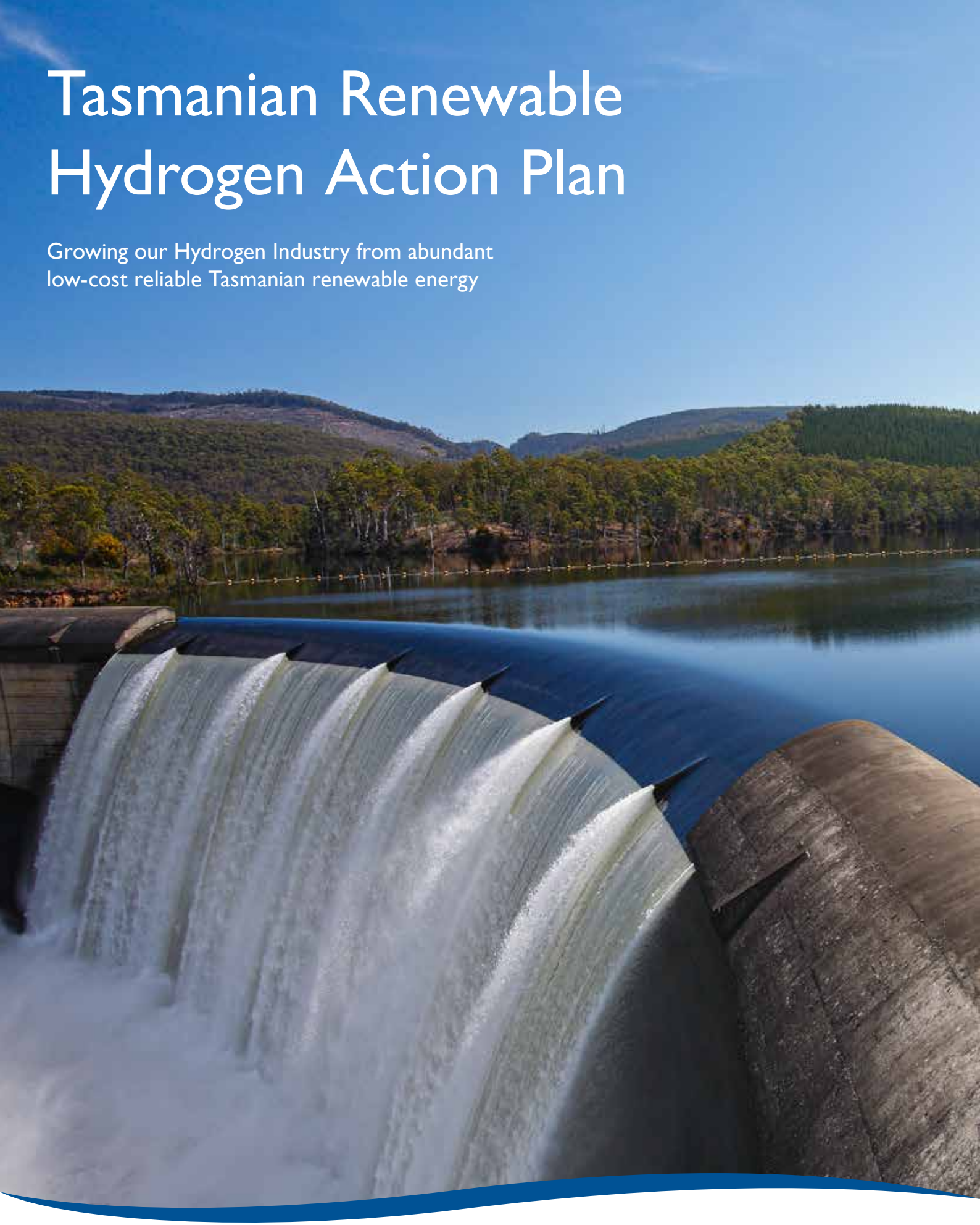
Tasmanian Renewable Hydrogen Action Plan

Growing our Hydrogen Industry from abundant low-cost reliable Tasmanian renewable energy



Department of State Growth

Tasmanian Government

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Ministerial foreword

The global supply and use of energy is dramatically shifting as countries are now looking to cleaner, renewable forms of energy in order to decarbonise their economies. The use of hydrogen, produced from renewable energy, is emerging as a means of achieving these goals.

Tasmania is ideally positioned to play its part in this transition. Tasmania has a proud 100 year history of hydro-industrialisation which has established our presence as the renewable energy state of Australia.

Indeed, the overwhelming majority of our electricity is generated from our substantial hydro resources, as well as a significant contribution from our world-class wind resources.

This sustained investment in renewable energy infrastructure and technology has attracted energy intensive, jobs rich major industry and placed Tasmania as a leader in renewable energy supply, knowledge and expertise.

The Government is committed to continuing to build upon its achievements to ensure that renewable energy remains a key economic driver in Tasmania's future.

We are expanding Tasmania's renewable energy capacity and supporting and progressing major national renewable energy projects such as Project Marinus and Battery of the Nation. We have a large number of wind generation projects under construction, or being planned, and are on-track to be self-sufficient in renewables by 2022.

Tasmania will be the first state in Australia, and among an elite few locations globally, with 100 per cent renewable power generation. There is also significant opportunity to expand on our existing renewable energy capacity, with 8 700 megawatts of wind power, and 3 400 megawatts of pumped-hydro potential available in Tasmania.

Essential to this exciting transition is the establishment of a Tasmanian renewable hydrogen industry. Access to low-cost and reliable Tasmanian renewable energy makes us the perfect location for renewable 'green hydrogen' production, for export and for use in Tasmania. Importantly, with our existing renewable energy, this can commence now.

The firming capability of Tasmania's Government-owned hydro power, combined with our world-class wind resource, provides us with a key advantage in being able to produce renewable hydrogen at low cost.

Indeed analysis indicates renewable hydrogen production costs could be 10 to 15 per cent lower in Tasmania than from other Australian power grids and 20 to 30 per cent lower than from dedicated off-grid variable renewables.

Tasmania also has high quality industrial precincts, including the Bell Bay Advanced Manufacturing Zone and in the north west coast region, with access to deep-water ports, strong transmission infrastructure, significant water availability and road and rail infrastructure to enable renewable hydrogen production, straight from our electricity grid. It is clear that Tasmania is the perfect location for a renewable hydrogen industry, for export and for local use, with capacity for gigawatt scale production over the longer term.

I was encouraged to see a significant level of response to the draft Tasmanian Renewable Hydrogen Action Plan, and I am thankful for the valuable insights provided by stakeholders into the opportunities and challenges associated with the development of a renewable hydrogen industry in Tasmania. The feedback from the consultation process has been essential in informing the development of the final Tasmanian Renewable Hydrogen Action Plan.

Our Plan will benefit investors through access to low-cost hydrogen production, and will benefit Tasmanians through job creation and economic growth, particularly in regional areas.

The Tasmanian Government is committed to renewable hydrogen industry development in Tasmania and is facilitating this through a comprehensive $50 million over 10 years package of support measures. This includes a $20 million Tasmanian Renewable Hydrogen Fund and $20 million in concessional loans. Additional measures include up to $10 million worth of support services including competitive electricity supply arrangements and payroll tax relief. These support measures will be delivered through a competitive Expression of Interest process, which will commence shortly after the release of the Action Plan.

With our world-class renewable energy, Tasmania is an ideal location to produce cost-competitive renewable hydrogen on a large-scale to meet this emerging export and domestic demand and become a global leader in renewable energy supply.

We welcome the opportunity to share our vision, and I encourage you to engage with the exciting opportunities the development of a Tasmanian renewable hydrogen industry presents.

Hon Guy Barnett MP

Minister for Energy

Action Plan – Overview

Vision Tasmania will use our existing and expandable renewable energy resources to become a leader in large-scale renewable hydrogen production. From 2030 we will be a significant global supplier of renewable hydrogen for export and domestic use.

Explore the opportunities for using locally produced renewable hydrogen in Tasmania and for export.

Actions

Investigate opportunities for the use of hydrogen transport technologies in the state, with an initial focus on 'return-to-base' transport activities, such as buses, fleet vehicles, freight (including road and rail) and marine applications (such as ferries and barges).

Investigate optimised deployment and use of hydrogen refuelling infrastructure, with the intent of promoting open access where practical, to best facilitate industry development.

Explore opportunities to trial hydrogen fuel cell electric vehicles within government fleets to gain first-hand experience of the technology and act as a potential catalyst for broader uptake across the private sector.

Work with the incumbent natural gas distribution network infrastructure owner to explore opportunities for hydrogen blending at 10 per cent and to investigate potential trials of higher hydrogen blends in Tasmania's hydrogen compatible gas distribution networks.

Hydro Tasmania will investigate the production and use of renewable hydrogen as a component of its hybrid energy systems on King and Flinders Island, and for incorporation into its hybrid energy solutions services.

Work with Tasmania's Antarctic and energy business sectors to investigate the opportunity for hydrogen based renewable energy systems to provide power and fuel requirements in Antarctica.

Investigate industrial applications of Tasmanian renewable hydrogen, including opportunities for the use of 'green' ammonia and related products, derived from renewable hydrogen, for use in the Tasmanian agricultural sector.

Investigate opportunities for export of renewable hydrogen from identified sites, including the Bell Bay Advanced Manufacturing Zone and in the north west coast region.

Provide financial support for renewable hydrogen projects for export and domestic use, and continue investment attraction activities including with international trade partners.

Actions

Tasmania's Coordinator-General will continue its investment attraction and industry development work, including with prominent international proponents and consortia, to facilitate investment in renewable hydrogen production for export and domestic use.

Continue to foster international partnerships with governments and businesses in countries seeking to import renewable hydrogen, including Japan, South Korea and China, and to strengthen relationships through facilitating and attending trade delegations.

Industrial precincts in Tasmania, in particular the Bell Bay Advanced Manufacturing Zone and in the north west coast region, will continue to be promoted as prime hydrogen hub locations.

Deliver a comprehensive $50 million package of renewable hydrogen support measures over 10 years through a competitive Expression of Interest (EOI) process, commencing in the second quarter of 2020. The support package will include:

- a $20 million Tasmanian Renewable Hydrogen Fund
- $20 million in concessional loans
- $10 million worth of support services including competitive electricity supply arrangements and payroll tax relief
- assistance for developing offtakes for hydrogen end-use
- facilitating land and infrastructure access
- access to discounted professional services.

Work collaboratively with supportive local governments and representative organisations to facilitate renewable hydrogen development.

Tasmania's renewable hydrogen advantage Tasmania is uniquely placed to develop a large-scale renewable hydrogen industry using its abundant existing and expandable world-class renewable wind energy firmed by reliable hydro power, abundant fresh water, and access to industrial zones with high quality infrastructure. These attributes allow renewable hydrogen production in Tasmania at relatively low cost.

Tasmania's development pathway Commences with renewable hydrogen production for use in Tasmania, leading into the development of export supply chains, and scaling up to be a significant global supplier of renewable hydrogen.

Ensure a robust and supportive regulatory framework and assess supporting infrastructure.

Actions

Continue progressing the *Land Use Planning and Approvals Amendment (Major Projects) Bill 2018*. The Bill will amend the *Land Use Planning and Approvals Act 1993* to introduce a new single assessment process for major projects.

Review state-based legislation and regulations that are relevant to the hydrogen industry, particularly in regard to safety, and participate in national regulatory review and reform processes implemented under the National Hydrogen Strategy.

