

Advancing Queensland's hydrogen industry

September 2018



Queensland
Government

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Advancing Queensland's hydrogen industry

Foreword

There is a strategic opportunity for a new hydrogen industry to advance Queensland's priority for creating jobs in a strong economy.

Hydrogen is already used in Queensland by the resources sector, for metals refining, for our agricultural sector and biofuels.

If hydrogen can be produced and transported in a more cost effective way this will support our existing resources and agricultural sectors as well as our emerging biofuels industry.

There is a further potential to convert Queensland's sunshine and wind into hydrogen so that Queensland becomes a major exporter of renewable energy.

Our significant renewable resources of solar and wind energy, our existing gas pipeline infrastructure and access to ports give us a competitive advantage in the future production and export of hydrogen.

Queensland's proximity to Asia and our existing energy industries position us to meet the needs of our long-established trading partners including Japan, which imports 94 per cent of its energy and is investing heavily to transition to hydrogen.

As the world responds to climate change we need to draw on our natural advantages to meet growing international demand for cleaner energy.

Recent technological advances in the production, storage and transport of hydrogen have renewed global interest in its potential as a renewable energy carrier.

Queensland has the skills base to support an innovative industry that addresses challenges in the competitive production, storage, transport and use of hydrogen in domestic and international markets.

We want community and industry feedback on the existing and future challenges of the hydrogen industry, and the pathways to facilitate growth.

We encourage your participation and will consider all comments. Collaboration will inform our strategy to grow a world-class hydrogen industry in Queensland.

Together we can develop a thriving renewable energy economy for future generations.



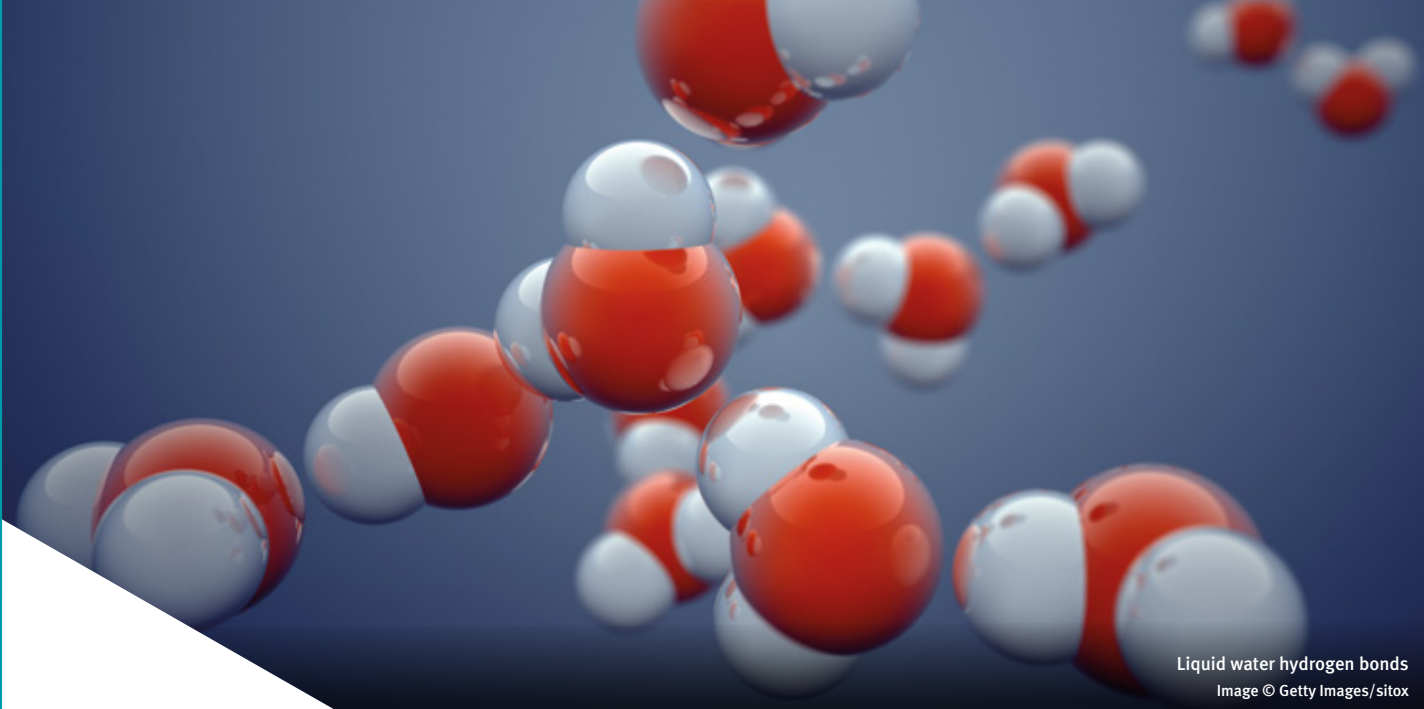
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The Honourable Anastacia Palaszczuk MP
Premier of Queensland and
Minister for Trade



