sub>2</sub> in low-grade water, producing O<sub>2</sub>, clean water and biomass. The latter can be used to derive valuable bio-products (e.g. renewable fuels, bio-plastics, green chemicals and bio-fertilisers).

The modular units for microalgae production being designed by the Centre for Solar Biotechnology are robust, economically scalable, automated, high-efficiency systems. In addition to their productive use they can be crafted into visually striking 'living art' architectural designs that will attract visitors, locals, business and innovators. The project is guided by robust techno-economic and life-cycle analysis to ensure that production systems are feasible, durable and sustainable.

## Strengthening value chains and ensuring they are competitive and inclusive ultimately leads to greater economic outcomes for investors and communities alike

### Case Study: The Kakadu Plum Value Chain

Improving the efficiency of **Kakadu Plum/Gubinge value chains** to grow a robust and sustainable industry has been a major research project undertaken by partners of UQ QAAFI: Kindred Spirits Enterprises – Traditional Homeland Enterprises (T.H.E.) and Charles Darwin University. The aim is to review the existing value chains within the established Kakadu Plum (KP)/Gubinge (*Terminalia ferdinandiana*) industry to address the issue of supplying consistently high-quality KP/Gubinge products to ensure a more reliable supply of products, which can better capture market access and grow customer loyalty. Existing Aboriginal suppliers of KP/Gubinge in the Thamarrurr Region of the Northern Territory and the Kimberley region of Western Australia are working with researchers to undertake an extensive review of the existing value chain by mapping, analysing and identifying efficiencies, impediments and coming up with solutions to overcome them. Innovative solutions to local processing and maintaining fruit quality will be trialled and new commercial applications will be developed. In addition to identifying production and facilities enhancements, the project will also work to develop training tools for product costing, startup businesses, hygienic processing of food and quality assurance.



Image courtesy of Dr Fred Fialho Leandro Alves  
Teixeira from the UQ School of Architecture.



## Seek out the highest value bio-based products and services with UQ

UQ has a proven track record in commercialising high-impact technologies that contribute directly toward building better bioeconomies. Australia's leading technology transfer company UniQuest manages the intellectual property of UQ and has successfully commercialised critical innovations and has a suite of available technologies and discoveries for licensing or investment. From [NexGen](#) and its application of INTrait™ technology to develop more salinity-resilient crops and healthier, disease-resistant plants, to the revolutionary breakthrough of [Bioclay](#) sustainable crop protection spray, UQ is working to develop high-tech, environmentally sustainable alternatives to chemicals and pesticides, while solving some of the world's greatest food-security challenges.

### Case Study: Novel bioderived and biodegradable wood plastic composites from wastes

The use of bio-based products is integral to the development of a sustainable bioeconomy. UQ is pioneering the development of a [biobased and biodegradable wood plastic composite](#), comprised of polyhydroxyalkanoates (PHAs) generated from pulp and paper waste. These high-performance wood paper composites have improved melt flow, leading to better binding, and utilise PHA-rich biomass, which avoids the cost and environmental burden of polymer extraction. Unlike standard wood plastic composites, these PHA wood plastic composites have a suitable disposal at the end of their life, due to their biodegradability.

### Case Study: Indigenous opportunity sprouts from desert discovery

Commercialising bio-based resources and products is critical to a sustainable future. UQ nanotechnologists are working with remote Indigenous communities to process [native spinifex grass](#) into diverse commercial applications, from super-strong roads and tyres to super-thin condoms and surgical gloves. UQ and the Dugalunji Aboriginal Corporation recognise local Aboriginal traditional owners' knowledge about spinifex and ensure that they have ongoing equity and involvement in the commercialisation of the nanofibre technology.

### Case Study: Nexgen plants delivers cutting edge virus resistance technology

[Nexgen Plants Pty Ltd](#) enables virus resistant plant varieties to be developed for major food, fibre, energy and ornamental crops used around the world. The Nexgen technology enables resistance for RNA-type viruses to be conferred in a plant variety using either transgenic or intragenic breeding methods. It can also be used to screen tilling populations and germplasm collections for naturally occurring resistance. This transformation process aligns with existing molecular breeding processes and provides durable resistance against plant viruses and resistance for a number of related virus isolates/variants.

## UniQuest Industry Connect programs can promote your organisation to world-leading technologies

UniQuest, UQ's commercialisation company, places UQ uniquely as an innovation powerhouse with an outstanding track record in commercialising our research, so we can provide tangible solutions to the people who need it most.

**Connect with UniQuest**  
[enquiries@uniquet.com.au](mailto:enquiries@uniquet.com.au)

## Bioeconomies that support Indigenous community engagement

Achieving a sustainable Australian bioeconomy is only possible through the valuable contributions of Indigenous knowledges and practices, which are increasingly sought to complement western scientific methods. Indigenous knowledges can advance our understanding, protection and harnessing of Australia's unique biology for the bioeconomy, and genuine partnerships with Indigenous communities and organisations can generate economic opportunities, improve environmental sustainability, and promote the cultural values of Australia's first peoples.

UQ aspires to the inclusion and promotion of Aboriginal and Torres Strait Islander knowledges as an integral component of its mission to create positive change, formalising this through development of a Reconciliation Action Plan 2019–2022 and associated Aboriginal and Torres Strait Islander Research and Innovation Strategy.

Examples include a \$1.57 million research project funded under the Federal Government's ARC Discovery Indigenous scheme (2021–25). Entitled '[A Deadly Solution: Towards an Indigenous-led bush food industry](#)', the initiative will work with traditional owners to investigate new technologies and applications for native Australian bush tucker, novel foods and ornamental plants for urban gardens.

UQ recently renewed its agreement with the **Dugalunji Aboriginal Corporation (DAC)** to continue 14 years of collaboration and knowledge exchange to extract nanofibres from spinifex grass in order to improve the physical properties of a range of commercial latex products. DAC's contributions will be formally recognised through shared ownership of the foundational patent applications and intellectual property related to spinifex-derived cellulose nanofibres.

Through the ARC-funded Centre for [Uniquely Australian Foods](#), UQ and global partners including the Technical University of Munich, Helmholtz Association in Germany and McGill University in Canada are also collaborating closely with Indigenous organisations in the world's first detailed study of the rich nutritional properties of the green plum (*Buchanania obovata*), a bush food native to the top end of Australia traditionally used as food and medicine by Aboriginal communities in these areas. Collaboration with Indigenous-owned Gulkula nursery in Gove, East Arnhem Land, has already yielded successful propagation of the green plum, and the project aims to work closely with Indigenous communities to promote Indigenous ownership, ensuring that commercial outcomes from taking the product to market benefit these communities.





Image courtesy of the **Queensland Alliance for Agriculture and Food Innovation (QAAFI)**; Green Plum Tree, East Arnhem Land, Northern Territory, Australia.



“The United Nation’s Intergovernmental Panel on Climate Change (IPCC) has declared a code red for humanity; innovation and investment in the bioeconomy is now a necessity, not a luxury.”

**Professor Hugh Possingham**  
Queensland Chief Scientist  
and Professor, UQ

## Five of the world's top 100 climate scientists are based at UQ and are prioritising conservation and the protection of biodiverse ecosystems

Leading the 2021 Reuters Hot List of prominent climate change scientists in 16th position worldwide, UQ's **Professor Ove Hoegh-Guldberg** is recognised internationally for his work in coral reef systems. Professor Hoegh-Guldberg is a professor of marine studies at UQ. He is also Deputy Director for the ARC Centre of Excellence for Coral Reef Studies, and a key representative on the Intergovernmental Panel on Climate Change, the United Nations body for assessing the science related to climate change.

### Case Study: Underwater Earth

More than one million high-resolution images from 860 of the world's coral reefs have been made available to scientists by UQ and ocean conservation non-profit, Underwater Earth.

Project leader Professor Ove Hoegh-Guldberg said the research and images were integral to better protecting the world's reefs.

"Coral reefs provide food and livelihoods for hundreds of millions of people globally and are home to thousands of species," Professor Hoegh-Guldberg said.

"Yet coral reefs have been severely impacted by climate change, poor land management practices, pollution and invasive species.

"Urgent conservation action is required to protect these reefs from the impact of climate change and local factors such as pollution and overfishing."

Professor Hoegh-Guldberg said research is required to better understand how coral reefs are responding to these pressures and to identify management options for mitigating these impacts and restoring degraded coral reefs.

**With Professor Peter Mumby, Professor Hugh Possingham, Professor James Watson and Professor John Pandolfi also recognised in the Reuters top 100 hot list**, UQ's scientific expertise and research impact in the field of climate science is undoubtedly highly regarded around the world.



Energy



## Building the energy bioeconomy

UQ is transforming traditional and renewable energy technologies with a view to improving their environmental, social and economic impacts. Meeting the world's growing demand for energy, while minimising related impacts on the environment, represent great technical challenges.

UQ's capabilities in innovative energies have received a major boost through significant infrastructure investments, and attracting research leaders in the fields of solar energy, biofuel research and geothermal energy research.

As we look toward a low carbon future, investment in products ranging from high-value biopharmaceuticals through to future fuels is anticipated to deliver impactful outcomes. Alongside UQ's [Warwick Solar Farm](#) initiative to generate its own electricity by harnessing the sun, UQ has partnered with Siemens with funding support from the Australian Government to establish a new [Industry 4.0 Energy TestLab](#) facility that will enhance global knowledge of electricity networks by focusing on power-system analytics, energy management and microgrids.