Work collaboratively with other governments and industry to facilitate the development of a renewable hydrogen certification scheme that recognises and values Tasmania's renewable energy characteristics and sustainable water resources.

Work collaboratively with national infrastructure assessments carried out under the National Hydrogen Strategy.

Work with local infrastructure providers to assess infrastructure requirements associated with renewable hydrogen developments. This will include working with TasNetworks to assess the network requirements at identified sites including the Bell Bay Advanced Manufacturing Zone, and exploring options for minimising network costs. Water requirements will be assessed in consultation with TasWater and TasIrrigation. Port requirements for export will be assessed in consultation with TasPorts.

Establish a dedicated Renewable Hydrogen Development Unit within the Department of State Growth to support implementation of the Tasmanian Renewable Hydrogen Action Plan, and support Tasmania's contribution to implementation of the National Hydrogen Strategy.

Build community and industry awareness, develop skills, and support research and education.

Actions

Ensure nationally developed community education and awareness raising materials and programs related to hydrogen are relevant for, and made available to, the Tasmanian community.

Facilitate the delivery of community education and awareness raising sessions related to renewable hydrogen.

Continue to facilitate industry stakeholder engagement, including through the delivery of an industry workshop in 2020 to advance the Tasmanian Renewable Hydrogen Action Plan.

Facilitate the implementation of the Australian Government funded $17 million 'Energising Tasmania' initiative, to provide training in major energy development related priority skills needs areas such as engineering, project management, civil construction and trades.

The Blue Economy CRC, in collaboration with Government, will investigate:

- the use of hydrogen as a shipping fuel to support offshore aquaculture operations
- the use of hydrogen based renewable power systems to support offshore aquaculture operations
- opportunities to add value to hydrogen production by electrolysis by utilising the oxygen co-product in Tasmania's aquaculture industry.

Support the University of Tasmania's ARC Industrial Transformation Training Centre funding application through a $100 000 cash and in-kind contribution to support renewable hydrogen research.

Tasmanian renewable hydrogen

The factors to realise a global hydrogen economy are starting to emerge, and Tasmania is well placed to be at the forefront of this new industry.

Why hydrogen?

As the global push to decarbonise gathers pace, low carbon sources of energy will become increasingly important to achieve sustainability objectives. With no carbon emissions when produced from renewable energy, hydrogen is recognised as an important enabler for the transition to a global clean energy system.

Why now?

The potential of renewable hydrogen as a clean and flexible energy carrier has been recognised for many years, however the economic and technological challenges associated with creating a hydrogen economy have only recently started to be overcome.

With declining costs of renewable energy and hydrogen technology, and emerging export and domestic markets, the factors required to develop a global renewable hydrogen sector are starting to be realised.

Why Tasmania?

Tasmania is in a unique position to take advantage of the global momentum behind hydrogen.

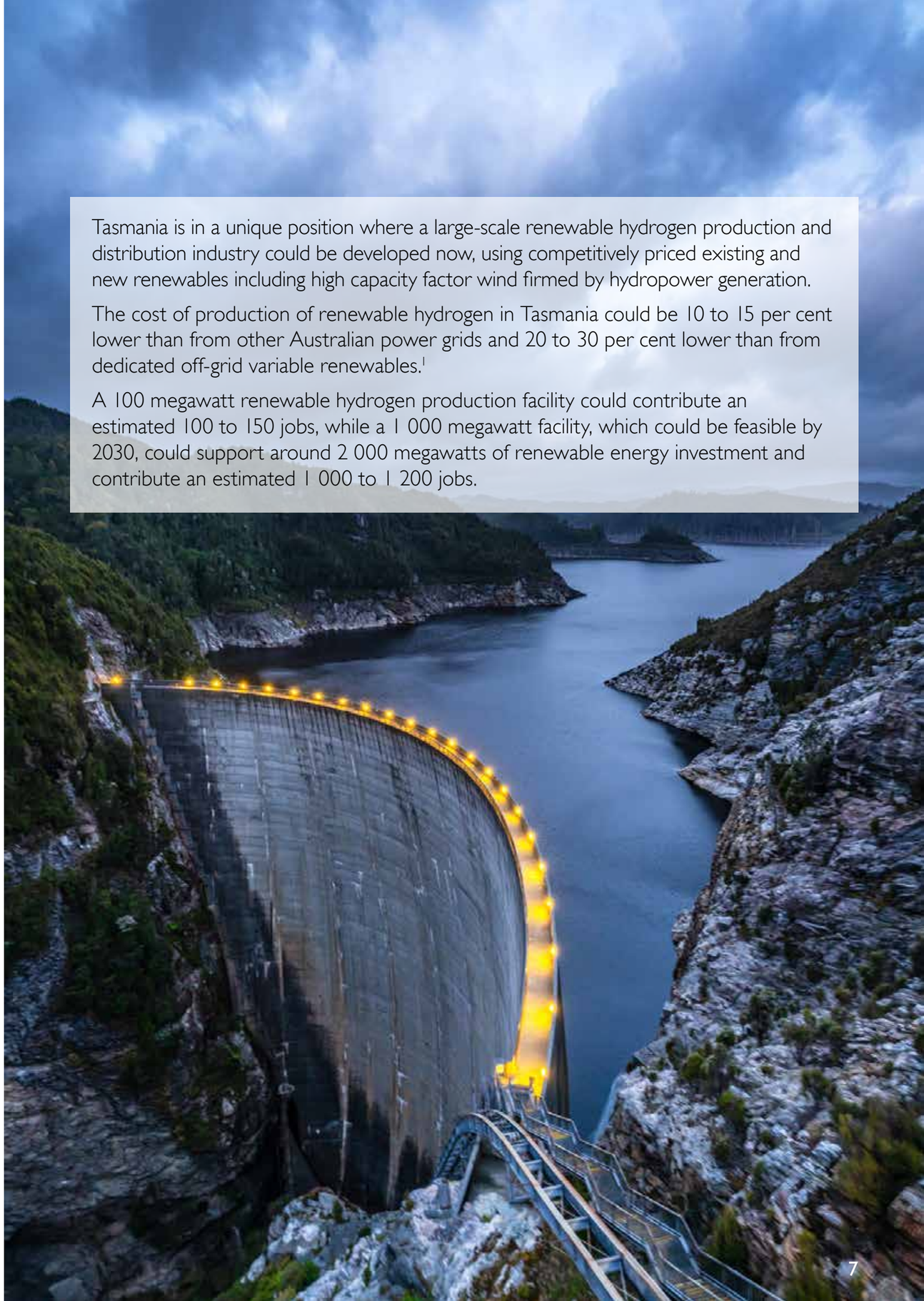
With its abundant renewable energy and water resources, Tasmania is well positioned to capitalise on this new global industry.

The Tasmanian Government is actively preparing for this exciting opportunity in recognition that Tasmania's strengths make it an ideal location for the development of renewable hydrogen projects.

Importantly, our mix of established reliable renewable generation can enable a renewable hydrogen industry much sooner, and likely at lower cost, than can be achieved in other Australian states.

Tasmania's key competitive advantages include:

- high renewable energy contribution from low-cost reliable hydropower and wind
- access to abundant fresh water
- industrial precincts with available land and access to high quality infrastructure.



Tasmania is in a unique position where a large-scale renewable hydrogen production and distribution industry could be developed now, using competitively priced existing and new renewables including high capacity factor wind firmed by hydropower generation.

The cost of production of renewable hydrogen in Tasmania could be 10 to 15 per cent lower than from other Australian power grids and 20 to 30 per cent lower than from dedicated off-grid variable renewables.[1]

A 100 megawatt renewable hydrogen production facility could contribute an estimated 100 to 150 jobs, while a 1 000 megawatt facility, which could be feasible by 2030, could support around 2 000 megawatts of renewable energy investment and contribute an estimated 1 000 to 1 200 jobs.

Vision and goals

Vision

Tasmania will use our existing and expandable renewable energy resources to become a leader in large-scale renewable hydrogen production. From 2030 we will be a significant global supplier of renewable hydrogen for export and domestic use.

Goals

By 2022 to 2024

- Tasmania has commenced production of renewable hydrogen.
- Locally produced renewable hydrogen is being used in Tasmania.
- Export based renewable hydrogen production projects are well advanced.

By 2025 to 2027

- Tasmania has commenced export of renewable hydrogen.

From 2030

- Tasmania is a significant global producer and exporter of renewable hydrogen.
- Locally produced renewable hydrogen is a significant form of energy used in Tasmania.

The emerging hydrogen opportunity

Hydrogen: a highly versatile fuel

Hydrogen – element number one in the periodic table – is the lightest, smallest and most abundant element in the universe. As an atom, it consists of one proton and one electron. As a molecule (H_2), it is a colourless, odourless, non-toxic gas. It is a highly versatile fuel that is carbon free when produced from renewable energy.

Hydrogen is an excellent carrier of energy and can be used in a broad range of energy applications, including as a fuel for transportation, as a substitute for natural gas, and for electricity generation. It can also be used as a chemical feedstock in a range of industrial applications (such as making ammonia, which is used primarily to make fertilisers).

However, hydrogen does not naturally occur in a useful energy form. It needs to be produced from substances containing hydrogen, such as water.

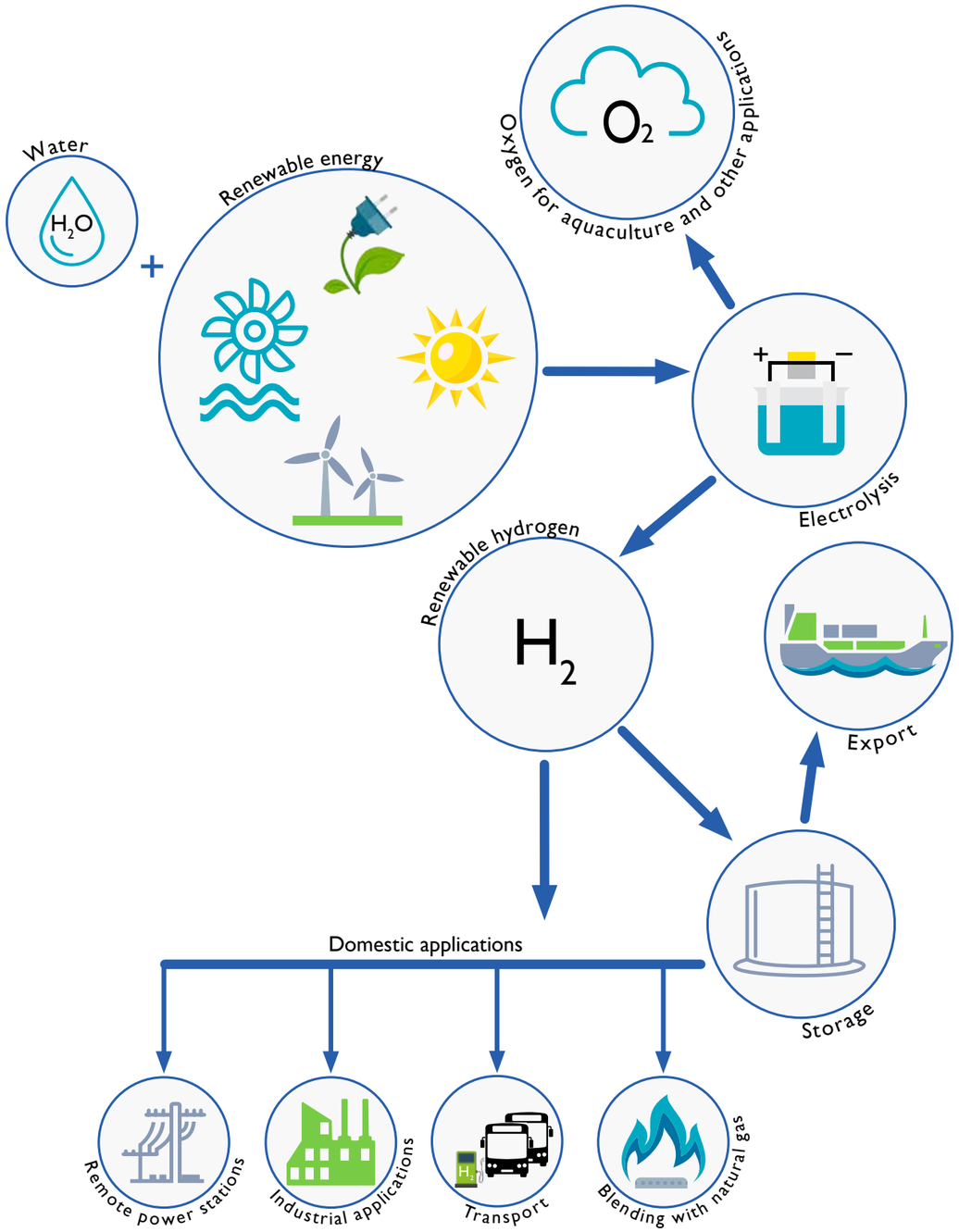
Renewable energy can be used to electrolyse water to produce hydrogen and oxygen. Hydrogen produced in this way is commonly termed renewable hydrogen or 'green hydrogen', and has no carbon emissions associated with its production or use.

