Submission No 15

INQUIRY INTO DEVELOPMENT OF A HYDROGEN INDUSTRY IN NEW SOUTH WALES

Organisation: University of Newcastle

Date Received: 26 February 2021

PROFESSOR ALEX ZELINSKY
VICE-CHANCELLOR AND PRESIDENT

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

26 February 2021

The Hon. Sam Farraway MLC
Chair, Standing Committee on State Development
(submitted online)

Dear Mr Farraway,

RE: INQUIRY INTO THE DEVELOPMENT OF A HYDROGEN INDUSTRY IN NSW

The University of Newcastle is pleased to provide this submission on the potential for a hydrogen industry in New South Wales.

NSW, and regional NSW in particular, stands to gain significant economic, environmental and social benefits from the hydrogen economy if it can harness its production and export potential, to be ready to participate in the global market.

The University is preparing for the hydrogen opportunity by enabling the conditions for growth. Our institution is working with a variety of stakeholders to begin the attraction of new industries and investment, and lead hydrogen research development and demonstration.

Communities and businesses of the Hunter and Central Coast are optimistic about the leadership role the region can play in our nation's hydrogen future. Collaboration and coordination is underway to position the region to meet the hydrogen opportunity. The establishment of a Hunter Hydrogen Taskforce and NERA's awarding of the only Hydrogen Industry Technology Cluster in the Hunter are important steps towards the development of a hydrogen industry for NSW.

Our submission draws on insights gleaned through working with international, national and regional partners, who share our interest in advancing the hydrogen economy. We welcome further engagement with the Committee on this important issue for our State and the future prosperity of communities in regional NSW.

Best wishes,

Professor Alex Zelinsky AO
Vice-Chancellor and President

KEY MESSAGES

Nations are striving toward low and zero emission economies, fuelling the hydrogen opportunity. NSW, and regional NSW in particular, stands to gain significant economic, environmental and social benefits if it can leverage its industrial and natural advantages, build its capabilities, and secure its position within the global clean hydrogen market.

The scale of the hydrogen opportunity is recognised, however the pathway to developing the industry faces challenges. There are substantial barriers to resolve in terms of current costs, transitioning to clean production, regulatory constraints, safety concerns and social licence.

Achieving greater efficiency in the production, storage and transport of renewable hydrogen a key issue. Markets will need to reach a tipping point before we see the uptake of technologies.

The ongoing role of research and development, and further opportunities to demonstrate technologies at pilot scale is important if we are to transition from emerging technologies to market activation. Innovation in industry, particularly manufacturing, will be central to decreasing the cost of producing and utilising hydrogen.

To realise this opportunity, NSW will require industry, governments and research institutions to work together to ensure our regions and communities are primed for investment. Projects that support capacity building and capitalise on regional and international connectivity will be critical for investor attraction.

The NSW Government can position regions across the state for success by investing and publicly supporting enabling activities that demonstrate technologies and encourage the growth of supply chains, build social license, and overcome safety and regulatory barriers.

The Hunter (inclusive of Lake Macquarie) and the Central Coast region is well-placed to capitalise on this looming opportunity and play a leading role in providing confidence to Government. The region is an energy powerhouse for NSW and Australia. The energy and resources sectors employ more than 16,000 people, or 47,600 people indirectly. The region also produces 63% of NSW's electricity.

Australia's economic and energy transition depends on the Hunter and Central Coast. As an energy and resources giant, the region will need to diversify its industrial base to sustain its prosperity- a hydrogen industry is an ideal opportunity.

The Hunter and Central Coast are primed for the hydrogen economy, boasting:

- A unique mix of advanced manufacturing industries and large-scale energy users,
- Energy generation networks and infrastructure,
- A highly skilled workforce,
- Port and export facilities,
  Regional coordination and leadership on hydrogen through the Hunter Hydrogen Taskforce and the Hunter Hydrogen Technology Cluster, and
- World-class research institutions at CSIRO and the University of Newcastle.

The Hunter and Central Coast provide an investment-ready platform, with the existing assets, infrastructure, capabilities needed for a hydrogen industry.

RESPONSE TO THE TERMS OF REFERENCE

1. The size of the economic and employment opportunity created by the development of a hydrogen industry in NSW, in particular those opportunities for regional NSW, including having regard to:

- **a) the emerging domestic and international trends in the production and demand for hydrogen, including in South Korea, the Netherlands, Japan and other Australian states and territories; and**
- **b) NSW's existing and potential linkages to those markets.**

Scale of opportunity

The International Renewable Energy Agency (IRENA) forecasts that around 8% of final energy consumption globally could be attributed to renewable hydrogen by 2050.