### **Case Study [Biofuels](#): UQ's capabilities in biofuel and bioenergy research span disciplines including plant science, microbiology, engineering, and biotechnology**

Our research covers many second-generation biofuel technologies including the development of alcohol (methanol, butanol) fuel products from bio-electrochemical systems, green diesel from vegetable oil, micro-algal biofuel systems and biohydrogen production. For example, through identification and manipulation of genes that can improve efficiency of biofuel feedstocks, UQ is making exciting biotechnology advancements in the development of feedstocks such as the legume tree *Pongamia*, *eSorghum* (a grass for arid environments), sugar (via the UQ-CSR SugarBooster program) and micro-algae.

Another focus is the engineering of green micro-algae as a source of biomass, biofuels, commodities and high value products, and includes using green algal cells and advanced bio-reactor systems to produce bio-fuels such as hydrogen in a CO<sub>2</sub>-neutral process. Additionally, microbial metabolic engineering of sugarcane for example, is leading to new bioproducts from cells.

One of UQ's stand-out capabilities is in the area of new nanomaterials, which is an integral part of clean-energy production and utilisation (including the development of chemical routes for biomass conversion into valuable chemicals, transportation fuels, and clean hydrogen production), and is highlighted by projects such as the catalytic conversion of carbohydrates/lignocellulose to key platform chemicals (fuel additives), using novel metal supported mesoporous materials.

In June 2021, the Queensland Government announced a \$2 billion investment into renewable energy and hydrogen jobs as part of the COVID-19 Economic Recovery Plan.

The Premier and Minister for Trade, The Honorable Anastacia Palaszczuk stated that "Queensland is positioned better than anywhere in Australia to capitalise on the jobs and industries that will flow from this cheaper, cleaner energy."<sup>2</sup>

**In October 2021, the [Queensland Premier announced one of the world's largest hydrogen-equipment manufacturing facilities is set to be built in Gladstone.](#)**

2. The Queensland Cabinet and Ministerial Directory, Media Statements

### Case Study: UQ Algae Energy Farm

The [UQ Algae Energy Farm](#) is a low-cost, high-output, solar-powered demonstration facility optimising new cost-saving technology for mixing, drying and harvesting microalgae, and improving production processes for use in animal feed, biodiesel production, human consumption and health products.

The Algae Energy Farm cultivates and harvests microalgae for a range of uses, including as a feed supplement for beef cattle. The farm has shown that algae can be grown easily in Australian conditions, leveraging feed and fuel, and without competing for arable land needed for food production.

### Case Study Solar: [UQ is harnessing the power of the sun to produce a wide range of hydrogen-methane and oil-based alternative-energy fuels](#)

The global market for photovoltaic systems is now expanding by 35% per year. However further cost reductions and increases in efficiencies and robustness would help to fast-track uptake.

The intermittency of solar energy requires that large-scale energy storage be developed and deployed in parallel if solar is to become a large contributor to overall energy supplies.

At UQ, researchers are very aware that Australia has more solar resources and particular base load supply than any other industrialised nation and are working together across disciplines to find new ways to harness the sun's abundant energy.

The Centre for Solar Biotechnology is host to an [advanced pilot-scale facility](#) at Pinjarra Hills, Brisbane. The facility, designs and tests high-efficiency microalgae systems and processes for the production of high value products as well as bulk commodities. These include foods, renewable fuels, advanced bioproducts and bioremediation.

### Case Study Hydrogen and Green Energy: Investing in sugarcane as clean energy to produce carbon-negative hydrogen

UQ is leading research investigating the use of [sugarcane as a clean energy source](#) to create hydrogen. Bagasse (sugarcane pulp) and other agricultural residues are an abundant resource that could generate 'green' or carbon-negative hydrogen at scale.

The process of using waste biomass from crushed sugarcane stalks and leaves is expected to produce hydrogen for under \$3 per kilogram. Researchers at UQ have identified that this form of hydrogen production could have a significant impact on the sugarcane industry, presenting much needed alternatives for crops and mill infrastructure.

In 2020, Australia announced a \$1.9 billion [investment package in future technologies](#) to lower emissions, including a new \$74.5 million Future Fuels Fund to help Australian businesses and regional communities take advantage of opportunities offered by hydrogen, electric, and bio-fuelled vehicles and a hydrogen export hub worth \$70.2 million to scale up demand for hydrogen.

This, partnered with the recently announced \$2 billion Queensland State Renewable Energy and Hydrogen Fund, and the [Queensland Government Hydrogen Industry Development](#) Fund, positions UQ well to partner for high-impact hydrogen research projects.

## Future fuels

UQ is a key partner in the [Future Fuels Cooperative Research Centre](#) (CRC) working collaboratively to enable the decarbonisation of Australia's energy networks. With key research focused on the areas of future-fuel technologies, systems and markets, social acceptance, public safety and security of supply, and network lifecycle management, this \$26.25 million initiative will address major challenges to Australia's energy supply. This supply includes gas as an essential component in our transition to cleaner fuels.

Building a robust light-driven 'solar-fuel' industry offers a solution to the dual challenge of fast tracking renewable energies into the fuel industry while retaining jobs.



## Industrial Biotechnology

### Inviting pharma and agrochemical industries to find new and improved products

**Microbes Australia** houses a library of over 100,000 cryopreserved bacteria and fungi, with fully annotated genomes and metabolomes, with value added biological profiling. It provides industry partners with ready access to a pre-assembled, pre-annotated and pre-authorised living resource, rich in chemical and genetic diversity, and the expertise needed to access embedded high value chemistry.

UQ invites you to invest confidently, and leverage new knowledge including new treatments for human, animal and crop diseases, and new solutions that match the environmental challenges we face.

## Building the industrial biotechnology bioeconomy

Industrial biotechnology, frequently referred to as the third wave in biotechnology, encompasses a set of practices and strategies that exploit the potential of living cells or components of cells such as enzymes, to generate a growing list of products relevant to the energy, food and health industries.

At UQ, we recognise the unique focal points that differentiate our approach towards bioeconomy development of the natural environments of land and sea as opposed to environment and community. We identify the importance of a focus on the technologies we develop to renewably manufacture energy and diverse goods for human use and consumption by differentiating sectors of energy and industrial biotechnology for successful bioeconomy development.

With key research infrastructure including the [Australian Research Council funded Industrial Training Centre in Biopharmaceutical Innovation](#), the [National Biologics Institute](#), UQ is leading the production of high-quality recombinant protein expression and purification at the Queensland node. Additionally, our role as a key partner in the global [Coalition for Epidemic Preparedness Innovations](#) (CEPI) network is testament to the high regard in which research capability in this critical field is held.

UQ vaccine-development initiatives in response to the COVID-19 pandemic employed critical and proven molecular-clamp technology and highlights UQ's ability to partner and scale up the advanced biomanufacturing of molecules for both industrial (e.g. fuels, plastics) and health (e.g. vaccines, vitamins) applications, relying on renewable materials and/or biological systems. UQ's expertise in the field of advanced biomanufacturing has led to further national investment in a pilot nucleic-acids biomanufacture facility ([BASE](#)) at UQ.

### Case Study: Systems and synthetic biology to develop sustainable bioprocesses

UQ researchers in the [Nielsen Group](#) are leading the development of experimental and computational tools to analyse and design complex biological systems. Expertise in metabolic modelling and flux analysis is available nowhere else in Australia, and in only a few labs across the world. Studies of biological systems as diverse as bacteria, baker's yeast, sugarcane, insects and mammals has attracted industrial partnerships with companies including Dow, Metabolix, US biotech Amyris, LanzaTech, Boeing, Virgin Australia and General Electric. These metabolic engineering partnerships have focused on developing new ways of producing aviation fuel, various materials and bioactives (antibiotics, biopesticides, monoclonal antibodies).

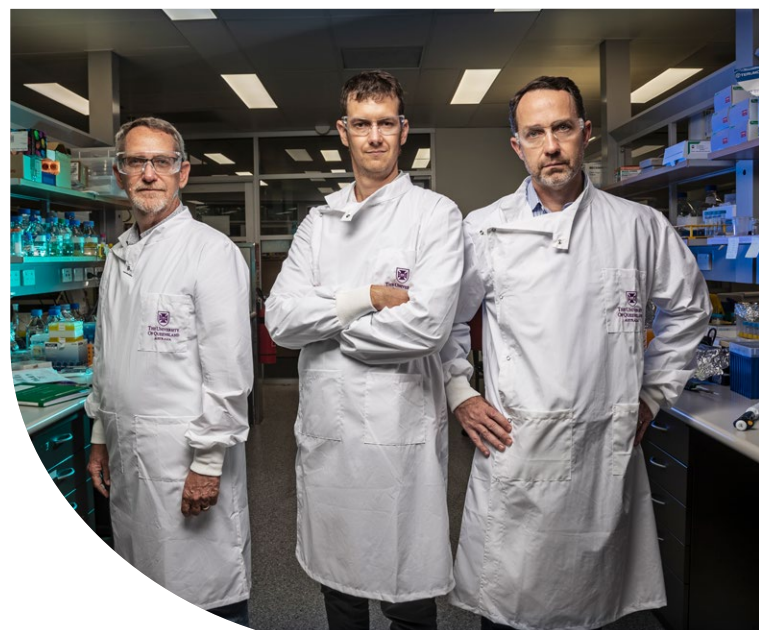
### Case Study: Enzonomy, an enzyme-based production pipeline for the bioeconomy

The development of sustainable production processes from renewable materials for essential commodities such as foods, energy and pharmaceuticals, and important materials such as plastics and fibres, is a major challenge for the global community to move to a healthier future trajectory. Scientists, chemical engineers and economists from UQ have joined forces with global partners to establish an innovative efficient production technology to convert renewable materials (e.g. sugars, fats) into platform chemicals that underpin the synthesis of a wide range of high-value products usable across multiple industrial sectors. Cutting-edge engineering of biological catalysts (enzymes), informed by natural evolution, will be used to build this innovative cell-free technology. The ability to scale up the process to industrial dimensions enhances its impact on the Australian bioeconomy.