A stylized, handwritten signature in black ink.

The Honourable Cameron Dick MP
Minister for State Development,
Manufacturing, Infrastructure and Planning



Liquid water hydrogen bonds
Image © Getty Images/sitox

Queensland's commitment to hydrogen

The Queensland Government is committed to developing a sustainable hydrogen industry.

As part of the 2018–19 State Budget, the Queensland Government allocated \$750,000 to investigate opportunities to produce and supply hydrogen at a competitive price to alternative energy sources.

The Queensland Government is also actively supporting industry to develop hydrogen projects that service the needs of both domestic and international markets. We are collaborating on a number of potential projects between Japan and Queensland. Trade and Investment Queensland has coordinated a number of Australian visits by a leading Japanese institution, the University of Tokyo and industry partners.

Through the Department of State Development, Manufacturing, Infrastructure and Planning we are providing facilitation services to a number of projects and are linking them with key partners. This includes discussions with the Port of Gladstone in relation to hydrogen projects and export opportunities.

The Queensland Government is supporting the development of innovative hydrogen technologies in Queensland. In 2017, Gladstone-based Southern Oil Refining received funding to facilitate a demonstration bio-hydrogen-generation unit.

Queensland's close proximity to Asia, established infrastructure and significant solar resources make it an ideal location for hydrogen production and export.

Due to Queensland's favourable location, a number of private sector proponents have approached the Queensland Government recently with proposals for demonstrating efficient and economic hydrogen generation and use in Queensland.

Trade and Investment Queensland has commissioned a report into the future trade and investment opportunities for Queensland's developing renewable hydrogen economy. This report, which is expected to be delivered in late 2018, will focus on Japan and other potential markets.

Three reports have recently been released about the hydrogen industry opportunity in Australia: the *National Hydrogen Roadmap* (CSIRO); *Hydrogen for Australia's Future* (Hydrogen Strategy Group for the COAG Energy Council); and *Opportunities for Australia from Hydrogen Exports* (ACIL Allen consulting for ARENA). The Queensland Government will use the information and recommendations in these reports to inform our future hydrogen industry strategy and to ensure Queensland capitalises on emerging opportunities.

The Queensland Government seeks your input on this discussion paper—the Queensland Government's investigation into the development of a sustainable hydrogen industry for Queensland.

Questions have been included throughout this document to prompt your views on certain aspects of the industry.