In a medium hydrogen demand scenario, Australia's share of global trade in hydrogen could be worth up to $5.7 billion in 2040, while the total economic contribution to the Australian economy could be up to $473 million in 2025.
Source: Opportunities for Australia from Hydrogen Exports, ACIL Allen, 2018

Emerging International Trends

Climate-related ambition remains the single most important driver for widespread use of clean hydrogen. The speed with which governments will push the transition to low-carbon energy sources in different countries and sectors remains a major uncertainty (International Energy Agency, 2019).

While low-carbon hydrogen can be attractive in the near term in certain applications, its major strength is its ability to help deliver very low emissions pathways and manage very high levels of variable renewable electricity. The challenges related to the uptake of clean, widespread use of hydrogen in global energy market include:

- Producing hydrogen from low-carbon energy is currently costly. An International Energy Agency analysis finds that the cost of producing hydrogen from renewable electricity could fall 30% by 2030 as a result of declining costs of renewables and the scaling up of hydrogen production. Fuel cells, refuelling equipment and electrolysers can all benefit from mass manufacturing.
- The development of hydrogen infrastructure is slow and holding back widespread adoption. Hydrogen prices for consumers are highly dependent on how many refuelling stations there are, how often they are used and how much hydrogen is delivered per day.
- This will require planning and coordination among governments, industry and investors.
- Hydrogen is almost entirely supplied from natural gas and coal today.
- Hydrogen is already at industrial scale around the world, but its production is responsible for annual CO2 emissions equivalent to those of Indonesia and United Kingdom combined.
- There is an opportunity to harness this scale, and transition to low emissions production.
- Regulations currently limit the development of a clean hydrogen industry. Government and industry must work together to ensure regulations are not an unnecessary barrier to investment.
- Trade will benefit from common international standards for the safety of transporting and storing large volumes of hydrogen and for tracing the environmental impacts of different hydrogen supplies.

Source: The Future of Hydrogen, Seizing Today's Opportunities, International Energy Agency, 2019

While there is significant economic advantage to be realised in securing a portion of the global hydrogen market, there are substantial barriers to resolve in terms of current pricing, transitioning to clean production, regulatory constraints, safety concerns and social licence.

The Emerging Global Hydrogen Market: At a Glance

- Current global hydrogen production, which is typically not produced through low emissions methods, is relatively stable at around 55 million tonnes (6,600 PJ) per year.
- Currently, non-energy uses of hydrogen dominate consumption, with production of ammonia accounting for around half of hydrogen demand. Use of hydrogen for energy purposes is estimated to be between 1 and 2 per cent of total consumption.
- Projecting the future global demand for hydrogen in applications where hydrogen is used as an energy source is a challenging task as the use of hydrogen in energy applications is still at a relatively early stage of adoption.
- Increased demand from the industrial sector is more likely to occur after its use for energy has grown. The Hydrogen Council has estimated that the first demonstrations of this use of hydrogen might be deployed in 2030.
- The need for signatories to the 2015 Paris Accord to reduce their greenhouse gas emissions to meet their abatement commitments is the primary driver for a potentially significant increase in the global demand for hydrogen. That requirement is being manifested in different ways, including: ensuring personal mobility needs, as internal combustion engines are phased out, decarbonising natural gas networks, using hydrogen to store energy to help ensure the reliability of variable renewable energy supplies and increasing energy security.

Source: Opportunities for Australia from Hydrogen Exports, ACIL Allen, August 2018

Several potential importers of hydrogen were examined by ACIL Allen. Four countries (China, Japan, Republic of Korea, and Singapore) were highlighted as prospective importing countries for Australian hydrogen by 2025.

Other markets with potential demand for hydrogen were Taiwan, Thailand, India, the State of California and the European Union. This selection was based a combination of factors such as: size of market; scope for the country to meet its hydrogen demand from its own production; existing policies and existing energy trade relationships with Australia.

Other countries (e.g. Norway, Iceland, the USA, various Middle East or North African countries and Brunei) were seen as likely to compete with Australia to supply hydrogen for export.

In a Report developed by *Future Fuels CRC*, the key findings from a review of 19 international hydrogen strategies and roadmaps were:

- There is considerable international interest in rapidly deploying hydrogen technologies over the next several decades in order to reduce carbon emissions, which could give rise to export opportunities for countries with a comparative advantage in producing hydrogen.
- There is considerable uncertainty regarding how quickly hydrogen and competing technologies will develop in terms of their effectiveness and cost-efficiency. Such uncertainty needs to be taken into account in formulating a strategy, either by taking a technological neutral or flexible approach, or not overcommitting down particular pathways.
- Hydrogen strategies should leverage areas of comparative advantage in production and use.
- Hydrogen strategies should also reflect the broader international environment, for example by drawing on hydrogen strategies in other countries.