Tasmania is ideally placed for the production of renewable hydrogen using its abundant renewable energy and fresh clean water. The combination of being an emissions free and versatile fuel makes renewable hydrogen an attractive energy carrier.

Renewable hydrogen can be produced, distributed, and used locally in a range of applications or exported to international markets. Developing international supply chains to move hydrogen in bulk quantities is actively being investigated with the aim to effectively and safely transport hydrogen worldwide. Options include transport by ship as liquefied hydrogen, or in other hydrogen carrying forms such as ammonia, methanol or liquid organic hydrogen carriers.

While the costs of hydrogen production and distribution are currently relatively high compared with other fuels, these costs are expected to fall significantly as the scale of production increases and with further technology development.

Tasmanian renewable hydrogen production and potential end uses



Global demand

Renewable hydrogen is projected to be an increasingly significant energy carrier as countries seek to decarbonise their economies, and global demand is projected to increase.

Scenario analysis carried out to inform the National Hydrogen Strategy indicates additional global demand for hydrogen of between two and nine million tonnes in 2030, and from around 20 to over 230 million tonnes in 2050.[2]

Countries such as Japan and South Korea have given clear indications that they will need to import significant quantities of emissions free hydrogen as they transition their economies, as a substitute for fossil fuel products for energy and transport purposes.

For example, Japan's hydrogen strategy indicates that it expects to import 300 000 tonnes by 2030 and potentially five to 10 million tonnes per year in the long term.[3] The Korean hydrogen roadmap indicates a requirement for over five million tonnes of hydrogen per year by 2040, with South Korea aiming to produce 6.2 million hydrogen cars for domestic use and export, and build 1 200 refuelling stations by 2040.[4]

This presents a significant opportunity for Australia, and in particular Tasmania given its key renewable hydrogen production advantages. The National Hydrogen Strategy indicates that by 2050 an Australian hydrogen industry could generate around 17,000 jobs and $26 billion in GDP nationally under a "hydrogen: energy of the future" scenario.[5]

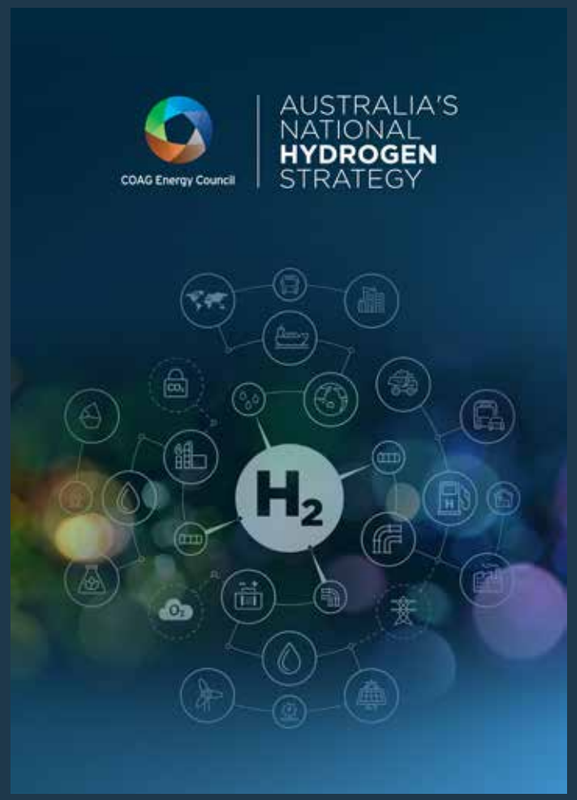
National Hydrogen Strategy

Australia's National Hydrogen Strategy was released by the COAG Energy Council on 22 November 2019. The Tasmanian Minister for Energy is a member of the Energy Council and is strongly supportive of the National Strategy and its implementation.

The National Strategy provides a framework for governments and industry to work together to build Australia's clean hydrogen industry. It outlines an adaptive approach focussed on removing market barriers, building supply and demand, and accelerating Australia's global cost-competitiveness.

The National Strategy, through work carried out by Geoscience Australia, has identified Tasmania as having very high potential for renewable hydrogen production. This is due to: strong renewable energy resources dominated by existing hydropower and wind, abundant fresh water, and good access to existing infrastructure.

A focus of the National Strategy is the importance of developing hydrogen hubs to facilitate industry development, with the intent of developing hubs in areas that can most efficiently leverage existing infrastructure, have access to energy and water, and have the potential to aggregate demand for export and/or for domestic uses.



The Tasmanian Government is highly supportive of the hydrogen hub concept, and has a number of sites well suited to hydrogen hub development. In particular the Bell Bay Advanced Manufacturing Zone is ideally suited to large-scale hydrogen production for export and domestic applications. Other potential sites include industrial precincts linked to ports in the north west and at other industrial precincts located across the State.

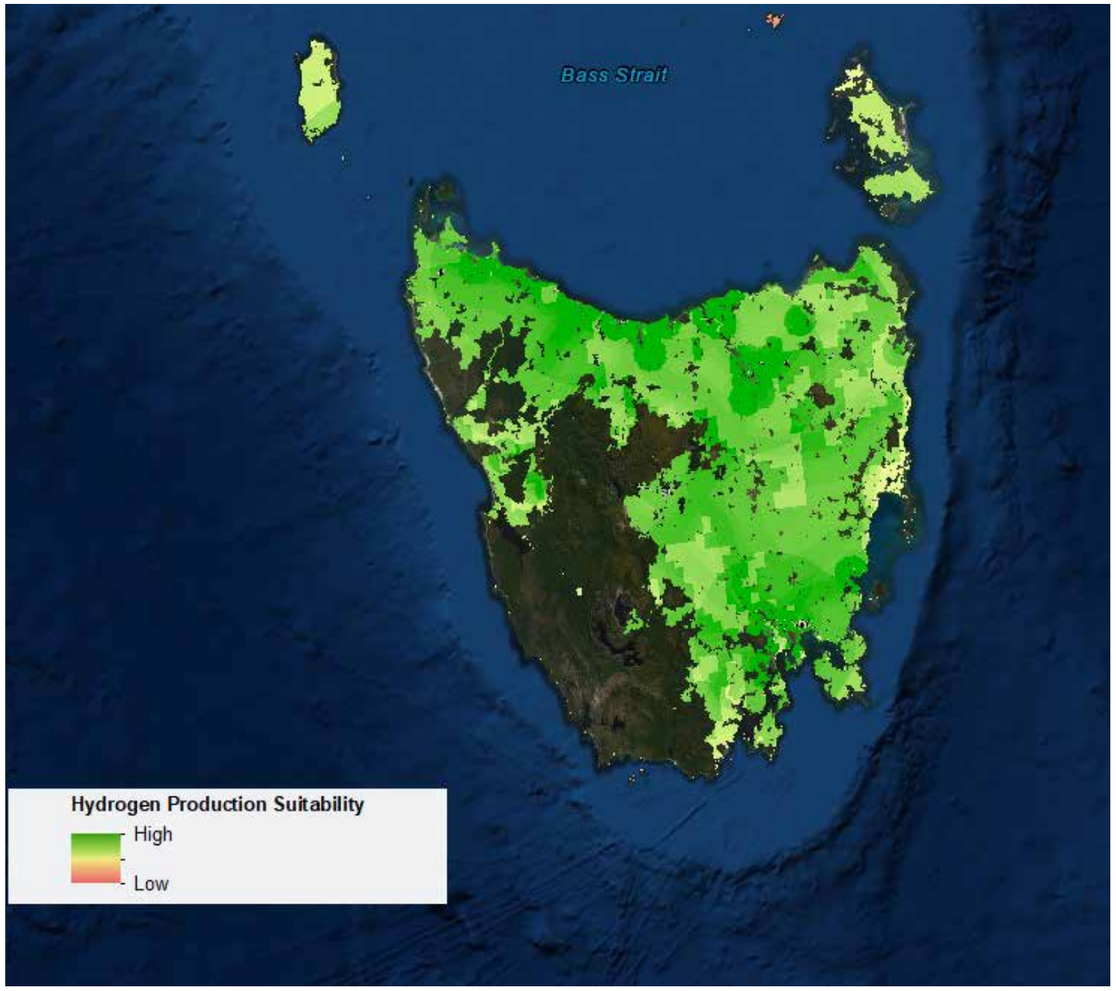
A range of important actions will be implemented collaboratively by governments under the National Strategy, including enabling hydrogen industry growth through engaging with international markets, providing assistance to build demand and ensuring appropriate regulations and standards are in place. Enabling community benefits is also a focus, through community education and confidence-building, and support for skills, training, research and development.

Crucially, the National Strategy is raising Australia's profile and potential as a key player in an emerging global hydrogen industry. This Action Plan complements the National Strategy, by identifying and facilitating Tasmania's unique renewable hydrogen industry development opportunities.

Tasmania's renewable hydrogen potential

The map below is reproduced from "AusH2 – Australia's Hydrogen Opportunities Tool" produced by Geoscience Australia.[6]

It indicates Tasmania's renewable hydrogen potential, including access to water, ports, pipeline easements and electricity infrastructure. Most of Tasmania is identified as highly suitable for renewable hydrogen production (outside of Tasmania's protected areas).



Tasmania's key advantages

Tasmania is uniquely placed to develop a competitive large-scale renewable hydrogen industry using its abundant existing and expandable world-class renewable wind energy firmed by hydro power, abundant fresh water, and access to industrial zones with high quality infrastructure.

Tasmania has several key competitive advantages for the development of a renewable hydrogen sector.