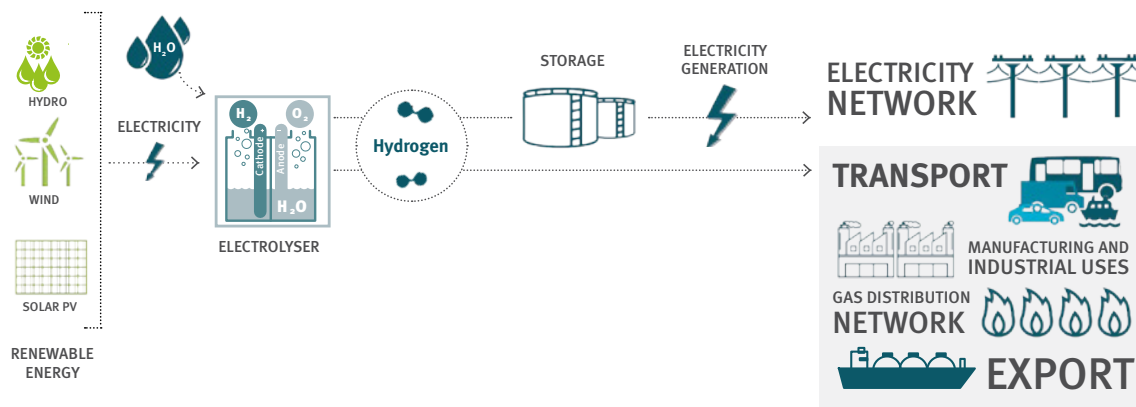
Your input will help the Queensland Government develop an environment that will allow a sustainable hydrogen industry to thrive in Queensland.

Have your say

Q: What role do you think the Queensland Government can play in supporting the development of a hydrogen industry?

Q: Are there any 'best practice' initiatives that the Queensland Government should be aware of?

Renewable hydrogen: The opportunity



About hydrogen

Hydrogen is the most abundant element in the universe and has promising potential as a clean fuel. Hydrogen is not naturally found in its pure form (H_2) and the process of extracting or producing hydrogen from other sources has historically been both costly and energy intensive.

Most hydrogen is currently produced from fossil fuels. It is used in a wide range of manufacturing and industrial uses including to make ammonia for fertilizers, refining metals, petroleum refining and methanol for making artificial material like plastics.

Renewable hydrogen can be produced using electricity from renewable energy sources such as solar, wind or hydro-electricity. Technological advances and market forces coupled with the global drive to decarbonise the economy, are forecast to continue lowering the cost of renewable hydrogen. Renewable hydrogen may be used as a direct replacement for fossil fuel produced hydrogen.

Advances in technology, coupled with demand-driven innovation and global momentum for low-emissions energy, are forecast to bring renewable hydrogen production costs down and lead to opportunities for the commercial scale export of renewable hydrogen.

Fast facts

Hydrogen is the first element on the periodic table and has an atomic number of one, meaning it has one proton in the nucleus of the atom. It is also the lightest element on the periodic table, and at normal room temperature and pressure it is tasteless, odourless, colourless and non-toxic.

Increasing demand for hydrogen

Driven by global momentum to decarbonise the energy market and remove sulphur from petroleum products, hydrogen generation is predicted to grow.

Industry has been buoyed by the formation of a global advisory body, the Hydrogen Council in 2017. The group consists of leading energy, transport and industrial companies including Toyota, Audi, ENGIE, Shell and Linde.

Global demand for hydrogen is increasing and the hydrogen market is expected to reach US \$155 billion by 2022. The Asia Pacific region is the largest hydrogen market in the world, driven by demand from Japan, China, Singapore and South Korea.

The growing global market for hydrogen fuel cell passenger vehicles and broader energy generation provides an opportunity for Queensland to adopt this technology and become a major exporter.

South Korea, Japan, the United States, Europe, and the United Kingdom have all made significant commitments towards a successful hydrogen energy industry. These countries have established programs to support the rapid scaling up of the commercial hydrogen energy industry. This includes supporting uptake of hydrogen fuel cell passenger vehicles, subsidising or building hydrogen refuelling stations, the development and deployment of hydrogen for electricity generation, trialling or introducing hydrogen powered buses into their public transport systems and supporting industrial uses of hydrogen energy.



Hyundai NEXO Fuel Cell
Image © Hyundai/Uli Sonntag

In Australia, CSIRO has recently released the *National Hydrogen Roadmap*. The objective of the roadmap is to provide a blueprint for the development of an Australian hydrogen industry. It is designed to inform the investment decisions of stakeholder groups that will enable the industry to continue its growth in a sustainable and coordinated manner. The *National Hydrogen Roadmap* has identified a number of potential uses for hydrogen, including: hydrogen-fuelled transport, remote area power systems, industrial feedstocks, export, electricity grid firming, heat, and synthetic fuels.