- The logistics of the transition to hydrogen should be a core focus of the strategy.
- The scale of activities should reflect the scale of the transition being targeted.
- Access to low cost, low emissions electricity is likely to be critical to the potential for a hydrogen export trade into the medium term, and for the potential of hydrogen to make a meaningful contribution to domestic GHG reductions. Availability of suitable geological features for CCS is also likely to be an important cost driver.
- International collaboration on standards for technology is potentially important not just for those countries that have comparative advantages in the development of the technology but also for potential users of the technologies developed.
- International collaboration is also likely to be necessary on ways to measure and certify the GHG intensity of hydrogen supplies for end users.

Advancing Hydrogen: Learning from 19 plans to advance hydrogen from across the globe, Future Fuels CRC, 2019.

Emerging Domestic Trends

State governments within Australia are developing blueprints for the development of the hydrogen industry to encourage investment and to enable industry to scale in a coordinated manner.

In understanding the economic opportunities associated with hydrogen, market activation related to the creation of a 'market pull' around industries that support the utilisation of hydrogen (heat, electricity, industrial feedstocks and transport) may provide shorter term opportunities to spawn a hydrogen industry.

Through the National Hydrogen Strategy (released in Nov 2019) the Australian Government lists four major national actions.

- Hydrogen Mission. CSIRO is developing a hydrogen mission that will bring together industry, government and other research organisations to deliver research, development and demonstration projects.
- Hydrogen Industry Cluster. National Energy Resources Australia (NERA) has funded 13 regional Clusters to support SMEs to take advantage of opportunities in the hydrogen industry feeding into a national network. The focus of the Hydrogen Industry Clusters is to build capabilities and drive industry collaboration and technological development across the hydrogen value chain.
- International collaboration on safety. The Australian Government is a member of the U.S. Centre for Hydrogen Safety. This gives all Australian governments access to some of the world's foremost expertise in hydrogen safety.
- National Hydrogen Infrastructure Assessments. The Australian Government will lead a National Hydrogen Infrastructure Assessment that will guide government and private sector investment as the industry grows.

An adaptive approach is being taken to capitalise on growth in domestic and global hydrogen demand through demonstration activities and by further building supply and demand through pilot, trials and demonstration projects. The focus is to:

1. Use hydrogen hubs as a springboard to scale
2. Enable industry growth through responsive regulation, building markets and attracting investment, international outreach and engagement
3. Build community confidence**.**

A Technical Study conducted by *ARUP 'Australian Hydrogen Hubs Study'* explored the supply chain infrastructure required to produce hydrogen for export and domestic hubs. The term 'hub' refers to a region that has the potential to aggregate demand for hydrogen (ARUP, 2019).

The primary advantages of hydrogen hubs (Table 1), include the ability to link markets to grow new services and provide value (sector coupling), decarbonising existing supply chains, leveraging economies of scale for infrastructure and increased workforce capabilities, and forming centres of industrial and academic excellence (ARUP, 2019).

Table 1: Primary advantages of hydrogen hubs

	Advantage	Description
1	Sector coupling.	Sector coupling refers to intelligent linking of systems and markets to create new services and provide additional value. Versatility to be used in different sectors enables benefits to be shared and prices to be lower.
2	Decarbonising existing supply chains.	Locating hydrogen hubs in already populated industrial areas provides the option to displace fossil fuels with clean hydrogen in a cost-effective way. This will benefit the existing industry but will also induce further investment in these locations.
3	Colocation.	Locating hydrogen generation in proximity to existing LNG, petrochemical and other resource-based industries (ammonia and methanol being key examples) will save costs by utilising the already existing infrastructure and skills – transmission & distribution lines, storage, transport routes and established industry knowledge. * It will also enable economies of scale and scope.
4	Centres of Industrial and Academic Eminence.	The creation of any hub stems the development of technology and encourages investment. Consequently, the creation of hydrogen hubs will attract hydrogen based industrial and academic institutions to the regions (based on the advantages above to be gained) creating "Centres of Eminence".

Source: ARUP Pty Ltd, Australian Hydrogen Hubs Study, 2019.

The ARUP Report identified over 30 potential hydrogen export hub locations established via desktop research and stakeholder engagement. The three sites identified in NSW included Newcastle, Port Botany/Kurnell and Port Kembla. The criteria used to identify suitable hydrogen export hubs included: land availability, energy and transport infrastructure, grid connectivity, industrial and workforce capacity, export potential, and social licence.

---

2. The State's existing hydrogen capabilities including:

- **(a) NSW's research and development capacity for all elements of the hydrogen supply and demand chain, including existing research and development work of the Government, academic and private sector; and**
- **(b) The State's energy and industrial infrastructure which could support the production, storage, distribution, use and export of hydrogen.**

Research and development capacity

New South Wales is home to some of the nation's top research and development organisations, including internationally renowned universities with outstanding expertise in energy technologies. The Hunter and Central Coast regions have a strong research and innovation ecosystem.