- Highly cost-competitive and reliable hydropower and wind generation, reflecting the world-class nature of Tasmania's renewable energy resources, with close to three gigawatts of installed renewable energy capacity.
- A very high renewable energy contribution (96 per cent in 2018)[7], with Tasmania on track to meet its target to be self-sufficient in renewables by 2022, making it the first state or territory in Australia with 100 per cent renewable power generation.[8] This is almost unique globally, and provides Tasmania with the capacity to develop a large-scale renewable hydrogen industry now.
- Feasible and abundant further renewable energy development potential, including approximately eight gigawatts of wind and multi gigawatts of pumped-hydro, which could support hydrogen production on a multi-gigawatt scale over the longer-term.
- The combination of wind power and capacity firming hydropower (and proposed future pumped-hydro schemes) that can provide a high electrolyser utilisation, compared to regions which have wind and solar generation, but limited firming of this variable renewable generation.[9]
- Tasmania has industrial precincts with available land and access to high quality infrastructure, notably the Bell Bay Advanced Manufacturing Zone which has existing and expandable port facilities, strong transmission infrastructure, and access to abundant fresh water.
- Access to a highly skilled and innovative workforce, supporting Tasmania's renewable energy and major industries, and world-class educational and research institutions including the Blue Economy Cooperative Research Centre.
- The comparatively small geographic size of Tasmania (relative to mainland Australia) means hydrogen infrastructure investment can be minimised while reaching the majority of the population. For example, a relatively small number of hydrogen refuelling stations would be required as part of an initial roll-out.

Together, these advantageous characteristics make Tasmania a highly attractive low-cost location for a large-scale renewable hydrogen production industry providing economic and environmental benefits.

1. Tasmania is a renewable energy powerhouse

Over the past 100 years Tasmania has built its economy around highly cost-competitive renewable energy, through Government-owned hydro power and network assets, with the existing power system supporting a range of energy intensive major industries across the state.[10] Tasmania's comparative advantages in renewable energy continue to provide a key platform for the development of major industries such as hydrogen.

Tasmania's existing electricity supply is dominated by hydropower, consisting of 30 power stations and more than 50 dams with a combined capacity of 2 283 MW.[11] Wind power is making an increasingly important contribution, with a total installed capacity of 564 MW once construction of the Cattle Hill and Granville Harbour wind farms is complete. The capacity of solar photo-voltaic power is also increasing in Tasmania, with approximately 135 MW currently installed.[12]

This substantial investment in renewable capacity is taking advantage of access to Tasmania's world-class renewable energy resources, which allows for highly cost-competitive renewable energy production.[13]

Tasmania generated 11 584 GWh of renewable energy in 2018, the highest of any Australian state or territory and represents 24 per cent of Australia's total renewable energy generation.

This is from a state with only two per cent of Australia's population. Tasmania is in the enviable position of already having a very high renewable energy contribution and is on track to be 100 per cent self-sufficient in renewable electricity production by 2022.[14]

The fully dispatchable (firm) nature of Tasmania's hydro generation can complement Tasmania's high capacity factor wind generation to provide renewable energy that is available when required. This allows for hydrogen production to be optimised with low energy price periods, and for high hydrogen production plant utilisation rates which can minimise the capital investment to achieve required production levels.

This unique combination of attributes allow for lower cost renewable hydrogen production, from highly cost-competitive Tasmanian renewable energy, relative to regions without significant emissions-free firming capacity to support their renewable energy generation.

The critical determinants of overall hydrogen production costs are electricity prices and electrolyser utilisation. Tasmania's relatively low renewable energy prices and ability to support very high electrolyser utilisation translates to competitive costs of renewable hydrogen production.

Analysis undertaken by Hydro Tasmania indicates that Tasmanian renewable hydrogen production is likely to be 10 to 15 per cent more competitive than grid-connected supply in other parts of Australia which need to offset emissions, and 20 to 30 per cent more competitive than off-grid supply from dedicated new wind or solar supply due to relatively low electrolyser utilisation.[16]

Importantly, Tasmania's existing renewable energy generation system means that Tasmania is already capable of renewable hydrogen production. Tasmania's hydro system is not capacity constrained and, in combination with new wind energy developments, could support significant additional load growth from large-scale hydrogen production.

In addition to substantial existing renewable energy generation, Tasmania has the potential to add significant new renewable energy infrastructure to support renewable hydrogen production.

Analysis under the Battery of the Nation initiative indicates multi-gigawatt wind development is feasible with scope for substantial pumped-hydro capacity by 2040.[17]

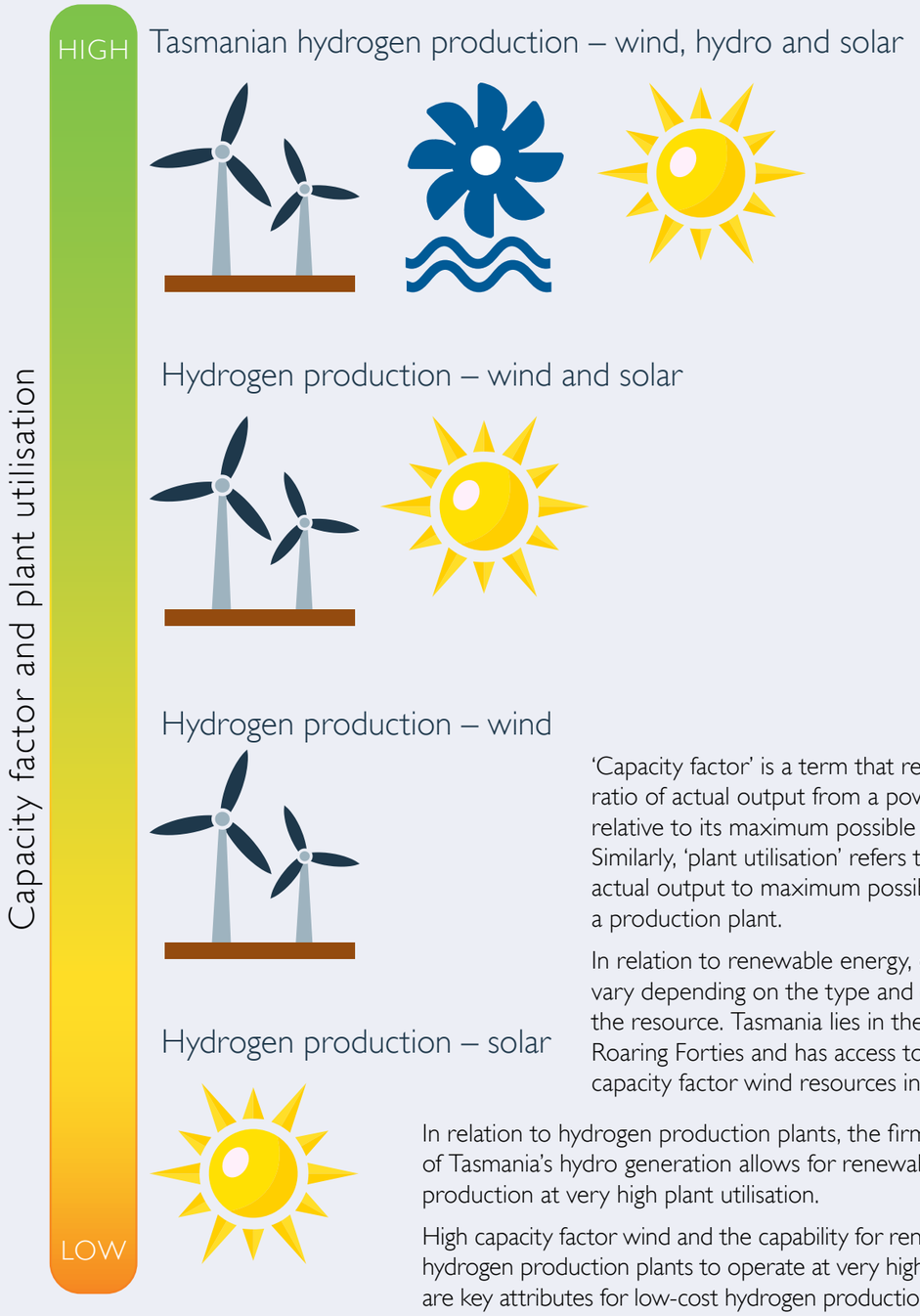
The Australian Energy Market Operator has also identified that Tasmania has among the most promising Renewable Energy Zones for wind energy development in Australia, with exceptional wind resources available in the north west, north east and central highlands regions.

Tasmania also has access to significant offshore renewable energy resources, including offshore wind, tidal and wave resources, which may become increasingly viable as the technologies to harness these resources further develop.[18] Tasmania also has significant bioenergy potential from forestry, agricultural and municipal residues.

Tasmania's combination of existing cost-competitive reliable world-class hydro and wind energy, its unique ability to optimise hydrogen production through the firming capabilities of hydropower, and access to abundant additional renewable energy resources including pumped-hydro schemes, make Tasmania an ideal location for the development of a large-scale renewable hydrogen industry.

With future wind resource expansion Tasmania could be capable of multi-gigawatt renewable hydrogen production in the long term. A one gigawatt renewable hydrogen production facility, for example, could contribute around 10 to 15 per cent of the one million tonnes of additional Australian hydrogen production estimated for 2030 in the "hydrogen: energy of the future" scenario analysis carried out under the National Hydrogen Strategy.[19]

Capacity factor and plant utilisation



'Capacity factor' is a term that relates to the ratio of actual output from a power station relative to its maximum possible output. Similarly, 'plant utilisation' refers to the ratio of actual output to maximum possible output from a production plant.

In relation to renewable energy, capacity factors vary depending on the type and quality of the resource. Tasmania lies in the path of the Roaring Forties and has access to the highest capacity factor wind resources in Australia.[15]

In relation to hydrogen production plants, the firming ability of Tasmania's hydro generation allows for renewable hydrogen production at very high plant utilisation.

High capacity factor wind and the capability for renewable hydrogen production plants to operate at very high plant utilisation are key attributes for low-cost hydrogen production in Tasmania.

Battery of the Nation and Project Marinus

Tasmania's Battery of the Nation initiative and additional Bass Strait interconnection (through Project Marinus) are projected to play a vital role in ensuring a reliable and affordable National Electricity Market as it transitions away from one dominated by coal generation to a more diverse supply mix with increasing levels of variable renewable generation.

The Battery of the Nation initiative has identified the potential for around 3 400 MW of pumped-hydro energy storage and around 8 700 MW of wind power development, together with 400 MW of 'latent' capacity in the existing hydro system.

Investigations into Project Marinus have identified that up to 1 500 MW of additional interconnection from Tasmania to Victoria across Bass Strait is technically and financially feasible and could be in service from 2027. This would unlock more low-cost, reliable and clean Tasmanian renewable energy for the benefit of the nation.

The construction of Marinus Link could provide an up to $1.4 billion injection into the Tasmanian economy and up to 1 400 direct and indirect jobs in peak construction.

The project will unlock wider added value to the Tasmanian economy estimated to be up to $5.7 billion and 2,350 jobs through renewable energy developments, including new wind farms and pumped hydro energy storage.[20]

Feasibility studies carried out by Hydro Tasmania have identified that Tasmania's total wind and hydro energy solutions are cost-competitive against all other known solutions, including the cost of interconnection.

In addition to providing low-cost and reliable clean energy to support the National Electricity Market, the significant additional wind and pumped-hydro schemes identified through Battery of the Nation could support a gigawatt scale Tasmanian renewable hydrogen industry.

The development of a large-scale renewable hydrogen industry is complementary to Battery of the Nation and Project Marinus, reflecting the underlying strength of Tasmania's existing and expandable renewable energy resources.