The establishment of a sustainable hydrogen industry in Australia has strong support amongst researchers and key stakeholders. Notably, Australia's Chief Scientist, Dr Alan Finkel AO has proposed a 'hydrogen city' be established where the gas supply of an entire Australian city would be converted to clean hydrogen.

The Hydrogen Strategy Group, established under the Council of Australian Governments Energy Council, has recently prepared a paper entitled *Hydrogen for Australia's Future*, which reviews the opportunity for Australia to capture the hydrogen export market and associated benefits in the domestic economy. The report concludes that: 'With the right policy settings, Australian hydrogen exports could contribute \$1.7 billion [per annum to the economy] and provide 2800 jobs by 2030'.

The recent establishment of Hydrogen Mobility Australia—a group of vehicle manufacturers, energy companies, infrastructure providers, research organisations and governments—also illustrates the private sector's commitment to develop a hydrogen industry in Australia.

CASE STUDY:

CSIRO

In Queensland, conditions are favourable to capitalise on domestic technological breakthroughs and the global momentum to grow the hydrogen economy. In August 2018, CSIRO demonstrated their world-first technology for re-fuelling hydrogen fuel cell vehicles at the Queensland Centre for Advanced Technologies. This project was supported by Hydrogen Mobility Australia members: BOC, Hyundai and Toyota. The unique membrane technology enables the production of ultra-high purity hydrogen from ammonia. The membrane breakthrough will allow hydrogen to be safely transported and used as a mass-production energy carrier.

The Queensland Government has committed \$200,000 to CSIRO for a pre-feasibility study into establishing an ammonia to hydrogen demonstration plant in Gladstone. The project will be a catalyst in opening up the supply chain of clean hydrogen to the world, including emerging markets in Japan, South Korea and Europe.



Toyota Mirai zero-emissions vehicle
Image © Toyota Australia

CASE STUDY:

The export story— overseas markets and Japan's need for Queensland hydrogen

Queensland is proud to be working in close partnership with Japan to develop hydrogen export opportunities. In recent years, Japan has increased its efforts to establish itself as a renewable energy society and has signalled its intent to pursue hydrogen as a core part of its energy solution.

Queensland has strengthened its already strong trading partnership with Japan with the signing of an international cooperation agreement between the Queensland University of Technology and the University of Tokyo's Research Centre for Advanced Science and Technology focused on renewable energy and hydrogen. The agreement formalises the relationship between the two universities and includes an undertaking to collaborate on joint ventures and academic and scientific activities.

Visiting Professor Masakazu Sugiyama said, 'Queensland has abundant sunlight and a pioneering spirit that we admire. We wish to collaborate together to package sunlight to export to Japan'.

Japan has shown interest in importing CO₂ free fuel produced at Southern Oil Refining's Advanced Biofuel Pilot Plant in Gladstone. Visiting the facility, Professor Sugiyama envisaged supplying Japan with hydrogen produced using clean energy sources such as solar energy or bioresources.

Why Queensland

Queensland has the potential to become a global player in the production and export of hydrogen by using our natural resources (including grid scale solar installations), creating a new wave of high-value, innovation-focused jobs in the process.

Queensland is well positioned to meet the growing international demand for hydrogen as well as supplying the domestic market. Strong and long-standing trading partners like Japan and South Korea have expressed interest in the potential for hydrogen production in Queensland. Our established infrastructure, close proximity to Asia, significant solar resources, and available land make Queensland well-placed to produce renewable hydrogen for domestic and international use.

Hydrogen's capacity to store renewable energy means it could play a pivotal role in Queensland's electricity network, supporting the transition to a clean energy future. Energy storage solutions will complement the growth of renewable energy sources like solar and wind. In mid-2018, Queensland had more than 2000 megawatts of renewable energy projects under construction or finalising commercial arrangements. Queensland's Renewable Energy Expert Panel estimated that 5500 megawatts of renewable energy capacity would be required between 2020 and 2030 to meet the Queensland Government's 50 per cent renewable energy target. This creates a particular opportunity for hydrogen to enable greater utilisation of this infrastructure.

