Australian Government
Department of Climate Change, Energy, the Environment and Water

# National Hydrogen Strategy 2024

## Summary

# Acknowledgement of Country

**Our department recognises the First Peoples of this nation and their ongoing connection to culture and country. We acknowledge Aboriginal and Torres Strait Islander Peoples as the Traditional Owners, Custodians and Lore Keepers of the world's oldest living culture and pay respects to their Elders past, and present.**

# Minister’s foreword

## I am pleased to present Australia’s 2024 National Hydrogen Strategy.

Hydrogen is central to the Australian Government’s vision for a Future Made in Australia.

It is a vital part of the generational economic opportunity presented to Australia to ensure our future prosperity through the net zero transformation.

Australia’s renewable energy resources are the envy of the world, and this transformation is underpinned by clean, cheap renewable power. Along with our mature innovation ecosystem, our experience making large export industries, and our record as a stable and trusted trading partner, we have the elements to be a global hydrogen leader.

This revitalised National Hydrogen Strategy is another step towards unlocking Australian hydrogen’s world-class potential. The enthusiasm of investors, businesses, communities and workers for hydrogen in Australia gives increasing confidence that we have what is needed to establish a world leading hydrogen industry with bright opportunities ahead. We can decarbonise new and existing manufacturing industries, like green metals and chemicals. We can set up new, large-scale clean exports. And we can bring safe, secure and well-paid jobs to Australians, especially in our regional powerhouses. They have the people and the skills to make sure the places that have powered Australia’s prosperity for generations continue to do so through the net zero transformation.

Investors value clarity and a clear plan. That’s why, in 2022, we legislated Australia’s greenhouse gas emission reduction targets for both the medium and long term. This strategy, which identifies targets and stretch potential for producing and exporting Australian hydrogen, strengthens that clarity. And with the substantial policy and Budget measures delivered by the Australian Government, we have a resounding message to the world: Australia is ready to be a global hydrogen leader.

New policies including the Hydrogen Production Tax Incentive and an expanded Hydrogen Headstart program unequivocally position Australia as one of the best places in the world to make green hydrogen. The challenge is now over to our emerging hydrogen industry to seize the moment.

I thank industry, investors, unions, universities, and others for their extensive input and support in developing Australia’s 2024 National Hydrogen Strategy. We invite companies, investors, workers, all levels of government and our communities across the country to take up the challenge and be part of this important opportunity.

**The Hon Chris Bowen MP**
Minister for Climate Change and Energy

# What is hydrogen?

## Hydrogen is the most abundant element in the universe

On Earth it is mostly bound to other elements in molecules such as water. When two hydrogen atoms bind to each other it is referred to as hydrogen gas or molecular hydrogen

Hydrogen is colourless, tasteless, odourless, non-toxic, and highly combustible

Electrolysers, which use electricity to split water into hydrogen and oxygen, are a critical technology for producing low-emission hydrogen

Approximately 58 kg of hydrogen is required to produce 1 tonne of Direct Reduced Iron

100,000 tonnes of hydrogen per year could fuel two green iron production plants

On a mass basis 1 kg of hydrogen contains as much energy as 2.4 kg of natural gas, however when transported as a gas in a pipeline, hydrogen is about 8.5 times less dense than natural gas