### Case Study: Reconstructing Ancient Proteins

[Reconstructing proteins to explain and engineer biological diversity](#) uses computational methods to construct entirely new proteins that operate in combinations nature never attempted. Resurrection and engineering of cytochrome P450 enzymes that have been extinct for over 400 million years has revealed remarkable opportunities for biotechnological innovation.

The approach allows us to establish what specific changes led to the evolutionary success of a protein, and to re-run evolution to generate proteins that perform in conditions suitable for industrial and agricultural applications — in particular, the sustainable production of novel pharmaceuticals and of hydroxylated fatty acids for bioplastics.





**Case Study: Queensland Sustainable Aviation Fuels Initiative: Evaluating the production of biofuels from three different biomass sources – sugar cane, oil from the seeds of the Pongamia tree and autotrophic microalgae**

**The Queensland Sustainable Aviation Fuel Initiative** was born out of an aviation industry desire for genuinely sustainable aviation fuels that will match current performance standards. The initiative was established through a Queensland Government National and International Research Alliances Program grant that brought together a consortium of university biofuel experts and industry for the \$6.5 million first stage of the program. The second phase to evaluate the business case is funded through the Queensland Government's Research Partnerships Program.

Hosted at UQ, the initiative involves partnerships with James Cook University, as well as leading companies including Boeing, Virgin Australia, Mackay Sugar Limited, General Electric, IOR Energy and Amyris.

## Advanced biomanufacturing has been refined for thousands of years.

**Case Study: The UQ [Centre for Advanced Materials Processing and Manufacturing \(AMPAM\)](#)**

AMPAM provides a focus for UQ's materials engineering and manufacturing activities, and those of its partners in major successful national collaborative ventures. The centre capitalises on emerging trends in manufacturing research where innovations in material developments are driving new combinations of metals, polymers, ceramics and composites that have not before been economically possible. With the Centre's industry and research members working together within AMPAM, the blending of technologies and processes will create new unique opportunities for materials development, processing and manufacturing.



**Materials and manufacturing for a more sustainable world**



**Materials and processes for extreme environments**



**Digital fabrication and design**

UQ is tackling the development of new-generation engineering materials, smart-functional materials and advanced-manufacturing technologies — including nanomanufacturing.

**The overarching goal is to develop new manufacturing methods and materials that provide solutions to the manufacturing and materials sector in a global economic context.** Our research has contributed to national and international advanced manufacturing within the automotive, aerospace, military, mining and mineral, and food industries.

Read the latest edition of  
**Small Things Big Changes**

**Case Study: Using genes to improve greenhouse gas conversion**

Collaborating to better understand the gene function of bacteria, UQ is working together with the [ARC Centre of Excellence in Synthetic Biology](#), the [US Department of Energy Joint Genome Institute \(JGI\)](#), [LanzaTech](#) and [Novo Nordisk Foundation Center for Biosustainability](#) (DTU Biosustain) to explore mechanisms to [convert greenhouse gas waste](#) from factories into environmentally-friendly chemicals and fuels.

Using recycled carbon to feed the bacteria, researchers are able to produce cleaner, greener chemicals using up gases that would normally contribute to climate change. By understanding the benefits of biological carbon capture, and learning exactly how these bacteria make energy, it will be possible to improve manufacturing efficiency and create a new way to make chemicals, bypassing fossil fuels.

### UQ research fuelled the world's first US-Australia bio-fuel flight flying Qantas from Los Angeles to Melbourne in 2018

The plane was powered by *Brassica carinata* (*carinata*), a non-food, industrial type of mustard seed. Following successful trials at the UQ Gatton campus, scaled-up commercial production is certain to contribute to the reduction of carbon emissions and has secured an alternative, environmentally friendly sustainable [bio-fuel alternative to petroleum](#).



Community



## Building a bioeconomy that supports the community

Urban, regional and island bioeconomies play a key role in securing a sustainable future for us all. With a key focus on knowledge leadership, the Queensland Alliance for Agriculture and Food Innovation (QAAFI) is host to the biannual global [TROPAG Conference](#), which brings together more than 800 globally renowned tropical forestry, agriculture, nutrition and food-research experts from 43 countries to address the grand challenges faced by surging population growth, climate change and resource scarcity. Collectively, they work together to secure long-term community growth and economic prosperity for generations to come.

With the global population expected to reach 9.8 billion by 2050, priority research in the areas of tropical forestry and agriculture, sustainable resource management and waste management will ensure UQ continues to support critical development of bioeconomies for **local, regional and island-based communities**.

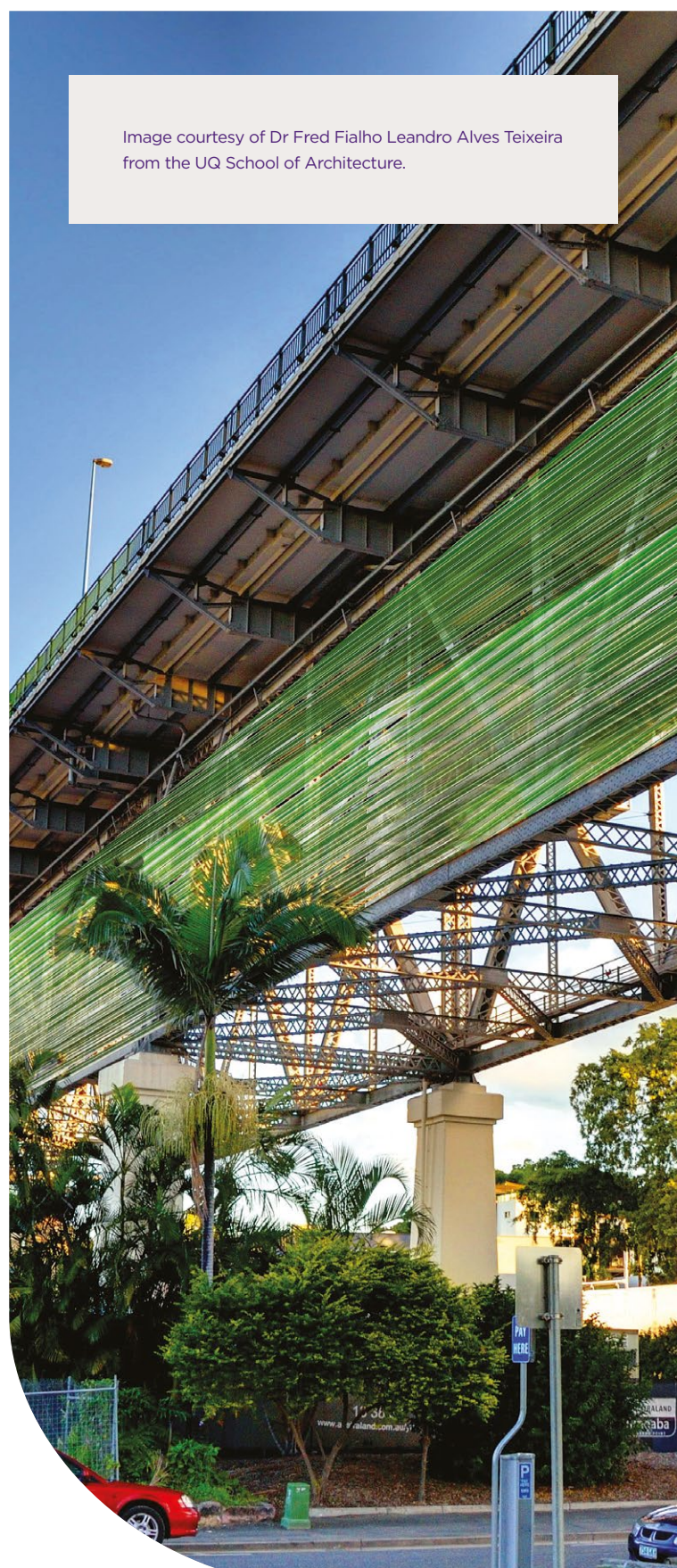
### Case Study: From good neighbours to strategic partners

UQ and the diverse countries of the Oceania region share long-standing and multi-faceted relations. As our closest international neighbours, our growing people-to-people links are helping strengthen economic, governance, health and social systems.

Our collaborative efforts also contribute to understanding one of the most biodiverse regions of the world and protecting the oceans, crops and animals that its communities rely on. UQ's International Development team has collaborated with [researchers](#) to develop a [customised leadership and management training program](#) for fisheries leaders in the Pacific, together with Pacific Community, Forum Fisheries Agency and the Centre for Adaptive Leadership (funded by the New Zealand Ministry of Foreign Affairs and Trade).