The growth of the hydrogen industry will create significant construction and operational jobs and generate broader supply chain development for Queensland manufacturers.



Southern Oil Gladstone facility
Image © Southern Oil/Richard Davies

CASE STUDY:

Southern Oil

The Southern Oil facility in Gladstone received \$1 million from the Queensland Government in 2017 to facilitate a demonstration bio-hydrogen-generation unit. The project will enable hydrogen production from multiple biological sources. The plant will produce bio-hydrogen sustainably using waste streams, potentially reducing running costs for a range of businesses throughout Queensland. If the trial is successful, it could be rolled out to other plants and support growth in this industry. The project was funded under the Advance Queensland Biofutures 10-Year Roadmap and Action Plan.

Key challenges and opportunities

Informed by engagement with researchers and industry, the Queensland Government has identified the following five key focus areas to support the growth of Queensland's hydrogen industry:

- supporting innovation
- facilitating private sector investment
- ensuring an effective policy framework for sustainable development
- building community awareness and confidence
- facilitating skills development for new technology.

The Queensland Government would also welcome feedback on the challenges and opportunities for developing a sustainable hydrogen industry.

Supporting innovation

The Queensland Government recognises innovation in industry and manufacturing as central to driving productivity. Our capacity to develop and apply cutting edge technology, systems and products is critical to our global competitive position in new industries.

Advance Queensland is the Queensland Government's vision for the future and exemplifies our investment in a stronger Queensland economy. Funding of \$650 million is supporting programs that drive innovation, build on our natural advantages, and help raise our profile as an attractive investment destination.

Since its launch in 2015, Advance Queensland has supported the research, development and commercialisation of numerous renewable energy and cleantech projects. Advance Queensland programs such as Industry Research Fellowships, Innovation Partnerships, the Industrytech Fund, Ignite Ideas, and the Business Development Fund all have the potential to support the development of innovative hydrogen technology projects in Queensland. Through Advance Queensland, the Queensland Government can support the research and commercialisation of technology to make hydrogen infrastructure more cost-effective.

Have your say

Q: What are the current challenges to the development of a hydrogen innovation system?

Q: Are there research or demonstration opportunities that the Queensland Government should further explore or prioritise?



CSIRO, Hydrogen Demo
Image © CSIRO/John Nguyen Photography

CASE STUDY:

Transit Systems

Queensland-based companies are excelling in the hydrogen field already. Transit Systems currently operates innovative bus services in Western Australia, New South Wales, South Australia, Northern Territory, Singapore and London; servicing 330 million customers on more than 3164 vehicles.

Transit Systems' international operations arm, Tower Transit, has a fleet of 10 hydrogen buses in the Transport for London network that are part of the Clean Hydrogen in European Cities Project. Tower Transit has been operating its hydrogen fuel cell buses since June 2013. They operate on a cascade fuelling system delivering gaseous hydrogen that has similar requirements (fuelling procedures and fuelling time) to a traditional diesel bus. Tower Transit operates routes that have been recognised as some of the busiest in London, servicing Central and East London. Tower Transit is the only operator of hydrogen powered buses in London. They are a Queensland-based company at the cutting edge of sustainable transport.

Facilitating private sector investment

The Queensland Government recognises the important role of private sector investment in creating jobs and growing a strong economy. That is why the Queensland Government is working with a range of domestic and international proponents on projects ranging from the production, storage and export of hydrogen through ammonia, solar powered hydrogen production, and the demonstration of hydrogen-fuelled vehicles.

The Queensland Government is actively supporting industry to develop projects that service the needs of both domestic and international markets. Existing and new businesses seeking to develop renewable hydrogen energy production or distribution can be offered a range of project facilitation services. Assistance may include linking research and commercial partners, assistance with identifying suitable sites, coordinating development assessment, and the identification of grants and funding programs for eligible projects.