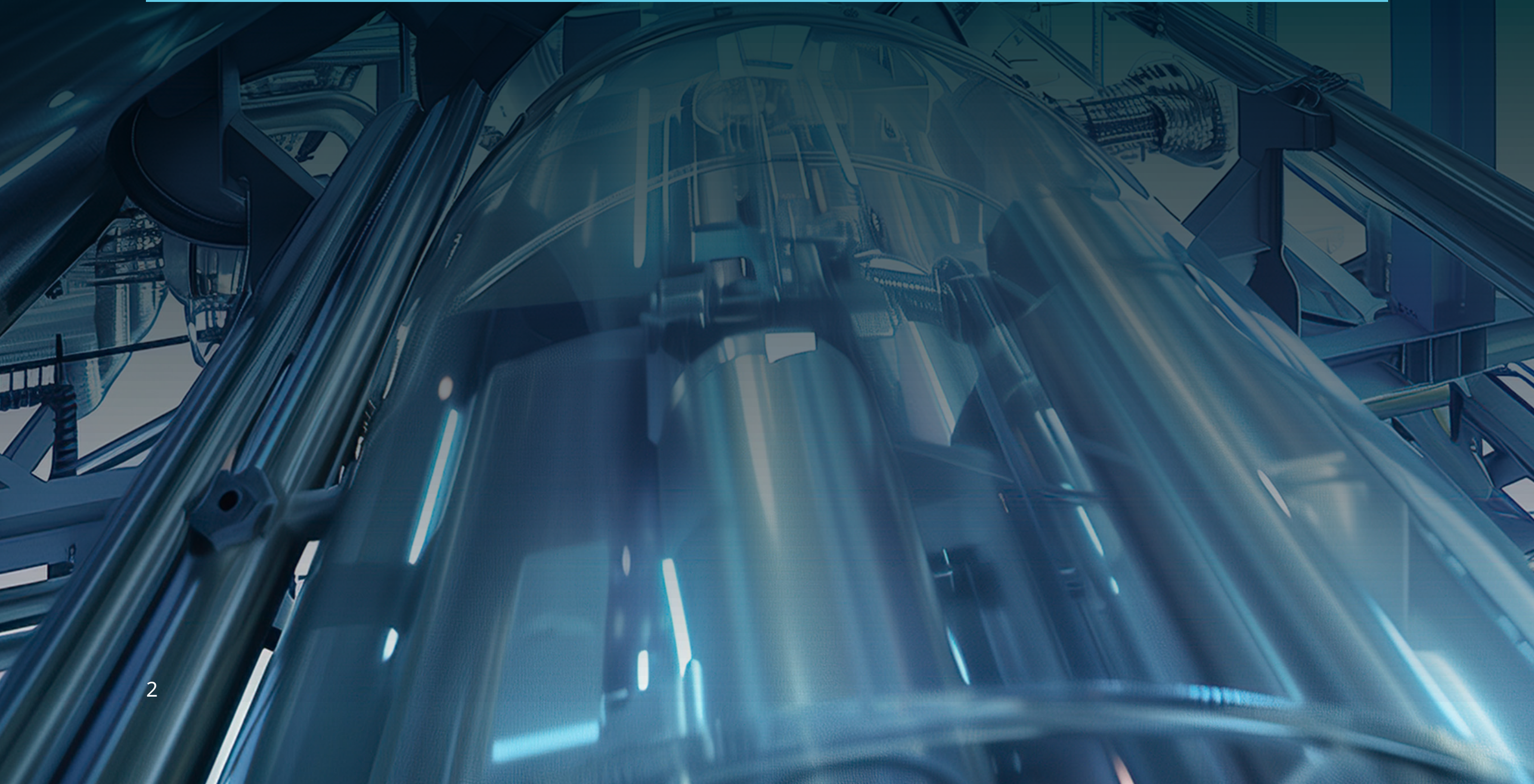
Using hydrogen instead of combusting natural gas avoids the equivalent of 6.2 tonnes of carbon dioxide emissions for every tonne of hydrogen

1 tonne of hydrogen can be used to make around 5.6 tonnes of ammonia, 10 tonnes of urea or 28 tonnes of diammonium phosphate (DAP) fertiliser

Hydrogen's energy can be released as heat through combustion or electricity using hydrogen fuel cell technology where the only by-product is water

1 kg of hydrogen contains as much energy as 3.2 kg of petrol

A hydrogen fuel cell car has travelled 1360 km on road using a single fuel tank containing 5.65 kg of hydrogen



# Strategy on a Page

**Vision – A clean, innovative, safe and competitive hydrogen industry that benefits Australia's communities and economy, enables our net zero transition, and positions us as a global hydrogen leader**

## Objectives

### Supply

**Australia's hydrogen industry is globally cost-competitive**

- 2050 production target and milestones
- Hydrogen Production Tax Incentive
- Hydrogen Headstart
- Future Made in Australia Innovation Fund
- Hydrogen Hubs
- ARENA support
- Concessional finance
- Strengthened approval processes
- Infrastructure planning
- Workforce, skills and training

### Demand and decarbonisation

**Identify and support the most prospective hydrogen demand sectors**

- Green metals (iron & alumina)
- Ammonia
- Long haul transport (heavy road, aviation, shipping)
- Power generation & grid support
- Safeguard Mechanism