Fisheries remain the most important ocean resource for livelihoods, employment and economic growth, as well as a critical source of protein in the Pacific. Well-managed and sustainable fisheries and aquaculture increase economic and food security. Additionally, key initiatives to [control pests without pesticides](#) or [real-time satellite systems to monitor global reef bleaching](#) are certain to protect the valuable island ecosystems upon which so many communities depend.

Image courtesy of Dr Fred Fialho Leandro Alves Teixeira from the UQ School of Architecture.





## Harvesting solar energy to reduce pollution in urban communities

**Urban communities** can benefit from the thoughtful application of advanced infrastructure that will not only increase the resourcefulness of city structures, but ensure high-polluting destinations increasingly adopt green-energy alternatives.

### Case Study: Integrating modular microalgae systems into buildings and urban infrastructure to create eco-cityscapes

Through the application of advanced urban infrastructure and architecture as seen in [GreenSmart Cities](#), UQ is delivering projects focused on designing robust, economically scalable, automated high-efficiency green-algae production systems, which are visually striking. Imagine the integration of modular microalgae systems into buildings to develop eco-cityscapes. These can provide thermal control, help to power buildings, abate street noise and produce bio-products while absorbing CO<sub>2</sub> and pollutants from the air.

Microalgae are rapidly growing, solar-driven microscopic 'cell factories' which capture CO<sub>2</sub> and can use low-grade water to reduce greenhouse gas emissions and improve air quality, while producing O<sub>2</sub>, clean water and biomass. This biomass can be used to derive valuable bio-products including renewable fuels, bio-plastics, green chemicals and bio-fertilisers.

## Water-sensitive cities

The [Cooperative Research Centre for Water Sensitive Cities](#) (CRC-WSC) brings together the interdisciplinary research expertise and thought-leadership to undertake research that will revolutionise water management in Australia and overseas. The \$30 million nine-year grant facilitates collaboration with over 85 research, industry and government partners. UQ is committed to delivering the socio-technical urban water-management solutions, education and training programs, and industry engagement required to make towns and cities water-sensitive.

### The Advanced Water Management Centre (AWMC)

is an internationally recognised centre of excellence in innovative water technology and management. In South-East Asia, the Singapore Public Utilities Board has funded UQ researchers to develop a **world-first** integrated strategy to achieve multiple beneficial uses of [iron salts in an urban water system](#). The research will substantially reduce the use of chemicals in the urban water system, delivering large economic and environmental benefits to urban-water utilities.



## Agriculture



## Building better bioeconomies for the agriculture sector

Through a strong focus on food and feed production, nutrition, protected cropping, plant breeding and reproduction and agribusiness development, UQ is driving the industrial transitions essential to support local and global bioeconomy development. With hundreds of world-class research projects underway, we share some of our most prominent achievements and exciting initiatives with a view to changing the way we think about the future.

### Case Study: Uniquely Australian foods

Through the Australian Research Council funded [Uniquely Australian Foods Industrial Transformation Training Centre](#), UQ researchers are embracing biocultural diversity while protecting Indigenous intellectual property and traditional ecological knowledge to transform the native food and agribusiness sector through the development of selected crops, foods and ingredients.

### Case Study: Space age plant breeding a world first at UQ

Improvements to make crops more nutritious, disease resistant and climate smart are essential to [feed a burgeoning world population](#). Building on inspiration from [NASA experiments](#) to grow wheat in space, UQ is applying technology that involves rapid growth of various plant and horticultural crops under 23-hour day lighting to speed up the breeding cycle, slashing the time to develop improved varieties for farmers. Meeting the demand from researchers and industry, this technique presents an answer to global future food security and offers a [valuable tool for plant breeders](#) to develop more robust crops.

The speed-breeding technology has been used to create novel wheat varieties in Australia and has been adopted by plant-breeding programs around the world. Applying the learnings to protein-rich pulses, speed breeding procedures paired with AI have also led to the development of a [genetic model for the ultimate chickpea](#).

### Case Study: Reduce your environmental impact with crop probiotics

Just as the human gut is teeming with bacteria, both good and bad, so too is the soil. Just as many of us turn to probiotics to help us feel better, a similar health revolution is happening in the agricultural industry.

Farmers now want to apply the same 'good bacteria' principle to plants, using '[crop probiotics](#)' containing beneficial microbes – or micro-organisms – to boost plant health and growth. Beneficial bacteria and fungi can help plants defend themselves against pathogens, acquire essential resources, and become more resilient against stressors such as drought, heat, insects or other pests, soil toxicity and nutrient limitations. At UQ, we have significant expertise across natural ecosystems and agro-ecosystems at the interface of plants, microbes and soil.

To support knowledge sharing across this space, UQ researchers have long been involved in a major project that is helping map the ecological community of microorganisms inhabiting Australia to create a unique, publicly accessible reference that will enable planners to better manage our environment.

Known as the [Australian Microbiome Initiative](#), the ever-growing database also aims to reduce Australia's biosecurity risks and increase awareness of potential agricultural and mineral hazards and opportunities.





### Case Study: The Integrated Bioeconomy Project (IBP)

Global food demand is forecast to increase by 2% per year to 2050 due to our expanding population and improved standards of living. This ensures a rapidly expanding food market, the supply of which will increasingly be impacted by climate variability, access to fresh water, and nutrients.

The [IBP](#) aims to deliver an advanced integrated production system with broad-reaching benefits. It consists of a high-tech protected cropping system (controlled biosphere) able to **produce up to 10 times more food than field production with 10 times less water.**

This can also be integrated into, and enhance, conventional field production. The project is guided by economic and life-cycle analysis to select and integrate the best combination of advanced greenhouse technologies, energy supply and heat-exchange systems, crop and algae production systems, CO<sub>2</sub> enrichment technologies, soil enhancers, nutrient recycling, water-purification capability and biological-control methods.

These are designed to optimise light, temperature, CO<sub>2</sub>, humidity, nutrients, and pest and disease control. These closed-loop systems will allow the conversion of abundant natural resources – sunlight, CO<sub>2</sub>, degraded land and low-quality water – into high-value products such as fresh nutritious food, algal products (e.g. nutraceuticals), while conserving energy and water.

### Case Study: New era in the discovery of life-saving medicines

[Soils for Science](#) is an Australian-first citizen science program dedicated to finding new antibiotics needed in the fight against the scourge of drug-resistant infections, better known as superbugs. More than half of all antibiotics available worldwide have been developed from microbes found in soil and nature, and Queensland is one of the most biodiverse environments in the world, spanning beaches, rainforests, wetlands and deserts.

This vast, untapped landscape is ripe for the discovery of microbes that could be developed into new antibiotics, anti-fungals and other medicines. You are invited to visit the [soils for science gallery](#) and request a [soil analysis kit](#).

### Case Study: Increasing crop yields with Hy-Gain for smallholders

In the field of agriculture and plant sciences, UQ is part of an international team led by the Centre for Crop Science collaborating on the \$29 million, five-year 'Hy-Gain for smallholders' research project, funded in part by the **Bill and Melinda Gates Foundation**. The aim is to introduce [sorghum and cowpea species that have significantly higher yields and are more sustainable](#) into the world's poorest farming communities to help improve food security, cut down on farming costs, and help farmers transition from subsistence living to farming for profit.

## World population is forecast to reach between 9.8 billion by 2050

Climate change, natural disasters, changing consumer trends, digital disruption and the COVID-19 pandemic, as well as population growth, all reinforce the need for the agrifood sector to shift significantly and do so within a rapidly changing landscape and diminishing timeline. Approaches regarding where and how we grow, produce, harvest, distribute and consume food must adapt to achieve and sustain the food and nutritional security of 10 billion people on earth by 2050.

This challenge is exceedingly complex and multidimensional. Approaching any solution will require the combination of wide-ranging resources, leading knowledge, and capability advanced through global partnerships spanning industries, governments and communities, in addition to research and teaching organisations such as universities. Potential solutions must be driven by the development of new knowledge, practice and technologies that are fit-for-purpose, perform effectively and can be readily adopted for continuing application by industry. All of this will require feasible and available support and training.

## UQ Protected Cropping Research Network

The UQ Global Change Institute Research Network in protected cropping is a multidisciplinary initiative that applies a holistic and partnered approach to this agrifood grand challenge through an extensive program of research, development and extension activities.

Internally, the network is comprised of expert UQ scientists in fields of biology, chemistry, materials, hydrology, energy, design, engineering, architecture, robotics, automation, data modelling, business and economics, social science, policy and skills.