The Queensland Government will continue to support the industry to develop, including by using existing support programs such as the Advance Queensland Industry Attraction Fund and the Jobs and Regional Growth Fund. Further information on assistance available to businesses, including financial assistance, is available at www.business.qld.gov.au

Have your say

Q: Are there other initiatives the Queensland Government should consider to facilitate new investment in hydrogen projects in Queensland?



Hydrogen storage system in waste incinerator
Image © Getty Images/Maciej Noskowski

Ensuring an effective policy framework for sustainable development

A regulatory framework that provides both certainty and flexibility is a central component to successfully growing a new industry. A careful balance is required to manage risks effectively and ensure community confidence, whilst also providing flexibility for a new industry to innovate and adjust their operations as they grow.

The Hydrogen Strategy Group report, *Hydrogen for Australia's Future*, emphasises the importance of the right policy settings in stimulating private sector investment.

The report recommended the development of a national hydrogen strategy to provide direction on matters such as progressing international export agreements, as well as developing regulations and standards to ensure safety in all aspects of the hydrogen sector.

The Queensland Government will collaborate with other jurisdictions to create a policy framework that facilitates the sustainable development of the industry. The Queensland Government's Hydrogen Working Group will coordinate efforts to streamline the development of the renewable hydrogen energy industry in Queensland.

Have your say

Q: What will create a positive regulatory and policy environment to grow the hydrogen industry in Queensland?

Building community awareness and confidence

Ensuring community awareness and building community confidence is essential for any new industry. The Queensland Government will:

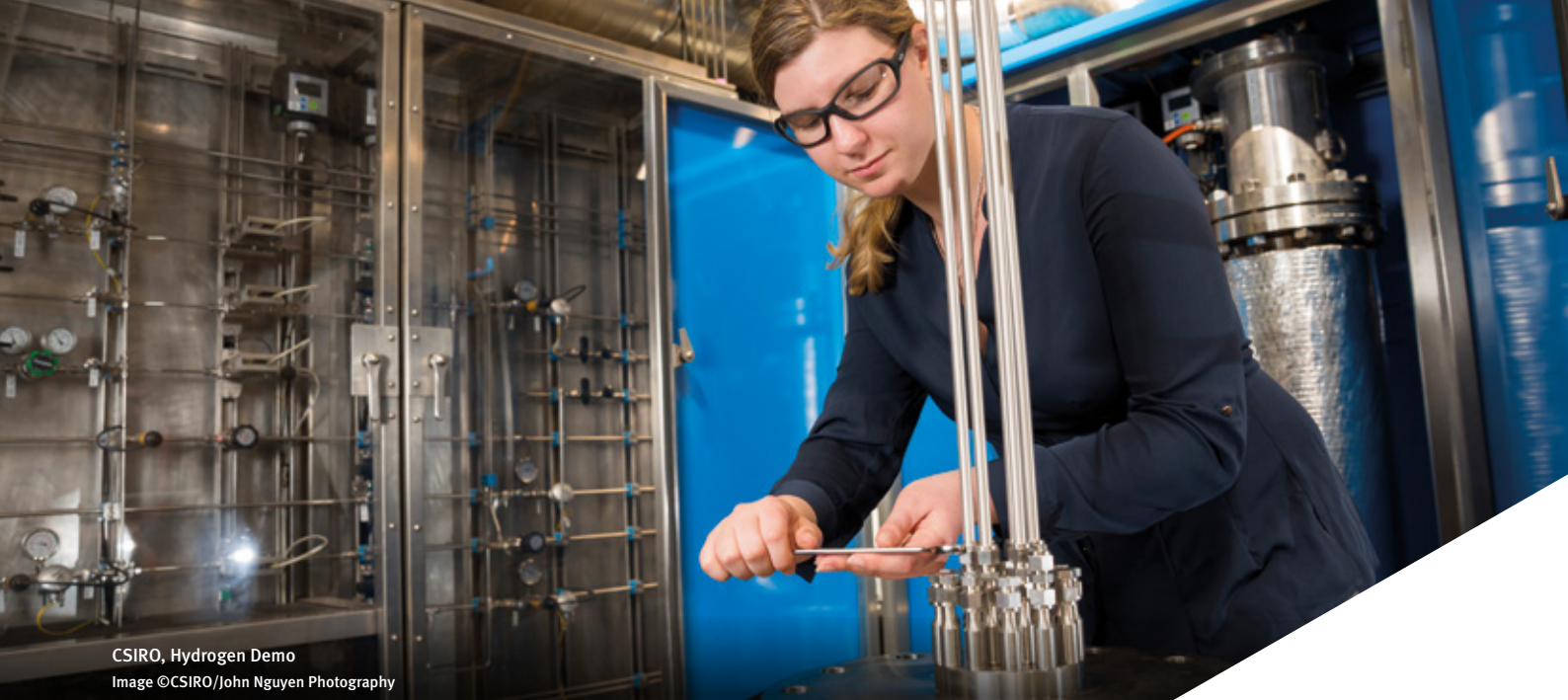
- raise community and industry awareness of the potential for Queensland-made hydrogen to supply growing domestic and international markets
- build community confidence in the industry through effective policy settings
- promote the opportunities for renewable and low emissions hydrogen energy by highlighting advances in technology and the overall benefits the industry will bring to Queensland.