### Community benefit

**Communities are aware of and realise the benefits of hydrogen**

- First Nations benefits sharing
- Regional jobs & business opportunities (NZEA)
- Australian Energy Infrastructure Commissioner
- Voluntary Industry Code of Conduct
- Planning for sustainable water use

### Trade, investment and partnerships

**Establish trade at scale and leverage purposeful partnerships**

- 2030 export target
- Investment attraction
- Guarantee of Origin expansion
- Secure supply chains
- International partnerships & co-investment

### States and territories

**Collaboration across governments to capture the hydrogen opportunity**

- Regulatory approval improvements
- Safety – best practice regulation
- Complementary funding and planning
- Hubs & precincts
- Workforce development

### Underpinned by

**Regular policy review and broader integration**

- Lower cost renewables
  - Capacity Investment Scheme
  - Research, development and innovation
- Annual reporting and 5-yearly reviews
- Sectoral decarbonisation plans
- Carbon leakage review

# Executive summary

## The 2024 National Hydrogen Strategy provides the framework for Australia to become a global hydrogen leader.

Hydrogen is a critical element of the global energy transition. This transition is well underway. The International Energy Agency (IEA) is both authoritative and clear. The high share of global energy held by fossil fuels is expected to decrease by 2030, for the first time in decades. Under commitments already made, the IEA finds that demand for coal, oil and gas falls by 74%, 43% and 42% in volume, respectively, by 2050. As countries increase their efforts to meet net zero, these falls will be even larger.

Australia's renewable energy advantages mean the nation is well-placed for export and manufacturing opportunities in the energy transformation. For example, the global hydrogen market is forecast to reach US$1.4 trillion in 2050. This includes around US$280 billion of interregional trade. Australia must capture the significant economic opportunities that are becoming available.

Australian hydrogen can be exported as an energy carrier to countries less able to generate renewable electricity. It can also be exported through low-emissions products that have been manufactured locally using hydrogen as a chemical or heat input to the production of green metals, ammonia and low-carbon liquid fuels.

Focusing on large-scale export and manufacturing industries will help bring down the cost of producing renewable hydrogen in Australia. It will also support our national emissions reduction goals. Hydrogen will play a role in decarbonising existing hard-to-abate sectors such as long-haul transport and aviation. It could also potentially support power generation. Under the production targets in this strategy, Australian hydrogen could avoid emissions of between 93 and 186 million tonnes of $CO_2$ per year by 2050.

Australia already has a globally significant project pipeline of more than 100 projects announced since 2019. The IEA reports that 20% of all announced projects globally are in Australia. This pipeline is larger than for any other single country. It represents approximately half of all export oriented projects announced globally. The pipeline is growing yearly. It is currently valued at $225 billion or more. The pipeline is overwhelmingly focused on renewable hydrogen production as Australia's extensive wind and solar resources provide the foundation for producing low-cost renewable hydrogen (refer Figure ES-1).

However, most projects remain at the feasibilty or engineering stage. Many other countries also have excellent renewable resources. The 2024 National Hydrogen Strategy is tailored to the development of an Australian industry. It accepts that Australia will need to actively compete with other nations to be considered a global hydrogen leader.

## Vision

**A clean, innovative, safe and competitive hydrogen industry that benefits Australia's communities and economy, enables our net zero transition, and positions us as a global hydrogen leader**