Hydro Tasmania has indicated renewable hydrogen industry development would be complementary to Battery of the Nation, particularly where these opportunities are developed in parallel, allowing revenue and risk diversification.[21]

2. Access to abundant water

While Tasmania is less than one per cent of Australia's land area, it has 12 per cent of Australia's fresh water supply and 27 per cent of Australia's freshwater dam storage capacity.[22]

The National Hydrogen Strategy identifies Tasmania as a region with abundant fresh water.[23]

Access to clean fresh water is a critical element of hydrogen production. While desalination of sea water is possible, this adds to the costs of hydrogen production. Options for co-investment in irrigation schemes and purification of wastewater could also be explored.

Renewable hydrogen production in Tasmania, even on a gigawatt scale, would only use a small fraction of the available fresh water and would not be expected to detrimentally impact on other water users or environmental flows. For example, a 1 000 MW renewable hydrogen production facility would require up to an estimated 4 000 ML of water per year, equivalent to around one per cent of Tasmania's total fresh water consumption in 2016–17.[24] [25]

Appropriate planning will, however, be important to ensure all industries and households have the water they need, particularly during drought periods.

3. Existing high quality supporting infrastructure

Tasmania has a number of industrial precincts with available land and access to high quality infrastructure, including access to electricity transmission, roads, rails and ports.

The Bell Bay Advanced Manufacturing Zone in particular is an ideal site for large-scale renewable hydrogen production for export and for domestic applications. Key attributes include:

- existing strong transmission connection built for major industry
- deep all-weather port with scope for expansion
- access to abundant fresh water
- an established industrial precinct with available space for large-scale development.

Tasmania's north west coastal region is also well suited to large-scale renewable hydrogen production. Burnie in particular is well placed for industry development. The region has extensive road and rail links, and access to deep-water ports for export located at Devonport, Port Latta and Burnie (which is Tasmania's largest port in terms of freight throughput). The region also has access to natural gas networks and has abundant fresh water.

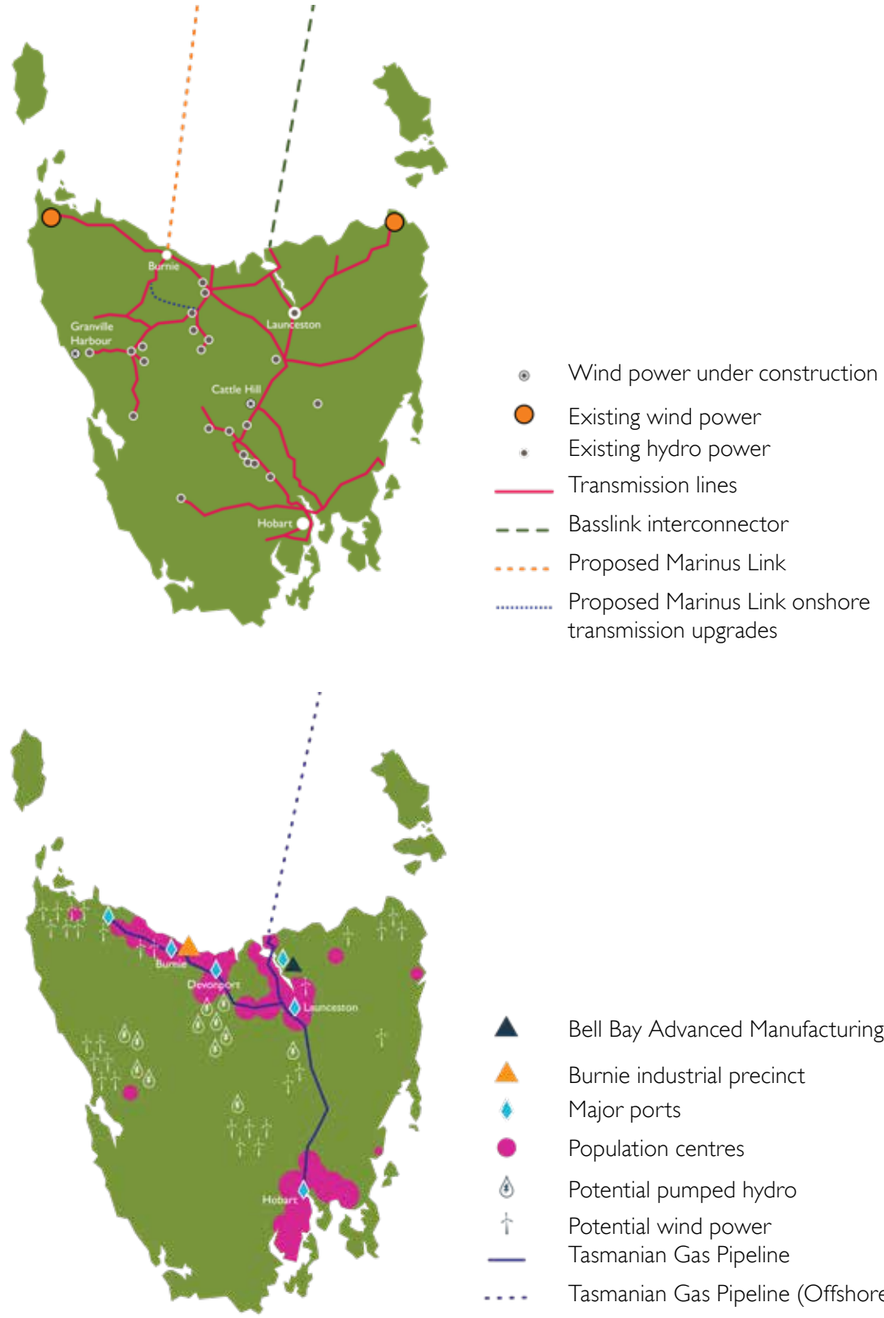
A particularly strong attribute of the north west region for renewable hydrogen development activities is its access to renewable energy generation and supporting transmission infrastructure. Major energy developments are planned for the region, including new wind farms, pumped hydro schemes (through Battery of the Nation) and a second transmission interconnector across Bass Strait (through Project Marinus). These developments will support further strengthening in transmission infrastructure in north west Tasmania.

In addition, there are many other industrial precincts in Tasmania that could support renewable hydrogen production for domestic applications. For example, industrial precincts at Westbury (in northern Tasmania) and Brighton (in southern Tasmania) are situated close to strong electricity transmission and natural gas distribution connection points, and are strategically located on major Tasmanian transport corridors.

These precincts could support the use of renewable hydrogen in transport, for blending in natural gas distribution networks or as an industrial or agricultural feedstock.

The west coast region of Tasmania, with its access to renewable energy resources, fresh water and transmission infrastructure, is also well suited to renewable hydrogen production.

Tasmanian renewable energy resource potential and existing key infrastructure



Bell Bay Advanced Manufacturing Zone

An ideal hydrogen hub

A key action under the National Hydrogen Strategy is the facilitation of hydrogen hubs. The International Energy Agency (IEA) has identified developing hydrogen hubs as a cost-effective route to achieving scale within industry.[26]

Hydrogen hubs are suitable regions in which there is existing infrastructure – such as powerlines, pipelines, roads, port infrastructure and railway lines – which can support economies of scale in producing and delivering hydrogen to end users. Location of hydrogen hubs at or near areas with high production potential can further increase cost-effectiveness.

The Bell Bay Advanced Manufacturing Zone meets all these requirements and is ideally placed to become a hydrogen hub, utilising Tasmanian renewable energy for large-scale renewable hydrogen production and storage, for export and to support domestic applications.

The Bell Bay Advanced Manufacturing Zone is Tasmania's premier large-scale major industrial precinct, located just 45 kilometres from Launceston. It has a suite of existing infrastructure well suited to renewable hydrogen production, including access to high voltage transmission assets, fresh water, as well as access to the precinct by rail, road, air and sea links, with close proximity to an adjacent deep water port which handles domestic and international bulk goods.

The Zone has available industrial zoned land suitable for large-scale renewable hydrogen production and storage, with the deep water port being adaptable for hydrogen exports. Bell Bay is also adjacent to the connection point for the Basslink interconnector. As such, electricity transmission connections at the Zone are strong, with existing transmission capacity available for new developments.

The Bell Bay region has a long-held reputation for actively supporting and promoting business, industry and job opportunities, including housing the first aluminium smelter in the southern hemisphere. It is a hub of knowledge and expertise in light and heavy industry, and the precinct has attracted a number of energy intensive major industries, including minerals processing, timber processing and gas-fired power generation.

Community acceptance and support will also be critical for hydrogen hub developments. The local community in the Bell Bay region has a proud history of supporting major industries, and there is strong interest in the region for renewable hydrogen industry development.

The Tasmanian Government will continue its focus on establishing the Bell Bay Advanced Manufacturing Zone as Tasmania's premier hydrogen hub for large-scale renewable hydrogen industry development.

Other industrial precincts, including in Tasmania's north west coast region, in particular at Burnie, will also be promoted by the Tasmanian Government as suitable hydrogen hub sites.

Potential hydrogen production capabilities

A renewable hydrogen production facility in the range of around 10 to 100 MW could be a viable first-stage commercial scale facility at the Bell Bay Advanced Manufacturing Zone. This could be developed without transmission network augmentation and could be situated on a number of available industrial development sites in the Zone.

It could be directly supplied with Tasmanian renewable energy (wind and hydro power), enabling high electrolyser utilisation and cost-competitive renewable hydrogen production.

A 100 MW renewable hydrogen production facility could contribute an estimated 100 to 150 jobs, mostly in regional areas. It could produce up to 14 000 tonnes of renewable hydrogen per year as either pure hydrogen or embedded within derivatives such as liquid hydrogen, ammonia or methanol. It would be likely to consume up to around 400 megalitres of water per year which could be sourced through existing infrastructure.

Such a facility could offer renewable hydrogen to the domestic market for end-uses such as transport (including road, rail and marine), injection to the local natural gas network, and industrial applications. Compressed hydrogen could be distributed from Bell Bay either by road or rail. The facility could also be scaled to meet emerging export demand.

Future expansion to a 1 000 MW renewable hydrogen production facility in the Bell Bay Advanced Manufacturing Zone is feasible with further infrastructure investment, and could produce up to 140,000 tonnes of hydrogen per year, representing nearly 15 per cent of the additional Australian hydrogen production estimated for 2030 in the "hydrogen: energy of the future" scenario analysis carried out under the National Hydrogen Strategy.[27]

A 1 000 MW facility could support around 2 000 MW of renewable energy investment, and contribute an estimated 1000 to 1 200 jobs. Existing hydro power and planned pumped-hydro augmentation could back additional wind generation to continue to provide high electrolyser utilisation for competitively priced renewable hydrogen production.

4. Other key attributes

In addition to its access to abundant renewable energy, clean fresh water and quality infrastructure, Tasmania has other key attributes that will support the development of a viable renewable hydrogen industry in the state.

Highly skilled workforce and world-leading educational and research institutions

Tasmania boasts a diverse and highly skilled workforce that has a proven track record of meeting the needs of industry, with particular strengths in major industrial businesses including advanced manufacturing and renewable energy, which employ thousands of Tasmanian workers.

Many of these workers received their training through Tasmania's world-class educational and training institutions, including the University of Tasmania and TasTAFE, which offer courses tailored to meet the needs of major Tasmanian industries. The University of Tasmania is consistently ranked in the top 10 research universities in Australia, and within the top two per cent of universities worldwide.