The Queensland Government will build on our existing links with domestic and international investors and our international trading partners to promote Queensland's opportunities in the hydrogen economy.

Have your say

Q: Are there any 'best practice' examples from other jurisdictions the Queensland Government could consider for engagement with the hydrogen industry and the broader community?

Q: What are the key hydrogen related issues that require greater community awareness to increase confidence and help support the industry's growth?



CSIRO, Hydrogen Demo
Image ©CSIRO/John Nguyen Photography

Facilitating skills development for new technology

The Queensland Government recognises the importance of maintaining a highly skilled workforce to ensure that Queenslanders can secure the opportunities of today and tomorrow.

It is recognised that new skills will be required to facilitate the growth of a sustainable hydrogen industry.

The Queensland Government makes significant investment in priority skills. In 2018–19, \$777.9 million in the Annual Vocational Education and Training Investment Plan will enable delivery of the training and skills needed by Queensland's industries. Investment each year is influenced by advice from industry on skills priorities and complements employer investment in workforce development.

The Queensland Government has committed to establishing the Manufacturing Skills Working Group to develop an implementation plan in response to the Jobs Queensland report, *Advanced Manufacturing Skills: A Skills, Training and Workforce Development Strategy for the Manufacturing Industry in Queensland*.

Skills issues identified in relation to the development of the hydrogen energy industry will be referred to the Manufacturing Skills Working Group for advice on workforce development, business development and training.

Have your say

Q: What training and skills are needed to grow a sustainable hydrogen industry in Queensland?

Get involved

You can help the Queensland Government create an environment that will allow a sustainable hydrogen industry to thrive in Queensland. Throughout this document, there are a number of discussion questions that are designed to prompt conversation on certain aspects of the industry's development. You can use these questions to guide responses or provide general feedback.

To have your say complete one of the following:

- complete the survey available at www.qld.gov.au/AdvancingHydrogen
- email your written submission to: hydrogen@qld.gov.au
- mail your written submission to:
Hydrogen Industry Development
Department of State Development,
Manufacturing, Infrastructure and Planning
PO Box 15009 City East QLD 4002

Consultation closes on Wednesday 17 October 2018.

Where to from here?

This discussion paper presents an exciting opportunity for Queensland. Your feedback will be used by the Queensland Government to develop a strategy that will ensure we can take advantage of the opportunities hydrogen provides for our economy, jobs, growth and for continuing to improve the lives of Queenslanders and their communities.

Industry, research and community views will build our understanding of the key issues, barriers and enablers to achieving the vision for Queensland in this space. This feedback will inform the development of the Queensland Government's Hydrogen Strategy, which will be released in early 2019.