### Objectives

**Supply**

**Australia's hydrogen industry is globally cost-competitive**
(Chapter 2)

**Demand**

**Identify and support the most prospective hydrogen demand sectors**
(Chapter 3)

**Community benefit**

**Communities are aware of and realise the benefits of hydrogen**
(Chapter 4)

**Trade, investment and partnerships**

**Establish trade at scale and leverage purposeful partnerships**
(Chapter 5)

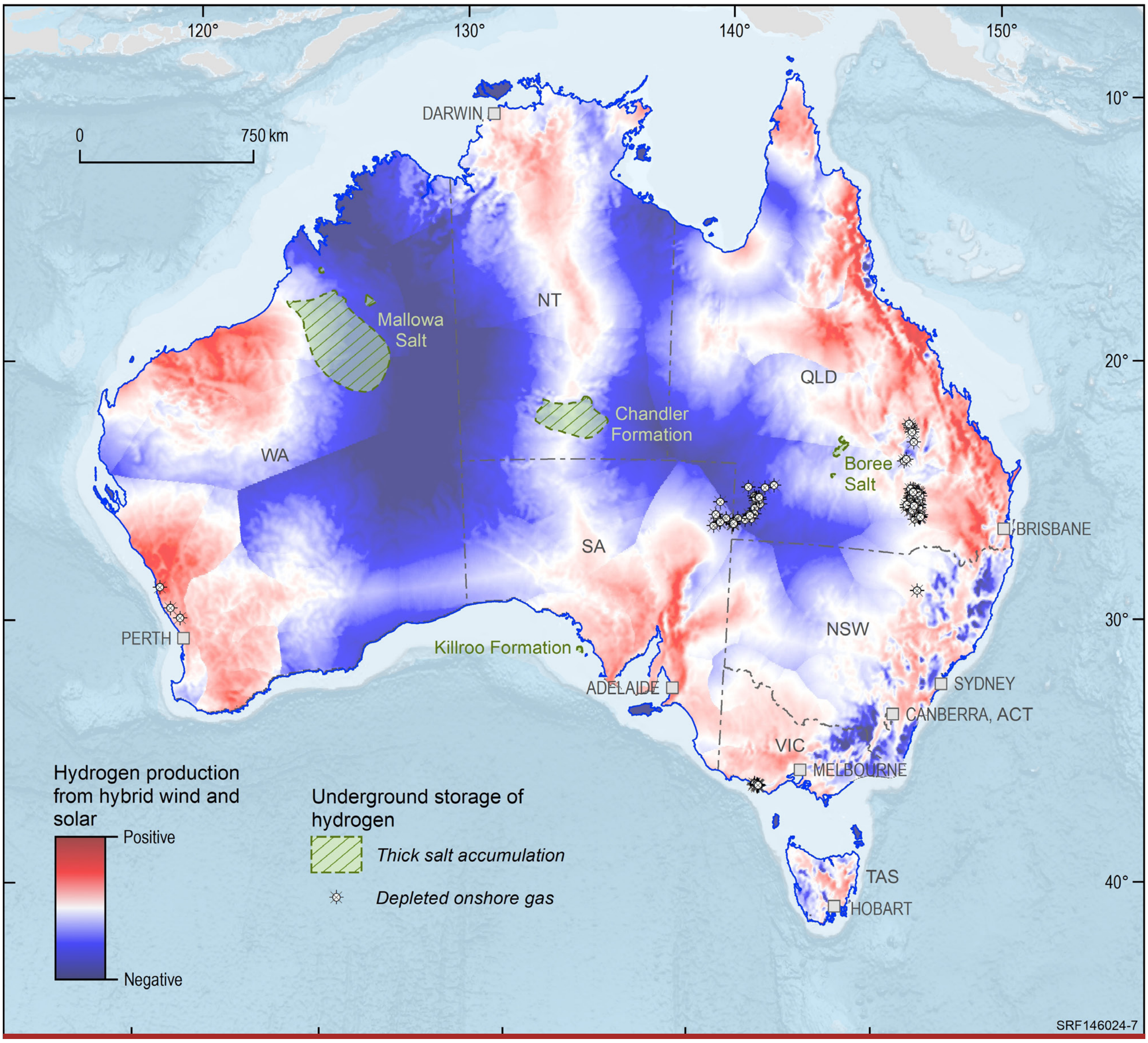



**Figure ES.1: Australia's hydrogen production potential**

Source: Geoscience Australia.

Renewable hydrogen is a priority industry in the government's $22.7 billion Future Made in Australia plan, through which it is the focus of targeted investment and other assistance. This long-term commitment, combined with the actions, targets, milestones and the monitoring and review framework detailed in this strategy, provides the necessary platform to take the next step to develop a successful Australian hydrogen industry.

The 2024 Strategy vision is for a clean, innovative, safe and competitive hydrogen industry that benefits Australia's communities and economy, enables our net zero transition, and positions us as a global hydrogen leader. The strategy identifies 4 objectives. The strategy's objectives are supported by specific actions, targets, collaboration across governments and associated enablers that will underpin their delivery.