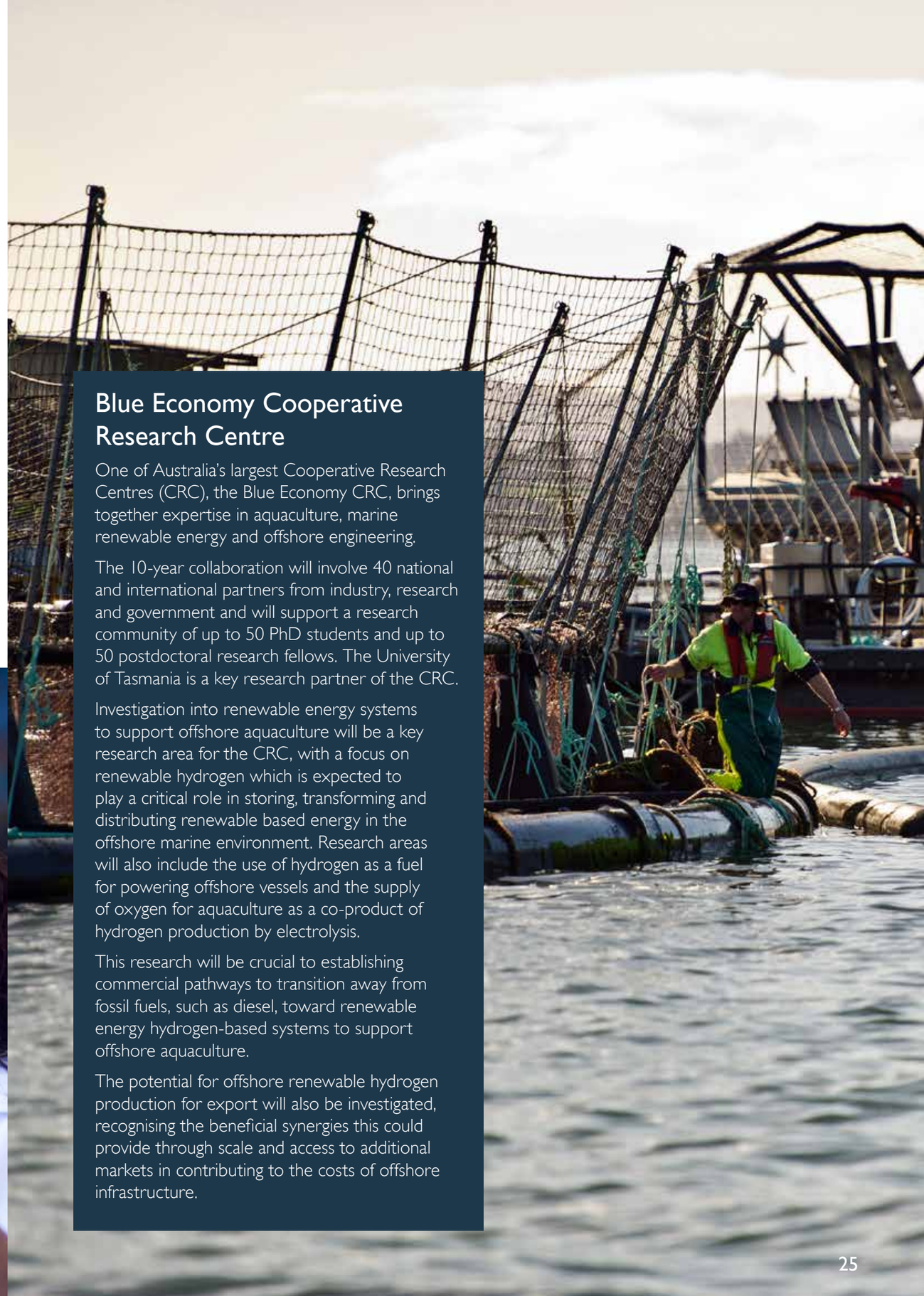
The capacity of Tasmania's workforce will soon receive a major boost, through the $17 million 'Energising Tasmania' initiative which will provide training in priority skills needs to further increase Tasmania's skilled workforce capacity, in readiness for major energy developments in Tasmania including Project Marinus, Battery of the Nation and hydrogen industry development.

Tasmanian businesses and educational institutions have a proven history of innovation, particularly in regard to the research, development and delivery of renewable energy-based solutions to overcome technical challenges and provide environmental and economic benefits.

UTAS Future Energy group

The University of Tasmania has an established Future Energy collaborative research group with a vision for Tasmania to be an internationally recognised experimental hub for energy. The group brings together diverse disciplines including engineering, economics, law, marine science, social science and humanities to research and develop options for future energy provision in Tasmania. Research into renewable hydrogen production and use is an emerging key research theme for the Future Energy group.

Hydrogen research work currently being scoped out includes the identification of Tasmania's competitive renewable hydrogen industry advantages that could foster economic growth, the potential for decarbonising Tasmanian industries using renewable hydrogen, and the integration of renewable hydrogen production into the state's power system.



Blue Economy Cooperative Research Centre

One of Australia's largest Cooperative Research Centres (CRC), the Blue Economy CRC, brings together expertise in aquaculture, marine renewable energy and offshore engineering.

The 10-year collaboration will involve 40 national and international partners from industry, research and government and will support a research community of up to 50 PhD students and up to 50 postdoctoral research fellows. The University of Tasmania is a key research partner of the CRC.

Investigation into renewable energy systems to support offshore aquaculture will be a key research area for the CRC, with a focus on renewable hydrogen which is expected to play a critical role in storing, transforming and distributing renewable based energy in the offshore marine environment. Research areas will also include the use of hydrogen as a fuel for powering offshore vessels and the supply of oxygen for aquaculture as a co-product of hydrogen production by electrolysis.

This research will be crucial to establishing commercial pathways to transition away from fossil fuels, such as diesel, toward renewable energy hydrogen-based systems to support offshore aquaculture.

The potential for offshore renewable hydrogen production for export will also be investigated, recognising the beneficial synergies this could provide through scale and access to additional markets in contributing to the costs of offshore infrastructure.

Hybrid Energy Solutions – innovative renewable energy for remote communities

Hydro Tasmania, with the assistance of the Australian Renewable Energy Agency, has delivered innovative hybrid energy solutions for large remote communities including King and Flinders Island.

These ground-breaking systems significantly reduce dependence on diesel and are capable of operating on up to 100 per cent variable renewable energy, the first megawatt scale off-grid systems with this capability in the world.

The production and use of hydrogen presents further opportunities to reduce dependence on diesel in these communities.

Entura

Entura, a part of Hydro Tasmania, is one of the world's most experienced specialist power and water consulting firms, with technical expertise grounded in more than 100 years of experience. Since the 1990's, Entura has taken this experience and knowledge and applied it to solve complex issues for businesses in Australia and around the world.

Entura provides consulting services from strategy, planning, design and construction through to operation, maintenance, risk management and training, to create safe and sustainable power and water solutions.

Entura was significantly involved in the development of Hydro Tasmania's Hybrid Energy Solutions, and continues to provide innovative energy solutions, including the opportunities that hydrogen presents to power remote communities.

Pro-industry government and favourable planning processes

The Tasmanian Government is focussed on facilitating and growing competitive and sustainable Tasmanian industries, that enables economic growth through supportive policy and effective regulatory frameworks.

The Government established the Office of the Coordinator-General in 2014 with the specific purpose of attracting and securing investment in major projects that support Tasmania's economic growth.

Through the Coordinator-General, the Tasmanian Government is actively working with a range of proponents, including prominent international proponents and consortia, to facilitate investment in renewable hydrogen production for export and domestic use. This includes assistance in navigating state regulatory and planning approval processes, with a key focus on timely assistance that puts community safety and social acceptance at the forefront.

To assist in its investment attraction activities, the Coordinator-General released a Tasmanian Renewable Hydrogen Prospectus in December 2019 which provides industry-specific detail on renewable hydrogen development opportunities in Tasmania, particularly in relation to the Bell Bay Advanced Manufacturing Zone.

It can be found at www.cg.tas.gov.au/Tasmania_Renewable_Hydrogen_Prospectus.pdf

In March 2019, the Tasmanian Government undertook a trade and investment mission to Japan, headed by the Premier and Coordinator-General. A number of meetings were held with Japanese corporations as a part of the mission, in relation to renewable hydrogen production opportunities in Tasmania for export to Japan.

These meetings stimulated significant interest in the prospects of cost-competitive renewable hydrogen production in Tasmania for export, with a number of non-disclosure arrangements subsequently signed to further investigate these opportunities.

In November 2019, the Premier led a trade mission to the United Kingdom where Tasmania's renewable energy and renewable hydrogen capabilities were the focus of a Renewable Energy Roundtable hosted by the Australia United Kingdom Chamber of Commerce. In addition, the Coordinator-General visited Singapore in November 2019, holding a range of discussions with government and industry specifically regarding Tasmanian renewable hydrogen opportunities.

The Tasmanian Government undertook a trade mission to China in December 2019 engaging with government and industry proponents. Significant interest and discussions occurred around the hydrogen opportunities that Tasmania presents.

The Tasmanian Government is also engaging with the South Korean Government and industry through H2Korea, which is a public-private partnership established with a goal to promote the hydrogen energy industry in line with the Korean Government's Hydrogen Economy Roadmap.

Many local councils and local representative organisations are strongly supportive of renewable hydrogen industry development in their regions, including in the north and north west of Tasmania where hydrogen hubs and large-scale hydrogen production facilities are particularly well suited.

The Tasmanian Government will work collaboratively with supportive Local Governments and representative organisations to facilitate renewable hydrogen development.

Tasmania has a number of planning approval pathways for industry development. To further improve these arrangements for major developments, the Tasmanian Government is progressing the *Land Use Planning and Approvals Amendment (Major Projects) Bill 2018* which will amend the *Land Use Planning and Approvals Act 1993* to introduce a new assessment process to provide for a single approval processes for major projects delivering multiple coordinated permits.

Hydrogen-ready gas distribution network

Tasmania has a relatively new natural gas distribution network, constructed from High Density Polyethylene (HDPE) which does not suffer the potential pipe embrittlement and leakage issues associated with high hydrogen blends in older gas distribution networks constructed from steel.

Therefore, the existing natural gas network has the potential to distribute a high proportion of hydrogen (blended with natural gas), with the possibility of carrying 100 per cent hydrogen to be investigated.

Geographically compact

Tasmania's relatively compact geographical size (relative to mainland Australia) can reduce costs and facilitate the ease of doing business, including potentially minimising hydrogen infrastructure investment while reaching the majority of the population. For example, a relatively small number of hydrogen refuelling stations would be sufficient to cover the main population centres and heavy transport routes.

Benefits of a large-scale renewable hydrogen industry

Developing a large-scale renewable hydrogen industry in Tasmania, using low-cost Tasmanian renewable energy, has the potential to provide significant benefits for Tasmania.

This includes flow-on and indirect benefits, with large-scale renewable hydrogen developments expected to stimulate significant renewable energy and associated infrastructure investment.

Analysis carried out to inform the National Hydrogen Strategy indicates that under a favourable "hydrogen: energy of the future" scenario an Australian hydrogen industry could generate around 17 000 full time jobs and $26 billion in GDP by 2050. A "hydrogen: targeted deployment" scenario, where there is growing hydrogen use in high value sectors, is estimated to generate around 7 600 jobs and $11 billion in GDP.[28]

Tasmania is ideally placed to take advantage of the emerging renewable hydrogen industry, providing economic and employment benefits particularly for regional areas. Tasmania has well-established and successful advanced manufacturing industries including in the marine, heavy vehicle and mining sectors. A domestic renewable hydrogen industry provides an opportunity to leverage value into these sectors and further support regional growth and employment.