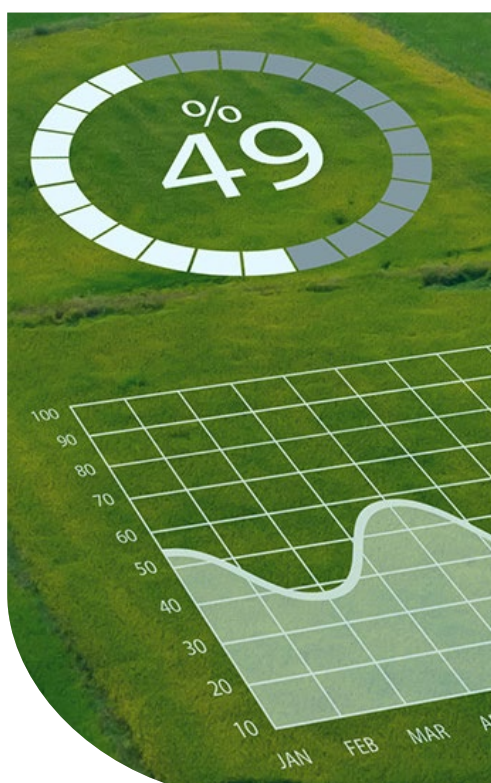
The wider network builds on existing and new partnerships with state and federal government research authorities, multinationals, small-to-medium sized businesses, grower groups and industry bodies, not-for-profit organisations, and technology startups, who share the desire to tackle this global challenge through knowledge exchange and collective activities.

UQ recognises that challenges of such scale can only be approached through assembling and harnessing diverse sets of deep knowledge and experience. We achieve this by leveraging our vast networks, facilities, and infrastructure; in addition to, creating suitable environments for all stakeholders to congregate and express ideas for the co-creation of viable and applicable solutions.

**Protected cropping** is an inevitable trajectory with societal, economic and environmental benefits and has the potential to transform products/production systems for domestic and global agrifood markets.

It applies controlled facilities for growing plants, regardless of external conditions and climatic extremes. Advantages of protected cropping are compelling, and include:

- Innovating, developing and growing existing and high value crops and products as part of modern manufacturing and new markets.
- Year-round supply.
- Water efficiency gains of up to 800% in contrast to outdoor farming.
- Systems that are more than 500% water efficient (crop yield/litre) through rainwater capture and recycling.
- Reduced food waste.
- Decreased impact on land and biodiversity (high crop output in smaller areas and reduced use of pesticides).
- Improved management of growing systems (zero emission energy source, optimised light, heat, agronomy and physiology in controlled environments, circular and closed loop designs).
- Enabling tools and technologies (e.g. real-time crop decision making tools, integrating robotics and automation, advanced sensor technology).
- More efficient supply chains and increased export potential.



## AgriFood Connect is ensuring science and technology translate seamlessly to industry

**AgriFood Connect** is a national organisation connecting the entire agri-food value chain. A joint initiative of the FKG Group, UQ, and Telstra, AgriFood Connect is committed to bringing together academia, governments, investors, corporations and startups to nurture intelligent connections and deliver smart solutions for industry.

Accelerating the development and adoption of technologies and innovative solutions that will benefit the agribusiness supply chain, AgriFood Connect is home to the **Agtech and Logistics Hub**.

Established in 2020, the Hub is proudly funded by the Queensland Government in association with the FKG Group, Toowoomba and Surat Basin Enterprise, University of Southern Queensland, and UQ. These key entities are embedded within the **AATLIS eco industrial precinct** in Toowoomba.

## Marine





## Building better bioeconomies for the marine sector

Emerging biotechnologies are enhancing the development of large-scale marine bioeconomies. The importance of preserving our natural resources can be balanced by the sustainable use of biomaterials for ocean productivity ventures in the areas of aquaculture, food production, and marine-based renewable energy.

At UQ, we can leverage the power of our involvement in multiple Cooperative Research Centre (CRC) projects intended to mitigate the impact of climate change, while harnessing the economic potential of our vast ocean estate in an environmentally mindful and sustainable way.

From estimating carbon sequestration rates to scaling up the benefits of seaweed cultivation and limiting [outbreaks that decimate aquaculture](#), research at UQ is driving solutions for healthy and sustainable environments, industries and livelihoods.

The UQ [Centre for Marine Science](#) is one of Australia's largest and most successful marine research hubs, with close to 100 research-intensive groups working collaboratively across four broad, interconnected research themes. Expertise spans policy, management, conservation and ecology; genomic, molecular and physical sciences; and engineering and advanced technologies.

The four key research themes are: coastal systems, coral reefs, innovation and blue economies, and society and changing oceans.

### Case Study: Innovation and Blue Economies

Marine animals, plants and microbes produce complex structures and chemicals beyond today's most advanced engineering and manufacturing capabilities. These have the potential to generate clean energy, materials, high value fine chemicals and new pharmaceuticals. The ocean is also the primary source of nutrition for communities worldwide.

Harnessing the remarkable capabilities of marine organisms and building better systems to capture the ocean's potential, [UQ researchers](#) are partnering with industry, government and the community to create environmentally sustainable and economically viable bioeconomic and technological solutions.

### Case Study: The Blue Carbon Initiative is mitigating climate change through coastal ecosystem management

UQ researchers are playing a leading role in the international [Blue Carbon Initiative](#) exploring the organic carbon stored in marine ecosystems. Mangroves, salt marshes and seagrasses are important ecosystems containing blue carbon, as they capture carbon in their soils and vegetation. They also contribute to a wide range of other ecosystem services, such as habitats for fisheries and biodiversity, protection from floods and extreme storm events, and improvement of water quality.

The removal and degradation of these ecosystems has resulted in carbon-dioxide emissions, loss of carbon-capture capacity and reduced coastal protection, in turn reducing the resilience of coasts to climate change. Scientists at UQ are working to conserve and restore mangroves, salt marshes and seagrasses, which will in turn enhance both carbon-capture and climate-change adaptation, among other tangible benefits for communities.

## Leverage the power of Cooperative Research Centres (CRCs) and partner with UQ to solve the greatest industry challenges

### Blue Economy - CRC

The [Blue Economy Cooperative Research Centre](#) is delivering innovation in sustainable seafood and renewable-energy production for a marine nation. With multiple stakeholders investing a total of \$329 million toward the CRC in 2019, the Australian Federal Government has contributed \$70 million to bring together national and international expertise in aquaculture, marine renewable energy and marine engineering as part of a collaborative effort where [UQ is partnering](#) with industry, researchers and the community to develop innovative and sustainable offshore industries to increase Australian seafood and marine renewable-energy production.

Australia has the third-largest Exclusive Economic Zone (EEZ) with over 80% being classified as offshore. Renewable energy from these sources can be captured and converted into electricity for both onshore and offshore use, as well as transformed into energy 'carriers', such as hydrogen, for storage or export.

### Case Study: Biofouling-free Aquaculture – UQ is working to combat industry challenges

Development of vast marine ecosystems will pave the way for new industries to support the economic growth of island and coastal communities. Across the areas of renewable energy, coastal tourism, waste disposal, maritime transport, fisheries and aquaculture, investment in addressing sector challenges in a sustainable and environmentally mindful way will be essential.

At UQ, we are leading the [Biofouling Challenges and Possible Solutions](#) project, with the goal of helping to create aquaculture free from biofouling, reducing stress and risk to fish health, as well as reducing damage to off-shore renewable-energy generation and aquaculture infrastructure caused by biofouling.

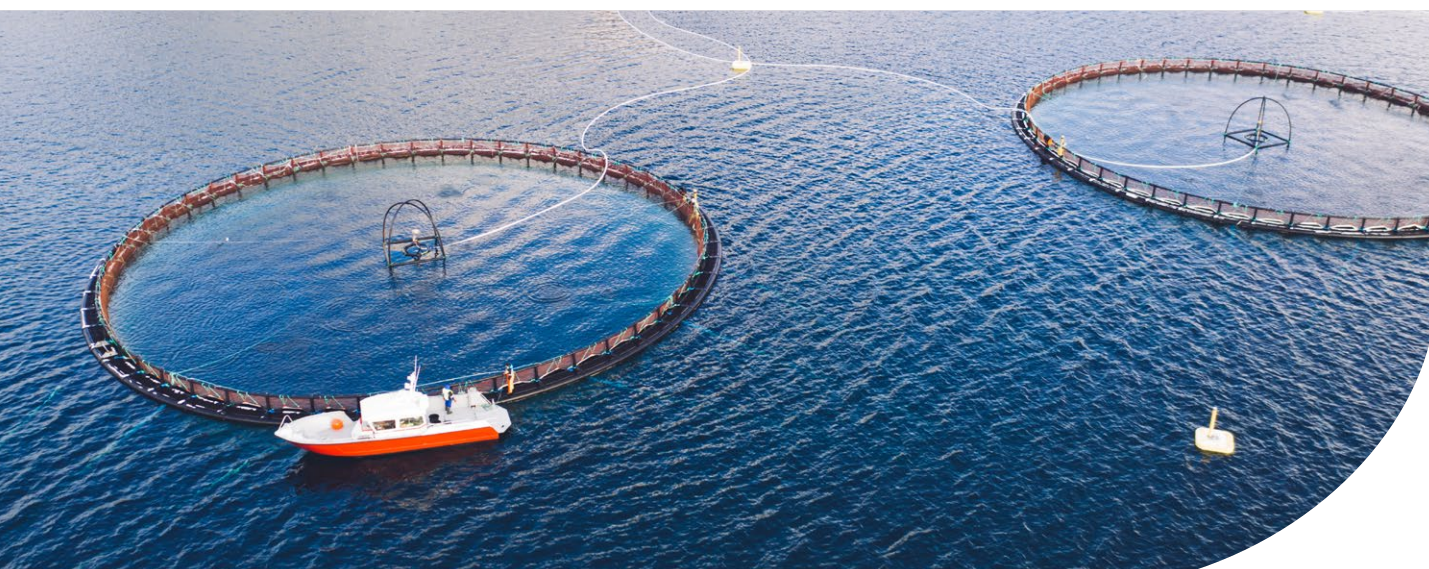
### Marine Bioproducts - CRC

Announced in 2021, a total of \$270 million has been earmarked to support a large-scale 10-year [Marine Bioproducts Cooperative Research Centre](#) (MB-CRC), representing a significant opportunity for the development of Australia's bioeconomy.