# Objective 1:
# Supply - Australia's hydrogen industry is globally cost-competitive

**Success against this objective will see Australia produce sufficient volumes of hydrogen at a price that will attract demand from domestic and international buyers.**

At this early stage, the cost of renewable hydrogen production is high. The industry is nascent and public investment for early movers will generate learnings to reduce the production cost over time.

The Australian Government will implement significant production support through the Hydrogen Production Tax Incentive and Hydrogen Headstart programs. These will help drive deployment, build experience in the hydrogen and finance sectors with large-scale projects, and help bridge the commercial gap. These are key strategic investments that will deliver on this objective and ensure Australian hydrogen projects are globally cost-competitive.

The strategy also sets a long-term hydrogen target out to 2050, consistent with Australia's net zero emissions target, supported by 5-yearly milestones. These structures will help guide infrastructure planning and provide a long-term signal to investors about the role hydrogen will play in the Australian economy.

Renewable energy is the biggest component of the hydrogen cost stack, so reducing the cost of renewables is essential to building viable Australian hydrogen businesses. Multiple initiatives are now in place to drive cost reductions, including support for innovation to bring through the next generation of technologies, and for renewable energy deployment to deliver economies of scale.

Other actions targeted at hubs and infrastructure, workforce, supply chains and innovation will also reduce project costs and enable the industry to grow.

### 2050 production target and milestones

Setting 5-yearly production milestones out to 2050 will provide the trajectory we will need to realise our goal to be a global hydrogen leader, with hydrogen providing both a critical component to our domestic decarbonisation strategy, and enabling new economic opportunities to emerge.

Australia will target producing at least 15 million tonnes of hydrogen annually, with a stretch potential of 30 million tonnes annually, by 2050.

## Hydrogen Production Tax Incentive

The $2 per kilogram Hydrogen Production Tax Incentive will provide time-limited, demand-driven production support to eligible producers of renewable hydrogen through Australia's tax system, forming the basis of government support to the sector to 2040.

## Hydrogen Headstart

The Hydrogen Headstart program represents an early strategy action to address the current financial gap between the production cost and sale price of renewable hydrogen. It is focussed on industry early-movers with well developed projects.

## Future Made in Australia Innovation Fund

Renewable hydrogen is a National Interest Priority industry under a Future Made in Australia. The Future Made in Australia Innovation Fund will fund deployment of innovative technologies and facilities linked directly to priority industries.

## Hydrogen Hubs

The Australian Government's existing investment in hydrogen hubs in regional Australia remains an important building block to a large scale hydrogen industry, with expanding linkages to our future clean energy export industries.

## ARENA support

The Australian Renewable Energy Agency (ARENA) will continue to play an important role in funding clean energy technology research, development and deployment (RD&D). ARENA will support improvements in hydrogen technologies and projects and renewable energy generation.

## Concessional finance

Concessional finance through government special investment vehicles, including the Clean Energy Finance Corporation and the National Reconstruction Fund, will continue to play an important role in enabling large scale projects to proceed, prove new commercial models and provide confidence to capital markets.

## Strengthened approval processes

Streamlined and prioritised approvals processes at all levels of government are essential to the development of the clean hydrogen industry and the broader transformation of our economy to meet our 2050 decarbonisation goal.

## Infrastructure planning

Working with states and territories to analyse specific infrastructure needs for the hydrogen industry, as well as regular broad-based assessment at a national level to inform infrastructure prioritisation.

## Workforce, skills and training

Assuring the availability and safety of a suitably trained workforce will be central to the growth of the hydrogen industry.

# Objective 2:
# Demand and decarbonisation – Identify and support the most prospective hydrogen demand sectors

**Hydrogen has many potential applications, but the strategy focuses on the use-cases that are currently most prospective. These demand sectors are more likely to support the hydrogen sector to scale up, contribute to domestic decarbonisation, and contribute to our economy through large-scale export.**

These use-cases align with priority industries in the Future Made in Australia agenda and will create new jobs and opportunities for our country.

## Green metals (iron & alumina)

Global demand for green iron and steel is forecast to grow significantly by 2050. Hydrogen can provide a clean source of industrial process heat to the refining of our mineral resources and enable the export of hydrogen embodied green metals, such as iron and alumina.