Importantly, large-scale renewable hydrogen production would provide significant load growth for Tasmania, further strengthening Tasmania's status as an ideal location for major industry development. Load growth can benefit the whole community through placing downward pressure on energy prices by allowing greater cost sharing of largely fixed electricity network costs. This can be maximised by ensuring that renewable hydrogen production facilities are located in areas with spare network capacity.

The flexible nature of renewable hydrogen production could potentially provide valuable benefits for keeping the electricity system stable, for example through the provision of frequency control ancillary services. Assuming operation can be varied to help counteract variations in wind and solar generation, hydrogen production facilities could provide services which would assist in increasing the hosting capability of intermittent energy sources, benefiting the renewable energy that can be enabled through Project Marinus and Battery of the Nation.

Large-scale hydrogen production facilities could also participate in system protection schemes to assist in maximising utilisation of network assets.

Large-scale production of renewable hydrogen has the potential to provide significant economic benefits for Tasmania, through supplying export markets and local end-use markets including in transport, fuel substitution in gas networks, industrial applications and for remote power supplies (such as the Bass Strait Islands).

The use of locally produced renewable hydrogen can provide economic benefits through 'value-adding', with the entire supply chain, from renewable energy generation, to hydrogen production, through to end-use, occurring in Tasmania. This 'on-island' supply chain could also provide significant energy security benefits by reducing Tasmania's dependence on fossil fuel energy imports and increasing energy diversity.

Locally produced renewable hydrogen could also significantly reduce Tasmania's greenhouse gas emissions over the long-term across the stationary energy, transport and agriculture sectors. This could play an important role in contributing to Tasmania meeting its 2050 net zero greenhouse gas emissions target.

Tasmania's hydrogen action plan

Focus areas for developing a Tasmanian renewable hydrogen industry

Tasmania will use its comparative renewable energy advantages to support the development of a viable and cost-competitive Tasmanian renewable hydrogen industry.

Importantly, Tasmania's key capabilities to support renewable hydrogen industry development on a significant scale already exist, with the potential to support production on a multi gigawatt scale over the longer term in conjunction with further development of Tasmania's abundant world-class renewable energy resources.

The Tasmanian Government has set ambitious objectives for renewable hydrogen industry development in the State, commencing with hydrogen production for use in Tasmania, leading into the development of export supply chains, and scaling up to be a significant global supplier of renewable hydrogen from 2030 for export and domestic use.

These objectives for Tasmanian renewable hydrogen industry development will be achieved through the following focus areas:

- investigating and facilitating opportunities for the production and use of renewable hydrogen in Tasmania
- facilitating large scale renewable hydrogen production for export.

In recognition of the nascent state of the renewable hydrogen industry, and its significant potential in Tasmania, a series of financial support measures to help facilitate the development of a Tasmanian renewable hydrogen industry have been developed by the Tasmanian Government. Further information is provided in the Tasmanian Government Support section.

Investigating and facilitating opportunities for the production and use of renewable hydrogen in Tasmania

Supporting the development of a domestic market for the use of locally produced renewable hydrogen will play a critical role in establishing a viable renewable hydrogen industry in Tasmania, through:

- enabling initial investment in renewable hydrogen production and end-use technologies in Tasmania
- demonstrating the benefits renewable hydrogen can provide for Tasmania, and its safe production and use
- demonstrating Tasmania's renewable hydrogen industry capabilities, across the supply chain, particularly in regard to facilitating export based large-scale renewable hydrogen investments
- providing a pathway to build scale, from initial demonstration projects toward large-scale renewable hydrogen developments.

The development of a domestic renewable hydrogen market is considered to be a key enabler for establishing a viable renewable hydrogen export sector.

As hydrogen end-use technologies (such as fuel-cells) develop and become more cost-competitive, the local use of Tasmanian renewable hydrogen may become an increasingly important form of energy for the state across a range of end-use sectors. In the longer term, the use of locally produced hydrogen in Tasmania could provide valuable economic benefits through 'value-adding', as well as valuable energy security and environmental benefits by reducing dependence on imported fossil fuels.

Hydrogen could be used in a broad range of end-use applications in Tasmania, including in transport, blending with natural gas, for remote power and for industry applications. The Tasmanian Government will further investigate the opportunities for using locally produced renewable hydrogen in Tasmania, and how it can best facilitate these end-use opportunities.

Transport

The transport sector is one early adoption end-use application for hydrogen, as the price of hydrogen is approaching cost-competitiveness as a substitute for conventional transport fuels such as diesel and petrol. The use of hydrogen for transport can also provide significant environmental benefits, through reducing transport related greenhouse gas emissions and air pollution.

Hydrogen mobility technologies, in particular running hydrogen through a fuel cell to power an electric drive-train, have been implemented in a broad range of transport applications around the world. These technologies are seen to offer a comparable user experience to traditional internal combustion engine vehicles including driving experience, driving range and refuelling time. Hydrogen fuel cell technologies are also significantly more efficient than traditional engine vehicles.

As identified in the National Hydrogen Strategy, the use of hydrogen is likely to be particularly well suited to fuel cell based heavy vehicle applications, as it can avoid the potential weight issues associated with using batteries to power heavy electric vehicles, with quicker refuelling times. Together with battery electric vehicles, hydrogen mobility technologies provide the opportunity to harness Tasmania's renewable energy to power the state's transport sector and provide associated economic, environmental and energy security benefits.

The Tasmanian Government will investigate opportunities for the use of hydrogen transport technologies in the state, with an initial focus on 'return-to-base' transport activities, such as buses, fleet vehicles, freight (including road and rail) and marine applications (such as ferries and barges), as this can allow for the most efficient utilisation of associated hydrogen refuelling infrastructure.

The development of hydrogen refuelling infrastructure will need to occur in step with the deployment of hydrogen transport technologies. The Tasmanian Government will investigate optimised deployment and use of hydrogen refuelling infrastructure, with the intent of promoting open access where practical, to best facilitate industry development. This is consistent with the approach identified in the National Hydrogen Strategy.

The Tasmanian Government will explore opportunities to trial hydrogen fuel cell electric vehicles within its fleet to gain first-hand experience of the technology and act as a potential catalyst for broader uptake across the private sector. The use of hydrogen as a shipping fuel to support offshore aquaculture operations will be investigated by the Blue Economy CRC.

Gas networks

Hydrogen can be blended with natural gas in existing gas distribution networks. This has already been successfully trialled at blending rates of 10 per cent hydrogen in Australia. Existing gas appliances can safely use hydrogen blends at this level. Blends of up to 20 per cent hydrogen, utilising existing gas appliances, are currently being investigated in pilot projects in the United Kingdom and France.[29]

The incumbent natural gas distribution network infrastructure owner and operator is actively investigating opportunities for blending hydrogen at 10 per cent in parts of its network.

Tasmania has a unique advantage in that its relatively new HDPE gas network is compatible with hydrogen and could potentially allow for hydrogen gas blends up to 100 per cent.[30] This provides an important opportunity for Tasmania to trial higher blends of hydrogen than is possible in older steel-based gas distribution networks in other parts of Australia.

For example, a controlled trial could be carried out in a small part of the network in conjunction with end-users, noting end-use facilities and appliances would need to be compatible with high hydrogen gas blends, and that appropriate safety arrangements would need to be in place.

The National Hydrogen Strategy supports continued pilots, trials and demonstrations of hydrogen in gas distribution networks, where they are conducted in a safe manner, with a view to reviewing higher blending rates into the future.

The Tasmanian Government will work with the incumbent natural gas distribution network infrastructure owner to explore opportunities for hydrogen blending at 10 per cent and to investigate potential trials of higher hydrogen blends.

Remote power supplies

The use of hydrogen could be particularly well suited to powering remote communities and commercial operations, as a fuel replacement for imported diesel. Indeed, the National Hydrogen Strategy strongly supports research, pilots and trials for hydrogen use in remote applications.

While diesel consumption to power the Bass Strait Islands has reduced significantly as a result of Hydro Tasmania's innovative renewable hybrid energy systems, diesel is still required as a back-up fuel. The use of hydrogen, particularly if it is locally produced from the abundant renewable energy resources available on the Bass Strait Islands, could remove the need for expensive diesel imports for power generation. It also provides the significant benefit of being able to utilise otherwise wasted 'spill-over' renewable energy to produce hydrogen for later use.

Hydro Tasmania will investigate the production and use of renewable hydrogen as a component of its hybrid energy systems on King and Flinders Island, and for incorporation into its hybrid energy solutions services.

The Tasmanian-based Blue Economy CRC will investigate the use of hydrogen based renewable power systems to support offshore aquaculture operations.

Tasmania is ideally positioned, as a key gateway to the Antarctic, to facilitate the use of hydrogen based renewable energy systems to provide power and fuel requirements for Antarctic nations' research operations. As a highly versatile fuel that can be produced on site, hydrogen is an ideal energy carrier for the Antarctic region, and presents a pathway to transition away from dependence on fossils fuels.

The Department of State Growth will work with Tasmania's Antarctic and energy business sectors to investigate the opportunity for hydrogen based renewable energy systems to provide power and fuel requirements in Antarctica.

Industrial applications

Hydrogen is already used as a feedstock in a range of industrial applications, such as chemicals manufacturing.

There may be opportunities for renewable hydrogen to be used as a carbon-neutral feedstock in a range of Tasmanian industries, for example in ammonia production for agriculture or in industrial processes. This could leverage off any larger-scale production of 'green' ammonia in Tasmania for export. There may also be opportunities for the use of renewable hydrogen in industrial processes such as metals manufacturing (replacing high carbon processes involving fossil fuels).

The Tasmanian Government will investigate industrial applications of Tasmanian renewable hydrogen, including opportunities for the use of 'green' ammonia and related products, derived from renewable hydrogen, for use in the Tasmanian agricultural sector.

Oxygen is a potentially valuable co-product of renewable hydrogen production by electrolysis, particularly for use in the aquaculture industry and potentially for water treatment. The Blue Economy CRC is investigating opportunities to add value to hydrogen production by electrolysis by utilising the oxygen co-product in Tasmania's aquaculture industry.

‘Green Ammonia’ and ‘Green Methanol’

The greatest current demand for hydrogen is as feedstock for ammonia production, which is a mature industry with well-established storage, distribution and export processes already in place. Ammonia is used in the production of fertiliser, explosives and a range of other products. However, ammonia production is almost entirely derived from fossil fuels with associated greenhouse gas emissions.

Production of ‘green ammonia’ from renewable hydrogen presents a significant opportunity to not only de-carbonise the ammonia production industry, but also to provide a cost-effective route to building renewable hydrogen industry scale through an established industry. Indicators are that ammonia may be the most effective means of storing and exporting hydrogen, with the benefit of being able to use existing storage and shipping technologies. Ammonia may also be able to be used directly as a clean fuel, saving on energy conversion costs back to hydrogen for end-use. Globally, there is expected to be an increase in demand for ‘green ammonia’.

Methanol production derived from fossil fuels is also a mature industry, with similar opportunities and benefits associated with transferring to ‘green methanol’ production from renewable hydrogen. Methanol is mainly used in the production of formaldehyde, and is increasingly being considered as a transport fuel and for other energy applications.