The University of Newcastle is a research-intensive university ranked in the top 10 Australian universities. An established research leader in science, engineering, energy, resources, health and medicine, the University is translating research into innovation and is focused on working with industry and community partners to address pressing challenges. The University leads the Integrated Innovation Network (I2N), which links an active community of 4400 Hunter start-ups and entrepreneurs, regional incubators and clean energy networks. The University has campuses in Newcastle, the Central Coast and Sydney.

The CSIRO Energy Centre based in Newcastle hosts CSIRO's solar field and energy research hub. The Centre focuses on pioneering low-emission storage technologies and intelligent energy management tools for industry and households, and provides the knowledge to guide Australia's future energy mix and regional security. CSIRO is well positioned to support the emergence of a NSW hydrogen economy as part of its Hydrogen Industry Mission.

R&D Example 1: Newcastle Institute for Energy and Resources (NIER)
NIER is one of the University of Newcastle's flagship research institutes. NIER research teams work closely with industry to drive innovative outcomes and solutions in areas of national significance. Applied research includes low emission energy technologies of which there are currently 16 large scale hydrogen demonstration projects underway. NIER is a Federal Government initiative representing 21 research centres and groups, 138 engaged University of Newcastle researchers with 148 active industry partners.

R&D Example 2: NSW Energy & Resources Knowledge Hub
The Hub is a collaborative platform that supports innovation that will transform the NSW energy and resources sector. An initiative of the NSW Government, the Hub facilitates engagement between industry, research organisations and government. It also supports NSW business by sharing knowledge giving SMEs the resources needed to overcome challenges, thrive in their local region and be competitive in global markets.

R&D Example 3: Demonstration Projects
Large scale demonstration projects are underway that are attracting external funding and national and international partners. Through a partnership between the University of Newcastle and Southern Green Gas, an ARENA funded power-to-gas demonstration plant near Roma will trial the conversion of green hydrogen into renewable methane which will be injected into existing gas infrastructure and piped to households and industrial users.

R&D Example 4: Collaboration - The Advanced Energy Integration Initiative
The University of Newcastle through NIER led the establishment of a collaborative regional strategic partnership with eight research centres from University of NSW and University of Wollongong under the NUW Alliance. The initiative, known as The Advanced Energy Integration Initiative, aims to provide ways Australia can successfully integrate new energy technologies into the power grid. Eight research centres will deliver a major regional demonstration of energy integration.

Existing State Capabilities

NSW is well positioned to develop a hydrogen innovation ecosystem. The key existing attributes supporting the state-based development of the industry include:

- NSW is already home to an established hydrogen-based industry. The foundations for a significant expansion of an innovative hydrogen sector in NSW are being put in place.
- NSW is home to significant research and innovation capability, including in hydrogen. Over 60 hydrogen- related research and innovation projects are in train in seven of the state's universities, CSIRO and in private industry.
- With 1,171 megawatts currently committed in large scale solar projects in NSW and a significant pipeline of 15 gigawatts of proposed renewable projects, NSW generation capacity in supplying clean power for hydrogen production is substantial.
- NSW is an important energy exporter with significant developed black coal resources and established international-scale ports. Newcastle and Port Kembla are potential export ports for hydrogen. There are also local market opportunities for hydrogen producers in NSW.
- NSW has an established industrial base, extensive transport networks and major metropolitan and regional population centres.
- NSW also has a large and skilled workforce that has proven to be adaptable to changing skill requirements and includes expertise in gas transmission and safety protocols. The 'Smart and Skilled' program can provide subsidised training packages for business to create the new skills in the workforce they need.

Leveraging Special Activation Precincts for a regional hydrogen supply chain will deliver benefits for other industries such as agriculture, manufacturing, mining and waste management in further driving economic and job growth. Improving connectivity between Renewable Energy Zones and Special Activation Precincts and major export centres, including through freight and logistics industries, will create faster, easier access to global markets for regional NSW.

The NSW 2040 Economic Blueprint recognises well-established energy trading relationships with China, Japan, South Korea and Singapore. A focus on building domestic industry capability and capacity, supporting early investment for demonstration projects across the hydrogen value chain of production, transport, storage and use, and targeted investment in research and development capabilities will position the state for success.

The NSW Government has prioritised the following as part of the National Hydrogen Strategy:

- The development of supporting infrastructure and capabilities to underpin the sector. In recognition of NSW's expanding renewable energy and resource sector, and in capitalising on existing industrial sector that already utilises hydrogen, skills and research capacity.
- A coordinated framework for state significant projects utilising mechanisms such as Special Activation Precincts that can align with the development of hydrogen hubs in regional areas.
- Regulatory oversight, business support and R&D to leverage existing programs in the Office of the NSW Chief Scientist and Engineer, the Physical Sciences Fund, and Tech Vouchers.