## Ammonia

Clean hydrogen is the only viable pathway to decarbonising current ammonia production, which is essential to manufacture fertilisers and explosives. Ammonia also represents a viable means to transport hydrogen to other countries and will play a role as a fuel in a decarbonising maritime industry.

## Long haul transport (heavy road, aviation shipping)

There are good prospects for hydrogen to play a role either directly or indirectly through the production of low-carbon liquid fuels in the decarbonisation of the long-haul road, aviation and shipping sectors.

## Power generation & grid support

Internationally, Australian hydrogen can support other countries to reduce emissions from their power sectors and achieve energy security goals. Domestically, the ability to produce hydrogen with excess renewable generation and store this energy for use in peak demand also presents an opportunity for hydrogen to support the increased use of renewables in our electricity grids.

## Safeguard Mechanism

The Safeguard Mechanism provides a strong incentive for large industrial companies to decarbonise their operations, including by adopting hydrogen technology.

# Objective 3:
# Community benefit - Communities are aware of and realise the benefits of hydrogen

**A hydrogen industry will provide jobs and economic benefits to Australia. It can help diversify regional economies affected by the global energy transition.**

Governments can play a role in developing workforces and ensuring they are sufficiently mobile to address shifting demand across the country. Best practice engagement and responsible conduct by the businesses will ensure that projects gain the social licence required. Governments are also responsible for delivering appropriate infrastructure planning and regulatory frameworks for safety and environmental protection.

The clean energy transition provides an opportunity to reset the historic approach large projects have taken to engage with First Nations people. In addition to direct funding of First Nations communities to improve negotiations, governments can hard-wire the importance of best practice engagement into their funding programs. In this way, governments can encourage industry to partner directly with First Nations communities to develop the industry.

## First Nations benefits sharing

The expansion of the First Nations Renewable Hydrogen Engagement Fund pilot will enable First Nations communities that live near projects supported by the Hydrogen Headstart program to access the due diligence and advisory services needed to support their engagement with hydrogen project developers.

NZEA

## Regional jobs & business opportunities

The Australian Government is establishing a national Net Zero Economy Authority to ensure the workers, industries and communities that have powered Australia for generations can seize the opportunities of Australia's net zero transformation.

## Australian Energy Infrastructure Commissioner

The independent Australian Energy Infrastructure Commissioner will promote best practices for industry and government to adopt in regard to the planning and operation of projects.

## Voluntary Industry Code of Conduct

Best practice engagement with communities that are near new energy projects can underpin mutually beneficial outcomes. Setting clear expectations of all parties including through a hydrogen industry code of conduct provides an important foundation for these enduring relationships.

## Planning for sustainable water use

Water is an essential resource for many communities, particularly in regional Australia. Australian governments will consider principles and actions that will help plan for and manage demands for water, including from hydrogen, in a new National Water Initiative.

# Objective 4:
# Trade, Investment and Partnerships - Establish trade at scale and leverage purposeful partnerships

**Capturing a share of developing international hydrogen markets represents a significant economic opportunity for Australia.**

We are well-placed for this opportunity. However, our renewable resources alone will not be enough with other countries also possessing solar and wind resources moving to compete for global hydrogen opportunities. The key to realising significant economic benefit from our hydrogen industry will be establishing large-scale and enduring trade relationships. In parallel, strategic international engagement will help ensure Australia remains competitive in the next phase of global market development.

## 2030 export target

A base export target of 0.2 million tonnes of renewable hydrogen per year with a stretch potential of 1.2 million tonnes per year.

Setting an early export target provides a strong signal of Australia's intention to continue supplying energy to the global market. This matches the ambition of some of our existing trade partners who already have 2030 hydrogen targets.

## Investment attraction

As a large country with a small population, we will continue to welcome international investment in order to develop new industries like hydrogen. Austrade and NZEA will play active roles in attracting this investment.

## Guarantee of Origin expansion

The Guarantee of Origin (GO) is an internationally aligned scheme to measure and verify the emissions intensity of the hydrogen we produce.

The scheme will be both scalable and expandable, enabling similar verification of products produced from hydrogen including green metals and low carbon liquid fuels.

## Secure supply chains

We will build on our international clean energy bilateral partnerships and multilateral engagement to secure supply chains for our hydrogen industry.

## International partnerships & co-investment

Major international energy companies and investment houses are already participating in Australian hydrogen project development.