UQ is one of several research partners committed to building a world-class marine bioproducts and biotechnology industry.

The MB-CRC will focus on production of new sources of marine biomass such as seaweeds, marine micro-algae and filter-feeding animals and the use of advanced-manufacturing technologies and processes to produce a suite of novel bioproducts. A \$59 million contribution from the Australian Government is set to pave the way for [marine bioproduct innovation](#) that will transform the emerging marine-bioproducts sector.

UQ is partnering with government, industry and research partners to build the export potential of the planet's third-largest marine area.





## Environment



## Building better bioeconomies for the environment

UQ consistently ranks as a top performer in several of the world's most respected university league tables, and is currently #17 in the world for Environmental Sciences and Geography, and ranked in the top 25 for Earth and Environmental Sciences in the latest [Nature Index Tables](#). With these rankings comes great responsibility and the need for leadership, which has allowed UQ to attain this global recognition for its research and teaching endeavours across the areas of biodiversity, conservation, ecotourism, public health, mining and land rehabilitation.

Bioeconomies that support our environment will pave the way for increased sustainability across the core industries of tourism, health, agriculture and mining.

### **Case Study: Queensland's national parks have a role to play in the COVID-19 economic recovery and UQ ecotourism researchers are at the frontline**

UQ research confirms that biodiversity, preservation and rejuvenation efforts aimed at protecting our prized national parks will result in Queensland's global tourist hotspot destinations retaining their pristine outlook and contributing to local and national economic growth. Key to COVID-19 recovery efforts will be the return of tourism to popular coastal, regional, outback and urban precincts. The [research revealed](#) that 'tourists who visited a particular region to go to a national park, directly contributed \$1.98

billion to Gross State Product, and helped support 17,240 jobs'. To address the needs of industry and progress prominent research in the field, UQ partnered with [Ecotourism Australia](#) in 2018, signing an agreement that enabled four joint-PhD scholarships to be undertaken in the areas of social license, overtourism, sustainable places and low-carbon futures.

### **Case Study: Developing an environmental bioeconomy while preserving the world's largest collection of coral reefs and a UNESCO World Heritage Centre**

Through his role as Chief Scientist at the [Great Barrier Reef Foundation](#), and his position on the Reuters top 100 hot list for climate scientists, UQ Researcher **Professor Peter Mumby** is supporting environmental bioeconomies around the world and, most critically, here in Australia. From advising on the impacts of [overfishing](#) on coral reef ecosystems, to recommending cost-effective economic strategies and habitat mapping, [UQ researchers](#) are also delivering solutions and alternatives that protect the productivity rates of commercial fishing enterprises. At the same time, they are also opening the door to newer, less invasive alternatives that will serve to generate greater public awareness toward issues faced by natural resources, such as the Great Barrier Reef, by introducing eco-tourism initiatives such as [coral gardening](#) or nurseries, enabling the community and tourists alike to contribute to [reef restoration](#) and [preservation](#), while boosting the economy and regional employment.





“There is no viable pathway to net zero emissions that does not involve **protecting and restoring** nature on an unprecedented scale.”

**Mr Alok Sharma**, COP26 President

**Case Study: The Hidden Vale Wildlife Centre is striving to develop innovative and globally significant solutions for wildlife management and conservation**

The [Hidden Vale Wildlife Centre](#) is an inspirational partnership between the [UQ](#) and [The Turner Family Foundation](#). The centre is a well-established teaching, research and community engagement facility located on the property of Old Hidden Vale at Grandchester in South East Queensland. Facilities and resources include interpretation/engagement spaces, veterinary clinic, lecture theatre, office spaces, a vast range of equipment, superior wildlife housing and breeding facilities, and research areas equipped with state-of-the-art technology. It houses a diverse range of native wildlife, including both common and threatened species. Researchers have access to over 10,000 hectares of real-world research-focused land across multiple properties.

This exceptional fusion of land, facilities, resources and partnerships uniquely supports innovation and applied research, critically including valuable long-term research.

**Case Study: Functional biology key to mine rehabilitation**

UQ researchers are racing against time to [preserve the endangered \*Gossia fragrantissima\*](#). With seed production compromised in recent years due to environmental impacts, a bid to conserve the species is underway at UQ. Researchers aim to develop a successful protocol that will enable cryogenically frozen stem cells from the plant to regenerate and grow into new trees. With a rare ability to capture and store the heavy elements of manganese, nickel, cobalt and zinc in leaf tissue, the native *Gossia fragrantissima* from the Myrtaceae family, may have an increasingly critical role in phytoremediation and regeneration projects as a hyperaccumulator.

## Conservation and the protection of threatened species are critical when developing future-focused bioeconomies

UQ is situated in the state of Queensland, widely known as one of the most biodiverse places on earth. It is from Queensland that we can expand upon and exchange [ecological knowledge](#) and best practice with partners globally, contribute to the protection of natural habitats, and achieve policy outcomes in land and sea [conservation programs](#).

Supporting the state-wide focus on mitigating the environmental and health effects of climate change, UQ is developing critical deforestation protocols, managing habitation loss, documenting invasive, [threatened or endangered species](#), combatting infectious diseases and addressing fragmentation and environmental degradation.

Prioritising conservation endeavours, UQ is host to the [Centre for Biodiversity and Conservation Science](#) (CBCS), a world-leading solution-oriented research centre for biodiversity conservation. The CBCS is also partnered with global entity, [The Nature Conservancy](#), where together they are empowered to address critical conservation

efforts supporting the protection and preservation of reefs, forests, catchment areas, coastal ecosystems, agricultural land and natural resources. Projects focused on regeneration, rejuvenation and redevelopment of natural resources are of critical significance when developing sustainable bioeconomies.

UQ works in partnerships with scientists, governments, non-governmental organisations, and industry to solve the world's most important conservation problems. One such pivotal partnership involves the Australian Research Council's [Centre of Excellence for Environmental Decisions](#) (CEED) where UQ's leading researchers support efforts to bridge the interface between economic, environmental and social factors impacting conservation management, policy development and decision-making.

### Case Study:

Applying proven biodiversity offsets to compensate for the adverse effects of urban development, deforestation, mining and infrastructure projects on threatened species and ecological communities, UQ has also partnered with the National Environmental Science Programme's (NESP), [Threatened Species Recovery Hub](#) to co-develop an [expert elicitation framework](#) to identify the most effective, transparent and cost-effective approaches possible to address these critical challenges.

[UQ research](#) is mapping historic and projected habitation loss in areas of heavy deforestation revealing the undeniable impact human activity is having on a wide range of ecosystems.



## An environment rich in renewables

Demand for minerals and the secure supply of resources worldwide is increasing. UQ strives to find solutions to the complex problems facing the environment, humanity and the economy on the path to sustainability.

In 2021, the Australian Federal Government launched a 10-year rare-earth and critical-minerals value-add plan committing to a focus on green-energy futures. The plan features a \$1.3 billion [Modern Manufacturing Fund](#) to build capability, and support production and commercialisation of key commodities and products.

This was accompanied by the State of Queensland's announcement for a \$1.7 billion [CopperString 2.0 project](#) set to increase solar and wind generation that will support growth of the hydrogen export industry.

### Case Study: Centre for Social Responsibility in Mining

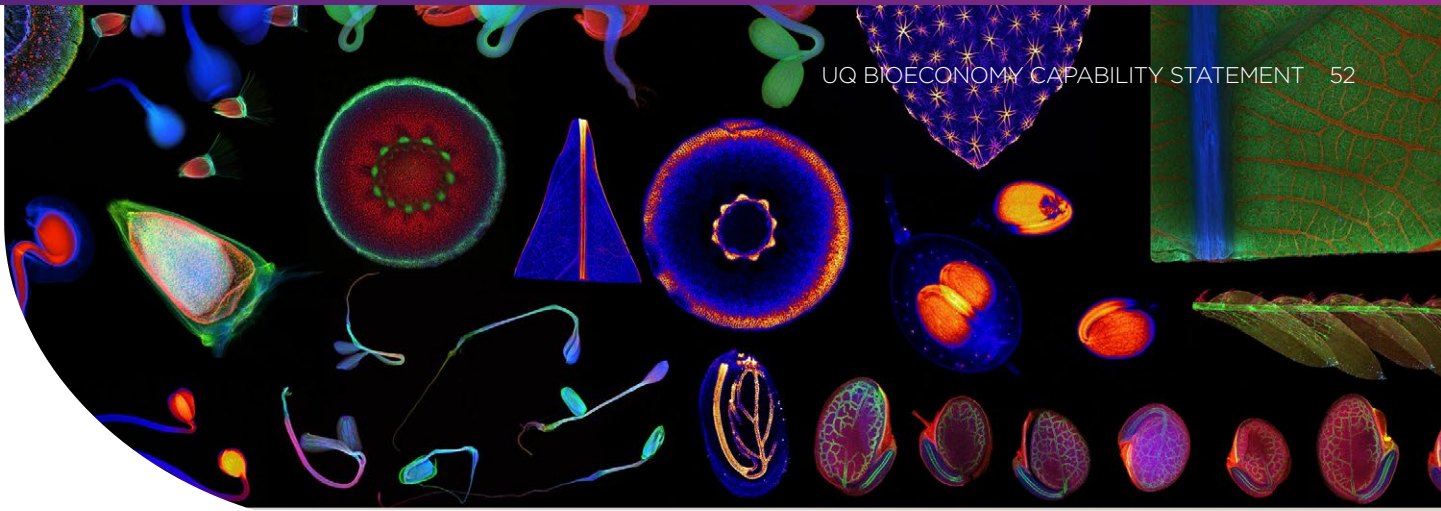
The UQ [Centre for Social Responsibility in Mining \(CSRMI\)](#) is a leading research centre committed to improving the social performance of the global resource industry. With a focus on social, cultural, economic and political challenges that occur when change is brought about by mineral resource extraction.