This position is further reinforced in various NSW Government policy and strategies:

- NSW 2040 Economic Blueprint: Investing in the state's future: recognises hydrogen as an emerging economic opportunity in NSW.
- NSW Electricity Infrastructure Investment Roadmap and Act: identifies hydrogen as a potential contributor to Renewable Energy Zones and a diverse energy mix for NSW.
- Turning Ideas into Jobs – Accelerating Research & Development in NSW Action Plan: which will augment the role of precincts and R&D to create jobs and industries of the future.

3. The capacity of and barriers to NSW becoming a major production, storage and export hub for hydrogen, including NSW's capacity to:

a) **develop and commercialise hydrogen technologies;**
b) **manufacture and export hydrogen production componentry, including electrolysis componentry;**
c) **manufacture and export hydrogen storage and transport infrastructure, including in heavy transport and shipping vessels;**
d) **generate green hydrogen through renewable energy sources;**
e) **use hydrogen for transport;**
f) **use hydrogen in its own industrial processes, such as in steel, aluminium and chemical production;**
g) **use hydrogen for electricity generation, including the feasibility of retrofitting existing and proposed electricity generation assets to use hydrogen; and**
h) **manage the safety and safeguarding of hydrogen utilisation.**

Hydrogen presents a valuable opportunity for regional NSW. The Hunter and Central Coast, in particular is Australia's energy capital. The region produces 63% of NSW's electricity. Our heavy industries comprise some of the largest users of energy in the State, providing essential grid stabilisation functions to the National Energy Market. The region is also home to Australia's internationally recognised energy research institutions including the University of Newcastle and the CSIRO Energy Centre. We are one of the largest producers of coal in the nation and the Port of Newcastle is the largest coal export port in the world. We have extensive energy transmission and network infrastructure. The energy and resources sector directly employs more than 16,000 people and supports another 47,600 jobs indirectly.

Australia's economic and energy transition depends on the Hunter. As an energy and resources giant, the nation's economic diversification from resource-led to the smart economy along with the decarbonisation of the economy, happens right here in the Hunter.

The Hunter and Central Coast has the capacity to be a global leader in this challenge and support other regions around Australia undergoing transformation. We are building from our highly skilled workforce, research capabilities, infrastructure and competitive advantage in energy and manufacturing to pivot into the new energy economy, and a clean, innovative, competitive and safe Australian hydrogen industry. Further detail of regional assets and capacity includes:

Strong manufacturing base and skilled workforce

This includes science, technology and engineering expertise across resources, energy, processing and fabrication, steel, transport, logistics and defence sectors. As the third-largest employer in the Hunter region, manufacturing businesses employ 9.9% of the region's workforce, compared with 8.5% for the rest of NSW.

The Hunter is well positioned to harness manufacturing opportunities related to the use of hydrogen as a feedstock for a number of industrial processes, including but not limited to the manufacture of ammonia, petroleum refining, and methanol production.

We have deep high-tech production capabilities through our advanced manufacturing sector that has demonstrated its ability to rapidly pivot when faced with pressing challenges. We not only have the capabilities to create technology and innovation - we can produce it at scale.

A partnership between the University of Newcastle, the local health district, engineering and manufacturing businesses over a weekend developed a prototype and won a NSW Government contract to build ventilators to be used on the coronavirus frontline here and abroad. The Hunter is a fast mover, with a vibrant start-up culture focused on clean energy, including businesses actively collaborating with this bid.

Our workforce also has **unique expertise and infrastructure to improve energy and fuel security and safety, and unlock further value in energy and gas sectors. Many Hunter and Central Coast-based industrial users and METS companies are already adept at operating with hazardous gas, the unique characteristics of hydrogen and additional safety considerations will extend the existing expertise of companies with a competitive advantage in the management of hazardous gases.**

Infrastructure, land, industry, supply chains and connections with domestic and international markets

The Hunter boasts a deep-water international port connected to Australia's energy trading partners. The Port is seeking to diversify and has plentiful land assets suitable for heavy industry and advanced manufacturing located adjacent to the export hub. The region also taps into existing electricity and gas transmission networks along with freight and logistics infrastructure ready to be utilised for the domestic market in hydrogen. The Hunter and Central Coast has long been a provider of cheap energy which has stimulated a concentration of manufacturing and heavy industry. With suitable land for growth close to international gateways, the region is well positioned to not only become an energy exporter, but a competitive trader in products and services produced from hydrogen. **A strategy that offers opportunity for demonstration at the Port of Newcastle, will support domestic adoption of hydrogen directly with the potential to utilise available land, logistics supply chains, industrial processes and expertise at scale. The Port has a vital role to play in accelerating the domestic growth cycle by supporting innovation, evolution and deployment of new and cutting-edge hydrogen technologies for export potential. The region's suitability as a major Hydrogen Export Hub and the Prime Minister's challenge to provide a solution to the Hunter and Central Coast's energy needs by 2021, creates urgency to take this activity forward now.**

Collaborative ecosystem that connects large energy providers, end users, SMEs and entrepreneurs

The communities and businesses of the Hunter and Central Coast are optimistic about the leadership role the region can play in our nation's future.