International partnerships fulfil a range of functions including knowledge sharing, RD&D collaboration, supply chain development and are the precursor to trade arrangements.

# States and territories
# Collaboration across governments to capture the hydrogen opportunity

**The 2024 National Hydrogen Strategy reflects the deep commitment to developing the Australian hydrogen industry at all levels of government.**

Each of Australia's states and territories has ambitious hydrogen initiatives or strategies that leverage local advantages. All are also actively participating in projects coordinated nationally. This includes, for example, providing a nationally consistent regulatory environment for hydrogen projects.

Delivering the National Hydrogen Strategy relies on complementary and consistent actions from the states and territories. They will play an important role in planning and developing new infrastructure, such as for water; while noting the emerging challenges of a changing climate, population growth and increasing water demand. In many cases, jurisdictional governments are also responsible for planning approvals and regulating large projects. All levels of government will need to ensure efficiency in assessing projects to ensure the growth of the hydrogen industry and broader energy transition. State and territory governments have a particularly important role in ensuring the progress of projects as they typically have a more direct relationship with individual communities.

Developing large-scale industrial projects will place considerable demands on Australian workforces. Ensuring the relevant workforces are available and mobile will enhance the efficiency with which they can be deployed.

## Regulatory approval improvements

Streamlined state and territory regulatory and planning approval frameworks will provide certainty to business and confidence to communities, as well as complement *Environmental Protection and Biodiversity Conservation Act* (EPBC Act) process reforms.

## Safety – best practice regulation

Nationally consistent best practice regulation for safety facilitates both project design and financing decisions by investors. All jurisdictions are developing a consistent national approach through the production of National Codes of Best Practice.

## Complementary funding and planning

The states and territories will deliver locally-focused hydrogen industry development funding measures that complement the support provided by the Australian Government. The states and territories will also incorporate growing hydrogen industry needs into their policy planning, for example infrastructure planning.

## Hubs & precincts

States and territories have the regulatory and legislative structures in place to establish hubs, zones or precincts that provide an advantageous operating environment for new and existing industries to thrive.

## Workforce development

Governments will continue to work together to deliver the training necessary to build the hydrogen workforce. At the same time, it will be important for states and territories to enable the mutual recognition of skills, licences, and registrations across jurisdictional boundaries to enable workers to relocate to new centres of activity as they emerge.

# Underpinned by Regular policy review and broader integration

**The Australian Government's long-term hydrogen vision is set in the context of a much larger national energy transformation. The complexity of the transition will require concerted effort, monitoring and adjustment over many years.**

Central to this monitoring and adjustment will be the continued publication of an annual State of Hydrogen report. This report is centred on an assessment of progress. This assessment will extend to include reporting against the strategy's targets, and milestones as well as other metrics of interest to a broader range of stakeholder issues, such as water. A more in-depth review will be undertaken at 5-yearly intervals, ahead of Australia's Nationally Determined Contribution under Article 4 of the Paris Agreement being updated.

## Capacity Investment Scheme

Support for renewable energy deployment, such as the Capacity Investment Scheme, will help drive down the cost of renewable energy which will in turn drive down the cost of producing hydrogen.

## Research, development and innovation

Investments in RD&D through ARENA, CSIRO, Australia's universities and other bodies will support technology advances and breakthroughs in hydrogen and renewable energy, which will help bring through the next generation of technologies, including ultra low-cost solar.

## Annual reporting and 5-yearly reviews

The Australian Government will expand the monitoring, benchmarking and public reporting of industry development through the annual State of Hydrogen report.

A regular planned strategy review every 5 years will provide a significant opportunity to work with states, territories and the industry to review progress and refresh our national strategy.

## Sectoral decarbonisation plans

The 2024 National Hydrogen Strategy has been developed with a view to Australia achieving net zero emissions by 2050. However, specific plans to achieve that target are being separately developed and will incorporate analysis and actions that have contributed to this strategy.

## Carbon leakage review

The current price premium associated with using hydrogen provides some incentive for the import of products with a lower cost but higher emissions intensity.

The Australian Government is reviewing additional policy options to address carbon leakage.