CSRMI contributes to industry change through independent research, teaching, and by convening and participating in multi-stakeholder dialogue processes.

Committed to contributing toward the UN SDGs, UQ experts support the review of mining-related contracts, oversee complex large-scale mining project agreements between companies and the state; host regions and local communities and provide appropriate solutions to support industry to address key challenges faced in the sector. Researchers have recently developed a [framework to monitor emissions](#) across the mining supply chain, the findings of which can assist in informing mitigation strategies that span mining, ore processing, and transportation to waste management.

Collaboration spans research and training focused on the lives and livelihoods of women working across the gemstone mining value chain in Madagascar and Sri Lanka, to human rights and gender-consideration issues and the impact mining may have on land, water and culture, with a particular focus on Indigenous and Tribal peoples. From mine closures and resettlement strategies, to bioremediation, rehabilitation and rejuvenation programs, CSRMI has capabilities and governance protocols to support the complexities faced by the resources and extractive industries.





### Case Study: Re-mining could be the environmental and economic solution we need to move and manage mine waste safely

Exploring new economy metals, many mine waste sights are forecast to contain concentrations of metals and mineral elements essential to the development of emerging renewable, medical and consumer technologies. Collaborating on a four-year, \$1 million project with the Queensland Government's Department of Natural Resources, Mines and Energy (DNRME) [UQ research](#) is examining new economy metal concentrations in Queensland's mine wastes.

This increasingly important work presents an economic and environmental incentive for the re-processing of mine waste that will support rehabilitation goals and reduce the longer-term environmental footprint left at sites upon their closure.

### Case Study: Securing a circular economy is critical to the minerals sector and to the future of our planet

UQ is at the forefront of research into how the mining industry can continue to provide essential materials while reducing environmental and social impacts. Opportunities exist for waste to be processed to create by-products, which could be used by the mining industry itself or by other industries. This critical [circular economy model](#) enables a model of take, make, use, recycle or reuse. Upcycling transforms by-products, waste and unwanted products from the production process into new materials or products, such as using mining waste as a soil additive, or for road construction. The recycling of electrical- and electronic-waste equipment can also extract metals that will contribute to resource efficiencies and extend the life of current primary-ore reserves.

### Case Study: Land rehabilitation to benefit from mineral-gel technology

UQ has partnered with Rio Tinto and Queensland Alumina Limited to initiate the development of a [mineral-gel technology](#) for effective, low-cost, rapid management of caustic red mud from alumina refineries. The gel links mineral grains into stable and benign soil-like structures so the red mud can sustain plant-root systems. This will aid not only land rehabilitation, but will also help with seepage management.

### Case Study: Innovations in agromining

The UQ [Centre for Mined Land Rehabilitation](#), is leading research on novel ways to extract critical elements, such as nickel and cobalt, needed for lithium-ion batteries and other high-tech demands. By farming [hyperaccumulator plants](#), and harvesting their metal-rich biomass, scientists have identified applications that can span from the remediation of pollution to the production of bio-sourced industrial metals and organic supplements for human consumption.

### Optimising Resource Extraction (ORE)

The Cooperative Research Centre Optimising Resource Extraction ([CRC ORE](#)) is transforming the minerals sector by developing and deploying innovative world-class technology to effect a step change in value across the whole-of-mine system. It aims to 'Optimise Resource Extraction' through site implementation of innovation to improve overall productivity. **UQ and commercialisation entity JKTech are essential partners** in the far-reaching \$34.45 million initiative, already seeding breakthrough software development with the Integrated Extraction Simulator (IES); it's used to predict and optimise mineral processing performance that engineers can then use to compare and cost new flowsheet designs and by researchers to prototype and refine new equipment models.

### Transformations in Mining Economies (TIME)

A national consortium **led by UQ** and the University of Western Australia has secured \$30 million from the Federal Government to help regional communities transition to a sustainable future after their local mines have closed.

The funding forms part of a total 10-year investment of \$135.4 million supporting mining communities to create sustainable community and development opportunities. The consortium will form a [Cooperative Research Centre for Transformations in Mining Economies \(CRC-TIME\)](#), with hubs in both Queensland and Western Australia.



## Teaching expertise and research infrastructure

UQ partners with esteemed public and private partners internationally to develop innovative academic programs and research outcomes. By continuing to foster and develop key teaching and research partnerships and strategic alliances with international institutions and organisations, UQ and its global partners benefit from increased academic, research and reputational reach. Thanks to our exceptional [research infrastructure](#), UQ delivers 100% of its research at world standard or above<sup>3</sup>, with outcomes that directly impact global society.

With more than 70 world-class facilities and services, 12 central research platforms, 14 national collaborative research facilities and more than \$300 million in research infrastructure, UQ researchers deliver cutting-edge research and research training that contributes timely solutions to the biggest challenges of our time.

By building more environmentally sustainable, economically viable and community-supported biological production systems, UQ research is delivering bioeconomic impact through partnering with industry, government and the community. For example, the teams at our [Protein Expression Facility](#) (PEF) support new vaccine development for both human and animal use. Teams at the Centre for [Geoanalytical Mass Spectrometry](#) are at the forefront of research into climate change, loss of biodiversity, urbanisation, population growth, and sustainable development of minerals and environmental resources.

Our researchers in the [Genome Innovation Hub](#) are leading the development of new techniques to understand the basis of successful plants and animals, while the [Centre for Microscopy and Microanalysis](#) (CMM) delves deep into the smallest building blocks of these systems. [Central Glasshouse Services](#) combines first-class facilities and staff to support plant and soil industry, research and education. Watch IMB's '[Earth's solar interface](#)' video to learn more.\*

**Connect with the UQ Research Partnerships Office**  
[researchpartnerships@research.uq.edu.au](mailto:researchpartnerships@research.uq.edu.au)

3. 2018 Excellence in Research Australia (ERA) assessment

\*To view this video, access the digital copy of this statement by scanning the provided QR code on the closing page.

## Partner with UQ to build better bioeconomies

For solutions to global problems, partnering with UQ will bring you one step closer to success. UQ's vision is to provide knowledge leadership for a better world. As part of achieving this vision, we aim to be Australia's most globally connected university and achieve a lasting influence on the communities with which we engage through the creation, preservation, transfer and application of knowledge.

Guided by a university-wide global strategy, UQ supports opportunities for international partnerships with world-class institutions, and government and industry bodies. Partnerships improve productivity, promote knowledge exchange and enable increased access to high-quality research infrastructure and equipment. Most importantly, they support international people-to-people links and offer benefits for industry partners who gain access to broad networks of knowledge and expertise. [Contact the Global Strategy and Partnerships team to learn more.](#)

### Research partnerships with purpose

UQ has a long history of successful partnerships with startups, local businesses, multinational corporations, governments, NGOs and other research institutions.

UQ [Research Partnerships](#) leads research collaboration, agreements and consultancy between UQ researchers and external partners. We can help your organisation develop research-led solutions to complex challenges.

### Connecting business and industry with research

UQ forges strategic industry partnerships to tackle global challenges, create career opportunities, and foster student mobility — all of which effect positive change around the world. By partnering with UQ, you and your business can gain privileged access to cutting-edge ideas, knowledge, state-of-the-art equipment and facilities, and talent. It does not matter how large or small your business or project is, we want to hear from you. Find out how business and industry can [connect with UQ](#) to create change.

### Commercialisation that will boost the economy and accelerate impact

[UniQuest](#) is Australia's leading technology transfer company and commercialises research from UQ to create change. UniQuest has founded more than 100 startups based on UQ's intellectual property — a milestone unsurpassed by any other Australian university. UQ technologies licensed by UniQuest have amassed sales of more than \$32 billion globally.

UQ is a significant contributor to the success of new and existing businesses. Beyond UniQuest, UQ's ilab Accelerator and incubator programs alone have helped 200 startup companies who have received more than \$90 million in investments and grants.

### Explore research training and industry PhD partnerships with UQ

Undeniably, it is to the benefit of both industry and research graduates that the skills and capabilities developed through their doctoral training matches the needs and expectations of future employers. Central to UQ's commitment to nurturing industry-ready graduates is our suite of advanced research and professional practice training modules within our Career Development Framework. Participating students acquire transferable skills and hone their professional adaptability.