A local industry consortium was awarded Hydrogen Cluster funding from NERA to accelerate the transition to the new hydrogen economy, and create the optimum environment for investment, growth and jobs. **The *Hunter Hydrogen Technology Cluster* will build pathways to capitalise on the Hunter and Central Coast's unique assets and to drive economic and business opportunities and the collaborative culture needed to attract and anchor businesses, researchers, investors, entrepreneurs and a future energy workforce.** As the only cluster to receive funding in NSW, this announcement signals the central role the region will play in developing a hydrogen industry.

The *Hunter Hydrogen Taskforce* was established in 2020. The aim of the Taskforce is to collaborate on hydrogen, identifying and mobilising key assets (including skills and expertise) to position the

Hunter competitively in the future hydrogen economy, including in the manufacturing sector. The taskforce is currently developing two key products: a roadmap, and major demonstration project (at concept/modelling phase). The Roadmap will provide a blueprint for the region to attract industries, facilitate research, support key public and private partnerships and address skill development for the future hydrogen economy. **Membership includes representatives from**: CSIRO, Ampcontrol, BOC, Ironbark, Port of Newcastle, Committee for the Hunter, HunterNet, Grattan Institute, University.

Funded by the NSW Government Office of the Chief Scientist and Engineer *the NSW Energy and Resources Knowledge Hub* and its existing links to the SME innovation ecosystem hosted at NIER brings regional partners together supporting SMEs to innovate, commercialise and scale-up with an engaged network of business partners.

The Hunter's *entrepreneurial and start-up culture* is strong with a focus on clean energy. A number of incubators, including Eighteen04, Slingshot, I2N Innovation Network and Dantia, are providing a physical and cultural space to foster collaboration and networking for tech entrepreneurs and scalable product-based enterprises targeting global markets for a new energy economy.

Research capabilities and record of energy industry collaboration and commercialisation

See comments under item 2.

Researchers and innovators are critical to enabling commercialisation. The following areas should be priorities for research, pilots, trials and demonstration projects:

- Switching current industrial hydrogen users to clean hydrogen
- Investigating new opportunities for clean hydrogen such as clean ammonia exports, clean fertiliser exports, industrial heating, iron ore processing and steel making
- Using hydrogen in remote applications, such as in microgrids for mining and remote communities, in farming and marine applications, at remote defence facilities and as fuel for heavy-duty mining vehicles
- Opportunities for backup power supply, such as for mobile phone towers, hospitals and other critical infrastructure
- Blending of hydrogen with natural gas and eventual use of 100% hydrogen in gas networks
- Using hydrogen for transport, including heavy/long-range road transport, rail and shipping
- Optimising hydrogen and electricity system interactions, such as through timing hydrogen production to match variable renewable generation and through use of hydrogen for storage and dispatchable generation
- Testing technologies that reduce the cost of making, moving, storing and using hydrogen
- Using water from sustainable sources like wastewater or seawater for hydrogen production
- Developing cross-sector linkages and deriving value from sector coupling.

Strong government partnerships and close engagement at State and Federal levels

Engagement with NSW Government Departments (DPIE & OCSE) and Industry Growth Centres (NERA, FIAL, Mets Ignited and AMGC) ensures the Hunter is well positioned for the future development of the hydrogen sector.

4. The economics of hydrogen's use in different sectors of the economy, including emerging opportunities to use hydrogen in industrial processes and as a feedstock.

Manufacturing

Manufacturing is the third-largest employer in the Hunter region, employing 9.9 per cent of the region's workforce, compared with 8.5 per cent for the rest of NSW.

The Hunter is well positioned to harness manufacturing opportunities related to the use of hydrogen as a feedstock for a number of industrial processes, including but not limited to, the manufacture of ammonia, petroleum refining, and methanol production.

Green Steel

There is also opportunity to further the development of hydrogen in other industrial processes including other chemicals manufacturing, iron and steel making over the longer term.