## Taking the next step

Our collective actions since Australia's inaugural 2019 Strategy have focused on the early foundations for industry growth. But to date we have lacked the incentives needed to drive economies of scale and build industry experience. The 2024 National Hydrogen Strategy builds on this early work and leans into the adaptive approach it established to refocus on accelerating growth through supporting development at scale. The strategy sets a growth trajectory through production targets and milestones and identifies the most prospective hydrogen use cases that will be the focus for ongoing policy support.

Hydrogen production incentives represent the centrepiece of Australia's revitalised strategy. These will help bridge the commercial gap and enable the sector to achieve scale by supporting early movers and building familiarity within the hydrogen and finance sectors with large scale projects.

The production incentives will also ensure Australian projects remain competitive in a rapidly evolving international policy environment and fill a significant gap in Australia's policy mix. They will help the current pipeline of projects achieve final investment decision and unlock the next wave of investment.

Technologies, markets and the international policy landscape have evolved rapidly in the past 5 years. Australia has many advantages that could be put to work towards becoming a global hydrogen leader, but until now has not had the policy support needed to unlock the hydrogen opportunity and be competitive globally. The Australian Government has responded through this revitalised strategy and the unprecedented support announced through the 2024-25 Budget. The challenge now is for all elements of our emerging hydrogen industry to seize the moment.

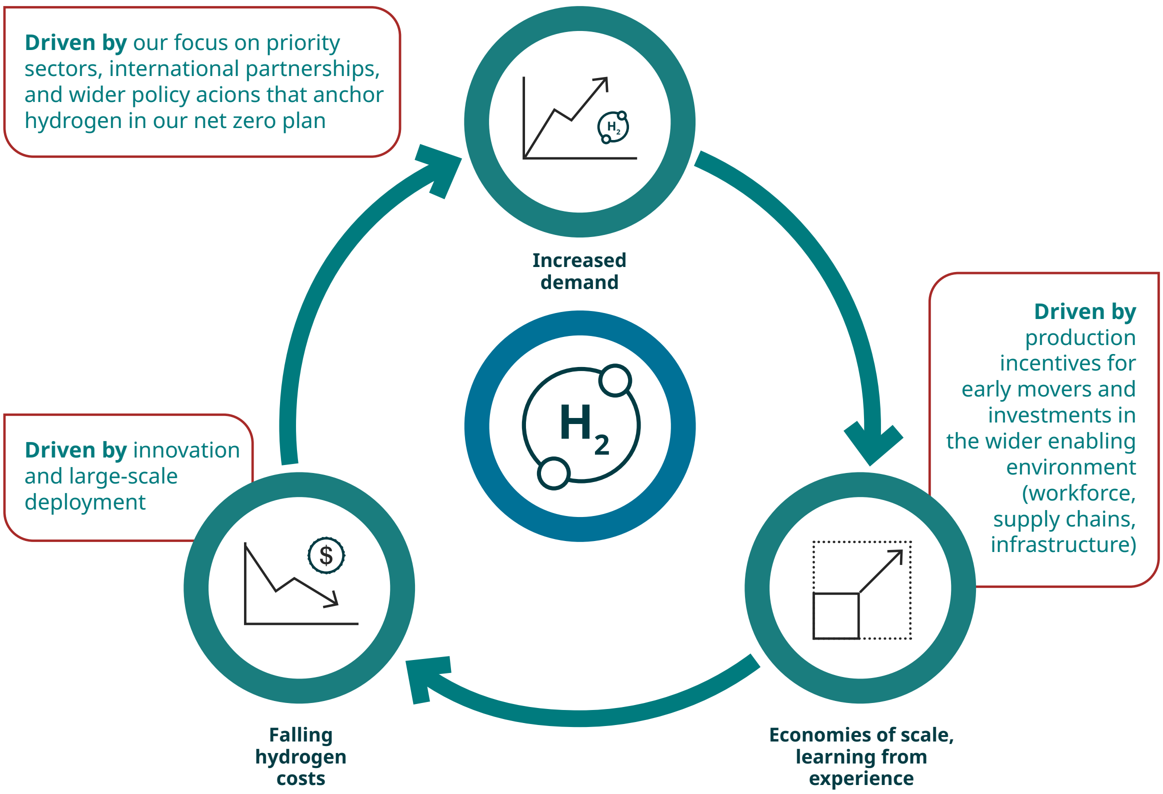



**Figure ES.2** **Policy to drive industry development.**

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