Tasmania is ideally placed for the production of ‘green ammonia’ and ‘green methanol’. The state’s unique capability to provide renewable energy on a continuous basis is particularly valuable for the downstream process of ‘green ammonia’ production from renewable hydrogen, which requires a steady electricity supply.

Facilitating large-scale renewable hydrogen production for export

Tasmania is ideally placed to develop a large-scale renewable hydrogen production and export industry, using its cost-competitive existing and expandable reliable renewable energy, and access to industrial sites with existing port access.

Tasmania’s Coordinator-General will continue its investment attraction and industry development work, including with prominent international proponents and consortia, to facilitate investment in renewable hydrogen production for export.

Partnering with importing countries and international consortiums provides mutual benefits, with importing countries and businesses providing access to market, technological expertise and production investment, and Tasmania providing low-cost firm renewable energy, access to existing infrastructure and a supportive investment environment.

The Tasmanian Government will continue to foster these international partnerships and to strengthen relationships through facilitating and attending trade delegations.

The Tasmanian Government will investigate opportunities for export of renewable hydrogen from identified sites. The Bell Bay Advanced Manufacturing Zone, with its strong transmission connections for renewable energy supply, access to a deep water port and abundant fresh water, will continue to be promoted as a prime hydrogen hub location for large-scale renewable hydrogen production, storage and export. Other industrial precincts, including in Tasmania’s north west coast region, will also be promoted as suitable hydrogen hub sites.

Tasmanian Government support

The Tasmanian Government has developed a comprehensive $50 million over 10 years package of support measures to facilitate renewable hydrogen industry development in Tasmania, consistent with meeting the *Goals* and *Vision* set out in this *Action Plan*.

Tasmanian Government support will help activate hydrogen industry development and reduce investor risk, recognising that international and domestic markets are still emerging and hydrogen technologies are not yet mature.

Key financial support measures include:

- a $20 million Tasmanian Renewable Hydrogen Fund, available on a co-contribution basis
- $20 million in concessional loans through the Tasmanian Development Board
- $10 million worth of support services including competitive electricity supply arrangements and payroll tax relief for renewable hydrogen related business operations establishing in Tasmania.

Assistance will also be available for developing offtakes for hydrogen end-use in Tasmania, including opportunities for hydrogen buses through Tasmania's state-owned public transport provider, Metro Tasmania.

Additional support measures offered by the Tasmanian Government include facilitating land and infrastructure access and access to discounted professional services through Tasmania's state-owned energy consulting business Entura.

The Tasmanian renewable hydrogen support measures will be delivered through a competitive two-stage Expression of Interest (EOI) process which is expected to commence in the second quarter of 2020 and will be aligned with ARENA's $70 million hydrogen funding round.

The support measures will be available for activities related to renewable hydrogen production, storage, distribution, export and use within Tasmania.

Eligible activities will include:

- Projects – to support capital investment in pilots, trials, demonstrations and pre-commercial projects. This may include a research and development component.
- Feasibility studies – to support investment decisions for large-scale projects.

Successful projects will be announced by the end of 2020, with a key selection criteria being the ability for projects to contribute toward meeting the Action Plan Goals.

The Tasmanian Government will also support activities to implement the Tasmanian Renewable Hydrogen Action Plan, and support Tasmania's contribution to implementation of the National Hydrogen Strategy, through the establishment of a Renewable Hydrogen Development Unit within the Department of State Growth.

Other supporting activities

There is also a range of important activities the Tasmanian Government will facilitate and participate in that will support the development of a viable hydrogen industry in Tasmania. Many of these activities are being considered under the National Hydrogen Strategy, and the Tasmanian Government will work cooperatively with related National Strategy implementation actions.

Regulations and standards

The production, storage, distribution and use of hydrogen, particularly in relation to energy applications and at scale, is relatively new and emerging. It also cuts across many sectors, reflecting the broad potential end-use applications of hydrogen, such as in transport, gas supply and electricity generation.

It is recognised that governments have a key role to play in ensuring consistent, robust and predictable regulations and standards are in place, that are also responsive and flexible, to support the emergence of a viable and safe hydrogen industry.

The National Hydrogen Strategy strongly supports a responsive regulation approach, to ensure that there are no regulatory barriers in place to prevent the growth of a hydrogen industry in Australia. This includes work to review legal frameworks that are applicable to the hydrogen supply chain including project approvals and environmental protection, and ensuring nationally consistent approaches towards regulation.

The Tasmanian Government will review state-based legislation and regulations that are relevant to the hydrogen industry, particularly in regard to safety, and will participate in national regulatory review and reform processes implemented under the National Hydrogen Strategy.

Tasmania will adopt the approach of facilitating national consistency where appropriate, while ensuring specific state based regulations are in place that reflect Tasmania's unique situations.

Renewable hydrogen accreditation

Global demand projections are for hydrogen produced from emissions free sources, to assist countries decarbonise their economies. A hydrogen certification or guarantee of origin scheme will provide importing countries and end users with assurances that the hydrogen they are purchasing is from sustainable resources and produced using renewable energy, and can legitimately contribute to carbon reduction goals.

The National Hydrogen Strategy indicates Australia will play a leadership role in developing an international scheme, and will advocate for the quick establishment of a 'minimal certification scheme' that verifies and tracks carbon emissions associated with hydrogen production, to avoid potential investment delays.

Tasmania's emissions-free renewable energy supply will avoid the need for costly carbon offsets or credits, which are likely to be required by hydrogen production projects receiving supply from emissions-intensive grids in other parts of Australia in order to achieve 'green' hydrogen certification status.

The Tasmanian Government will work collaboratively with other governments and industry to facilitate the development of a certification scheme that recognises and values Tasmania's renewable energy characteristics and sustainable water resources.

Infrastructure assessments

The importance of assessing local infrastructure requirements to support renewable hydrogen infrastructure investments is critical to ensuring that the industry is able to readily scale-up. The establishment of hydrogen hubs will increase demands on local supporting infrastructure. Managing these demands, and identifying expansion requirements, will require significant forward planning and coordination.

This is recognised by the National Hydrogen Strategy, with a National Hydrogen Infrastructure Assessment to be completed by 2022, and every five years thereafter, to support efficient hydrogen hub development.

The Infrastructure Assessments will consider hydrogen supply chain needs including electricity, gas networks, water supply infrastructure, refuelling stations, roads, rail and ports, while taking into account local community concerns and priorities.[31] These infrastructure assessments will guide government and private sector support and investment for hydrogen projects and future infrastructure projects. The Tasmanian Government will work collaboratively with infrastructure assessments carried out under the National Strategy.

The Tasmanian Government will also work with local infrastructure providers to assess infrastructure requirements associated with renewable hydrogen developments. This will include working with TasNetworks to assess the network requirements at identified sites including the Bell Bay Advanced Manufacturing Zone, and explore options for minimising network costs.

Water requirements will be assessed in consultation with TasWater and TasIrrigation. Port requirements for export will be assessed in consultation with TasPorts.

This will facilitate the locating of renewable hydrogen developments in areas that maximise the utilisation of existing infrastructure, which can both improve the financial viability of projects and provide broader community benefits (for example through greater sharing of existing network costs).

Community awareness, engagement and acceptance

The development of a viable hydrogen industry will only occur with community satisfaction that the production and use of hydrogen is safe, can provide local economic benefits, and protects the environment. As for any significant infrastructure development, comprehensive community engagement will be key to ensure the successful implementation of projects that are welcomed and supported by the community.

The National Hydrogen Strategy has a clear commitment to build community knowledge and engagement, and to provide information about the risks, benefits and safe use of hydrogen. The Tasmanian Government will facilitate the delivery of community education and awareness raising sessions related to renewable hydrogen, and ensure associated nationally developed materials and programs are relevant for, and made available to, the Tasmanian community.

The Tasmanian Government will also continue to facilitate industry stakeholder engagement, including through the delivery of an industry workshop in 2020 to advance the Tasmanian Renewable Hydrogen Action Plan.

Government supported renewable hydrogen demonstration projects, and activities carried out by research institutions, can also play an important role in raising community awareness, particularly in regard to the safe use of hydrogen.

Skilled workforce

Tasmania already has access to a highly skilled and innovative workforce related to its renewable energy and major industries. The Tasmanian Government recognises this existing skilled workforce base will require a further boost to ensure ongoing access to an appropriately skilled workforce as Tasmania implements its major energy initiatives, including the development of a renewable hydrogen industry and the Battery of the Nation and Marinus Link initiatives.

The Tasmanian Government will facilitate the implementation of the Australian Government funded $17 million 'Energising Tasmania' initiative to provide training in major energy development related priority skills needs areas such as engineering, project management, civil construction and trades.

The output of the 'Energising Tasmania' agreement will be a Tasmanian workforce better equipped with the skills necessary to build Tasmania's capability in areas of priority skills needed to support the Battery of the Nation initiative and more broadly the renewable energy and related sectors (including the emerging hydrogen industry).[33]

Research and innovation

Ongoing research and innovation will be critical to enable the development of a viable cost-effective hydrogen industry that provides economic, social and environmental benefits. Tasmania has established businesses and educational institutions with a proven history of renewable energy and major industry development focussed research and innovation.

The University of Tasmania and the CSIRO are important research partners in the Blue Economy CRC, which is investigating the potential applications of renewable hydrogen in the offshore marine environment as a key research theme. The Tasmanian Government is a supporting partner of the Blue Economy CRC, together with several key Tasmanian companies.

The University of Tasmania is seeking to expand its research capabilities related to low carbon energy futures for Tasmania, with a key focus on Tasmanian renewable hydrogen production and use, through an ARC Industrial Transformation Training Centre funding application. This will build on the UTAS Future Energy group's multi-disciplinary research work that is already underway.

The Tasmanian Government is supporting the University of Tasmania's ARC Industrial Transformation Training Centre funding application through a $100 000 cash and in-kind contribution to support renewable hydrogen research.

Endnotes

1. Hydro Tasmania White Paper: "Tasmania's 'green hydrogen' opportunity. Tasmania's unique advantage as a 'green hydrogen' development zone".
2. Australia's National Hydrogen Strategy, COAG Energy Council page 22. Current global demand for hydrogen is around 70 million tonnes per year. It is used predominantly as an industrial feedstock and is produced largely from fossil fuels.
3. Basic Hydrogen Strategy (Key Points), Ministry of Economy, Trade and Industry at www.meti.go.jp/english/press/2017/pdf/1226_003a.pdf
4. Hydrogen Economy Plan in Korea, 18 January 2019 at www.rvo.nl/sites/default/files/2019/03/Hydrogen-economy-plan-in-Korea.pdf
5. Australia's National Hydrogen Strategy op. cit, page 22.
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9. The capacity firming ability of Tasmania's hydro power means that renewable energy is available when required.
10. Including energy intensive metals smelting and paper manufacturing industries.
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31. Australia's National Hydrogen Strategy op. cit. page 38.
32. Australia's National Hydrogen Strategy op. cit. page 39.
33. Further information on the 'Energising Tasmania' initiative is available at www.federalfinancialrelations.gov.au/content/npa/skills/project-agreement/FPA_Energising_Tasmania.pdf

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Department of State Growth

Salamanca Building, Parliament Square
4 Salamanca Place Hobart TAS 7000

Phone: 1800 030 688
Email: info@stategrowth.tas.gov.au
Web: www.stategrowth.tas.gov.au