As an example, early-stage R&D in ironmaking and the progression to "green steel" is already underway at the University of Newcastle. Steel makers are large emitters globally and responsible for 5% of global greenhouse gas emissions. It is also one of the economic sectors that are the hardest to decarbonise, due to tough global competition, the dependence of the production process on carbon, and the need for new "breakthrough" technologies with high abatement cost and long investment cycles. The Hunter's historical underpinnings and expertise in ironmaking have seen the University of Newcastle host, for the past ten years, BHP's Centre for Ironmaking Research (CIMR). At NIER researchers are focused on next generation technologies using renewable fuels (hydrogen, electricity, biomass) or end-of-pipe capturing of CO2 and now the successful commercialisation of "low-carbon" technologies for steel making. The Centre specialises in defining the link between fundamental iron ore and metallurgical coal properties and their performance in the ironmaking process. The team is currently working on an application to the Australian Research Council to establish a major transformational research hub in green steel making. The application will allow for greater focused collaboration with Japanese universities and steel industry partners.

---

5. The infrastructure, technology, skills, workforce capabilities and other things needed to realise the economic opportunities of hydrogen as and when it becomes commercial in different sectors of the economy.

Integration with gas networks

As renewable generation capacity increases, attention is being focused on how surplus electricity generated by renewables can be captured for later use or to provide a source of dispatchable power. Balancing supply and demand across the electricity grid will require advanced solutions if energy systems are to fully decarbonise while maintaining current levels of cost and reliability. Hydrogen technologies can assist with both the integration and expansion of low-carbon electricity generation by providing grid stabilisation and demand management mechanisms. When excess electricity is

produced from renewable resources, such as solar, the electricity can be stored as hydrogen rather than feeding it back into the grid. Once stored, hydrogen energy can be produced with very little initialisation time, making it possible to store renewable energy until demand increases. The ability to manage grid demand will smooth pressure currently placed on the grid during times of peak use.

The Hydrogen Strategy Group COAG briefing paper *Hydrogen for Australia's Future* states: 'Hydrogen can be safely added to natural gas supplies at 10per cent by volume without changes to pipelines, appliances or regulations.' A detailed study has been commissioned as part of the development of the National Hydrogen Strategy to review any barriers to hydrogen injection in gas distribution networks from a regulatory, technical or legal viewpoint in each State. With further research and testing, there is potential to increase the concentration of hydrogen in the gas supply.

Energy Networks Australia, the premier national body representing Australia's gas distribution and electricity transmission and distribution companies, identified hydrogen innovation and pilot projects as immediate opportunities for the transformation to a net zero emissions energy system. Australia's gas entities including Jemena in NSW are currently progressing demonstration projects on the integration of hydrogen into the gas network.

A project exploring the synergies between hydrogen and Australia's energy networks is being developed as part of the Advanced Energy Integration Initiative and will potentially see the first two Post-Doctoral researchers working jointly between the University of Newcastle and the University of New South Wales to better understand the dynamics between hydrogen and Australia's electricity and gas networks.

Safety standards and skills

Safe widespread use of hydrogen in gas networks will require education on all aspects of industrial hydrogen systems particularly in safety management and training for associated trades and for others who are likely to work on or near gas distribution networks. Expertise at NIER's Priority Centre for Frontier Energy Technologies can be drawn on for the adoption of hydrogen as it relates to safety management in industrial settings.

Developing export and transport capacity

The Hunter and Central Coast can support NSW Government strategies to boost productivity and efficiency throughout regional NSW by focussing on greater integration of regional networks such as transport and logistics. The Hunter and Central Coast is a gateway to national and international markets for regional NSW. The region's ongoing economic prosperity will depend on its ability to capitalise on strategic assets and networks. The region's gateways, the Port of Newcastle and Newcastle Airport are important assets for trialling freight movements and logistics to support the growth of global markets.

Linking into NSW Government Special Activation Precinct (SAP) such as Parkes and Wagga, the Hunter and Central Coast provide opportunity for freight and logistics industries, creating faster, easier access to global markets for regional NSW to further open the domestic and export market linking developing precincts in advanced manufacturing and agribusiness through transport networks such the inland rail enhancing freight and logistics. The Hunter's existing industrial transport corridors and logistics networks provide pathways for transportation trials of large mass, high mileage vehicles.

Current opportunity lies in furthering the demonstration of the hydrogen fuel cell for domestic consumption in and around industrial operations and the utilisation for 'clean' long distance freight. There is an opportunity for the Hunter to play a role in hydrogen fuelled transport and hydrogen safety as it relates to transport. The use of hydrogen as a vehicle fuel through a hydrogen fuel cell is well documented as a development opportunity that would see a significant expansion of hydrogen production in Australia to overcome our reliance on fuel imports and bolster the growth of a domestic market in hydrogen.

---

6. The actions needed of the public and private sectors, to support the development of a hydrogen industry in NSW and to realise the associated economic opportunities, including actions to manage any safety risks in the hydrogen industry.

Regional Leadership

Regional leadership and collaboration among businesses, governments, research institutions and the community will play an important role in supporting the growth of the hydrogen industry and its enabling supply and export businesses.