Through the UQ Industry PhD Partnership (UQIPP), a select cohort of doctoral students collaborate on industry-aligned interdisciplinary projects and are provided a unique research training experience and targeted career development. Ideally three months in duration, these industry internships will provide students with supervision from our industry partner and academics from a range of UQ Schools. Contact the [UQ Graduate School](#) for more information.

### Future ready graduates with an entrepreneurial mindset

As one of Australia's leading research and teaching institutions, UQ is committed to nurturing the talent and skill sets necessary to drive industry growth, and research and development and can facilitate collaboration to develop a talent pipeline and training on multiple fronts. Through [UQ Ventures](#), students, staff and alumni have access to a suite of programs to build their skills in a hands-on environment and drive innovation across diverse industries and sectors.

## Connect with UQ

If you'd like to access a digital copy of this statement, please scan the provided QR Code or email [global.strategy@uq.edu.au](mailto:global.strategy@uq.edu.au).



## UQ research institutes

### Australian Institute for Bioengineering and Nanotechnology

With focus areas across advanced biomanufacturing, precision nanoscience, stem-cell ageing and regenerative engineering, advanced materials and agriculture nanotechnology, the [Australian Institute for Bioengineering and Nanotechnology](#) (AIBN) is solving society's problems through sustainable materials, healthy living and translational success.

### Global Change Institute

The [Global Change Institute](#) (GCI) draws together research excellence and expertise from across UQ, industry, government and the community to address grand challenges, which deliver impact to society, the economy, the environment, and culture. Research groups are currently focused on protected cropping, digital health and next-generation workspaces.

### Institute for Molecular Biosciences

Every cure starts with a scientific discovery by someone who imagined a better future. At the [Institute for Molecular Biosciences](#) (IMB) our goal is to create a better future by making breakthrough discoveries to improve health and wellbeing. The IMB is one of the largest life sciences institutes in the Asia-Pacific region. Research is framed through six research centres focusing on superbug infection, pain, heart disease, inflammation, solar biotechnology and the interplay of genomics and disease. We also undertake research in cancer, brain injury and disease, the environment and agricultural solutions.



### Institute for Social Science Research

The [Institute for Social Science Research](#) (ISSR) undertakes transformational, solution-focused research to address new and emerging challenges facing society. ISSR is an international leader in advanced interdisciplinary and evidence-based social science research, and works collaboratively with government and the private and not-for-profit sectors on pressing social science challenges across four key impact areas: Social Science of Policy and Practice, Social Science of Health, Social Science of Education and Social Science of Innovation and Technology.

### Mater Research Institute

With a vision to translate research discoveries and integrate them into improved healthcare, achieving impact through integrated research excellence is a key focus of the [Mater Research Institute](#).

### Queensland Alliance for Agriculture and Food Innovation

The [Queensland Alliance for Agriculture and Food Innovation](#) (QAAFI) is a research institute supported by the Queensland Government. Our mission is to significantly improve the competitiveness and sustainability of tropical and sub-tropical agriculture and food sectors through high-impact science. Our vision is sustainable agriculture and food achieved through science and innovation. We are a world-class connected research institute in crop, horticulture, animal, and nutrition and food sciences, delivering industry-driven economic, environmental, and social impact.

### Queensland Brain Institute

The [Queensland Brain Institute](#) (QBI), is a leading research institute focused on two of the greatest challenges of modern science: understanding brain function and the prevention and treatments of disorders of brain function. Understanding the incredible machine that is the brain, QBI researchers are delivering significant advances in areas such as Alzheimer's disease, schizophrenia, neurodegenerative disorders, visual perception and navigation, and deep brain stimulation. From cognitive neurology to psychiatric genomics and ageing dementia across to visual neuroscience and ecology in Australia's vibrant marine environment, researchers in QBI are understanding how the brains and sensory systems of humans and animals are shaped by their environment and behavioural needs.

### Sustainable Minerals Institute

Demand for minerals and the secure supply of resources worldwide is increasing. The [Sustainable Minerals Institute's](#) (SMI) vision is to find solutions to the complex problems facing the environment, humanity and the economy on the path to sustainability. The SMI is made up of six research centres, an international centre of excellence and the technology transfer company JKTech. Each centre is committed to delivering sustainable resource development and training the next generation of industry and community leaders.

## UQ faculties

- Business, Economics and Law
- Engineering, Architecture and Information Technology
- Health and Behavioural Sciences
- Humanities and Social Sciences
- Medicine
- Science

## UQ schools

- Agriculture and Food Sciences
- Architecture
- Biological Sciences
- Biomedical Sciences
- Business
- Chemical Engineering
- Chemistry and Molecular Biosciences
- Civil Engineering
- Communication and Arts
- Dentistry
- Earth and Environmental Sciences
- Economics
- Education
- Health and Rehabilitation Sciences
- Historical and Philosophical Inquiry
- Human Movement and Nutrition Sciences
- Information Technology and Electrical Engineering
- Languages and Cultures
- Law
- Mathematics and Physics
- Mechanical and Mining Engineering
- Music
- Nursing, Midwifery and Social Work
- Pharmacy
- Political Science and International Studies
- Psychology
- Public Health
- Social Science
- Veterinary Science



## Acknowledgements

This capability statement was prepared by the UQ Global Engagement division to support activity with strategic global partners. It represents a small sample of the many high-impact bioeconomy projects that are delivered across UQ. It is not representative of all bioeconomy engagement at UQ. Case study content has been adapted in accordance with published articles available for viewing on the UQ website or via the [Research Impact Showcase](#).

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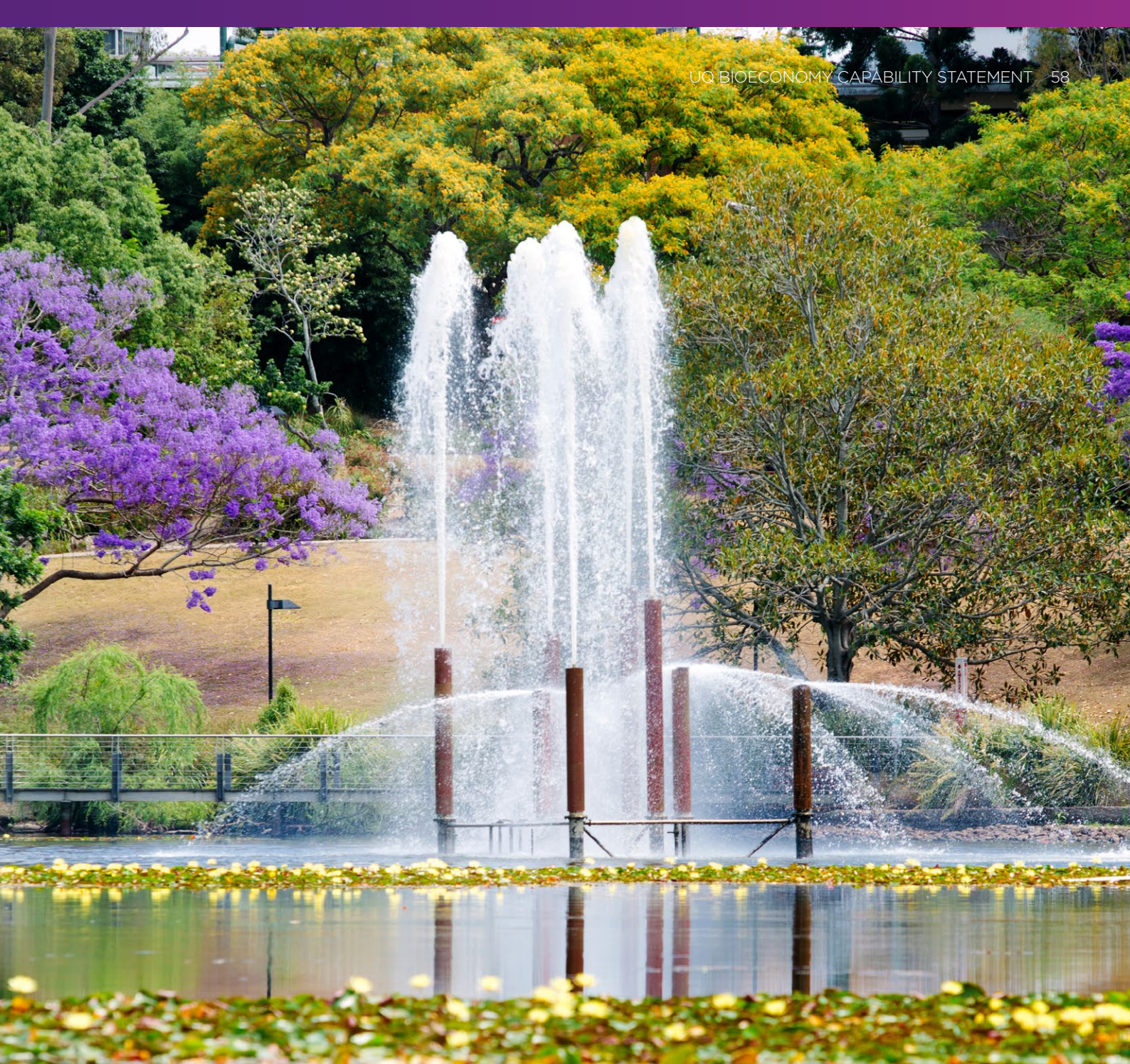
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