See item 3 for examples of regional leadership and collaboration in the Hunter and Central Coast.

The important role of Council is also recognised. Proactive engagement with emerging businesses and industry will be essential for developing and maintaining infrastructure, adjusting planning and zoning controls, supporting project consideration and approvals, and attracting investment. Councils throughout the Hunter, Lake Macquarie and Central Coast regions have been alert to opportunities in the hydrogen economy and are engaging with the community and industry on the path ahead.

An Enabling Environment

Successful industry development relies on a culture that encourages and is conducive to collaboration, supports the cross fertilisation of information across sectors, and facilitates strong partnerships between industry, researchers and government to drive innovation, accelerate technology to market and promote jobs growth.

The recently awarded NERA Hunter Hydrogen Technology Cluster serves as a strong example. The Cluster will act as a nucleus of knowledge exchange. Cluster partners will have access to best practise information, new research knowledge, opportunities and solutions, and an expertise-rich network. Collaboration will be used as a tool to advance innovation by creating opportunities for those in the network to work together to solve supply chain, technology and market challenges.

Investment Attraction

Projects that support capacity building, demonstrate potential in growth industries and capitalise on inter-regional and international connectivity will be critical for investor attraction.

Investment by government in regional demonstration projects will generate learnings for other industrial users, build community acceptance, and enable the development of appropriate regulatory frameworks.

Leveraging existing government mechanisms to support demonstration with industry is a critical strategy attract investment and build confidence in the policy settings. For example, the Australian Government has an extensive suite of measures to support clean technologies to market including:

- Australian Renewable Energy Agency (ARENA)
- Clean Energy Finance Corporation (CEFC)
- Clean Energy Innovation Fund (CEIF)
- Emissions Reduction Fund (ERF) and the Climate Solutions Fund (CSF)

Competitive Advantage

To further momentum, the Hunter and Central Coast can focus on opportunities to scale the hydrogen industry to enhance investor confidence and lower costs of production. This will involve:

- Capitalising on the region's industrial Port of Newcastle;
- Exploring partnerships that spur new clean hydrogen supplies such as existing gas infrastructure;
- Encouraging the utilisation of transport corridors to support the mobility of hydrogen;
- Engaging an existing skilled workforce.

A targeted regional strategy developed in consultation with Federal and State Government can provide a practical approach to encourage key sectors to establish a role for hydrogen including manufacturing, freight and long-distance transport, buildings, and power generation and storage.

Investments in one sector enable shared benefits for example, transport refuelling infrastructure could be made available to industrial users, such as forklift warehouse operations, for higher asset utilisation. In another example, electrolysers could produce hydrogen for blending into natural gas networks and for co-located refuelling stations. A remote mine site could produce hydrogen fuel on-site to use in vehicles as well as back-up power supply, with reduced local air pollution by replacing fossil fuel sources.

Knowledge sharing and RD&D

RD&D approaches that facilitate hydrogen's complex supply chains require governments, companies and communities to consult regularly. Successful demonstrations allow technologies to be de-risked from a technical standpoint, overcome relevant investment hurdles and continue to attract funds to improve their performance and achieve further reductions in cost. RD&D strategies that support the development of new applications for hydrogen, as well as clean hydrogen supply and infrastructure projects are crucial to lower costs and improve performance (CSIRO 2018,2019). Effective knowledge translation and sharing is essential for a growth market.

7. The potential for jobs in New South Wales, both directly in the hydrogen industry and in other industries powered by hydrogen.

The outlook for hydrogen industry related jobs is positive. The Report *Opportunities for Australia from Hydrogen Exports*, estimates that for a medium growth scenario, there would be up to 788 direct and indirect jobs created by 2025, up to 2787 in 2030 and 7142 jobs by 2040. The report says that if hydrogen production reaches the higher level of its range of estimates, the job numbers could be comparable to those generated by Liquefied Natural Gas (LNG) and its supply chain.

CSIRO has identified an opportunity for the advanced skills and capabilities developed to service the energy and resources industries can be repurposed for the hydrogen value chain. As a result, developing a local hydrogen industry in the Hunter and Central Coast would likely see capabilities that were developed during the resources boom redeployed to a new growth-oriented future energy industry with the Hunter's workforce profile potentially well suited to a future hydrogen industry.

The Hunters METS industry is a well-equipped workforce to translate skills and processes to the work with hydrogen. For example, many Hunter companies are already working with hazardous chemicals and gases. While it is recognised that regulatory controls and training is needed due to the nature and risk profile for hydrogen differs from that for carbon-based fuels, various companies and trades in the Hunter have the necessary experience to make adjustments to a hydrogen system.

---

8. Any other pertinent matters the Committee wishes to draw to the Government's attention in this regard.

N/A
