Innovate UK
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Virtual Global Expert Mission
Australia – Industrial Decarbonisation May 2022

Contents

Executive Summary

The Industrial Decarbonisation Global Expert Mission (GEM) to Australia took place virtually in May 2022 with the aim of better understanding the decarbonisation landscape and identifying synergies and opportunities for collaboration between the UK and Australia.

The mission delegation focused on three areas of clean technology: blue hydrogen, green hydrogen and carbon capture utilisation and storage (CCUS). These are key enabling technologies which require significant development and commitment to support and accelerate global decarbonisation strategies. These are also areas in which both the UK and Australia have signalled their interest in bringing businesses together to work jointly on commercially viable solutions.

In 2021, the Australia–UK Clean Technology Partnership (CTP)[1] was created to make low-emissions technologies globally scalable and commercially viable. Innovate UK has also launched its own Industrial Decarbonisation Programme and is highly interested in the Australian industrial decarbonisation landscape.

This report provides an overview of the main findings of the GEM. It begins by describing the innovation landscapes and decarbonisation strategies within the two countries. Subsequently it analyses the impact of decarbonisation technologies on their respective ecosystems and highlights a number of sector insights that are critical to consider.

Acronyms and Definitions

ARENA	Australian Renewable Energy Agency
BECCS	Bioenergy Carbon Capture and Storage
Carbon neutral	A state of net zero carbon dioxide emissions which can be achieved by balancing emissions of carbon dioxide with its removal or by eliminating emissions
CCS	Carbon Capture and Storage
CCU	Carbon Capture Utilisation (or transformation)
CCUS	Carbon Capture Utilisation and Storage
CO_2	Carbon Dioxide
CO2CRC	CO_2 Cooperative Research Centre
COP26	More commonly referred to as COP26, the 26th United Nations Climate Change Conference of Parties was held in Glasgow, Scotland, United Kingdom, from 31 October to 13 November 2021
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTP	Clean Technology Partnership
Decarbonisation	The reduction of carbon and an economic system that sustainably reduces and compensates the emissions of carbon dioxide (CO_2)
EOR	Enhanced Oil Recovery
Fossil-derived energy	A hydrocarbon derived form of energy using material formed naturally in the earth's crust originating from plants and animals that existed in the geological past such as coal, crude oil and natural gas
GEM	Global Expert Mission
GeoCquest	A project quantifying the impact of heterogeneity on CO_2 migration and trapping in saline aquifers
GHG	Greenhouse gas
GHG21	Greenhouse gas permit areas (in Australia)
Gt	Gigaton. One billion metric tonnes
H_2	The chemical formula for hydrogen gas (dihydrogen)
HESC	Hydrogen Energy Supply Chain

Acronyms and Definitions

IDRIC	Industrial Decarbonisation Research and Innovation Centre
Industrial Cluster	A regional concentration of related industries consisting of companies, suppliers and service providers, as well as government agencies and other institutions that provide education, information, research and technical support
Knowledge exchange hub	A platform for researchers and research users to share ideas, research evidence, experiences and skills
Modularisation	The design or production of something in separate sections
MT	Metric Tons or Tonnes
Mtpa/MTPA	Metric Tonnes Per Annum, a weight-based measurement value
MW	Megawatt. One million watts of electric capacity
Net Zero	A target of completely negating the amount of greenhouse gases produced by human activity which can be achieved by reducing emissions and implementing methods of absorbing carbon dioxide from the atmosphere
Private-Private partnership	A finance model for funding projects
Renewable energy	Also referred to as renewables; energy produced from sources such as the sun and wind that are naturally replenished and do not run out
SMR	Steam methane reforming
SuperSeal	Sealing potential/capability in relation to geological carbon sequestration
TW	Terawatt, a unit of power equal to one trillion (1012) watts.
UK-HyRES	The UKRI co-ordinator for research challenges in hydrogen and alternative liquid fuels
UKRI	UK Research and Innovation
WA:ERA	Western Australian Energy Research Alliance

1. Introduction

The development and adoption of clean energy have become a high priority and a clear commitment by the government, business, academia and the broad population in order to meet net-zero targets and cut carbon emissions.

Furthermore, the decarbonisation of key sectors of the economy is viewed as a crucial strategy to mitigate climate change and ease our dependence on fossil-derived energy by favouring the use of renewable resources.

There has been a renewed commitment by leading countries at the 26th United Nations Climate Change Conference of Parties (COP26) in Glasgow in November 2021 to lower greenhouse gas (GHG) emissions by focusing investment on key enabling technologies.

In the run-up to this commitment, Australian Minister for Energy and Emissions Reduction, Angus Taylor, and UK Secretary of State for Business, Energy and Industrial Strategy, the Rt Hon Kwasi Kwarteng MP, signed a letter of intent in July 2021 to make low-emission technologies scalable and commercially viable via the creation of the Australia–UK Clean Technology Partnership (CTP)[2]. The cooperation will focus on several key technology areas including clean hydrogen production, carbon capture utilisation and storage (CCUS) and near-to-market industrial solutions.

The UK government launched its Industrial Decarbonisation Strategy (IDS) in March 2021[3] which details the long-term strategy and investments required to achieve net zero by 2050. It focuses on the UK's manufacturing industry which contributes £170 billion to the economy and plays an essential role in society, contributing towards car manufacturing, food production and essential medicine production. The strategy offers a promising direction and provides wide-ranging measures that need to be implemented to support innovative technology in decarbonisation while encouraging competitiveness. It also focuses on practical, real-world demonstrations and adoption in seven industrial clusters around the UK.

The UK's foundation industries are vital for its manufacturing and construction sectors. The foundation industries are cement, metals, glass, paper, ceramics and chemicals, and there are programmes in place such as UK Research and Innovation's Transforming Foundation Industries Challenge which aims to transform the UK's foundation industries by making them internationally competitive, securing more jobs throughout the UK and growing the sector by 2024 in an environmentally sustainable way[4].

The launch of Australia's Long-Term Emissions Reduction Plan in October 2021[5] and its Technology Investment Roadmap[6] have provided a long-term strategy for the country to achieve net zero by 2050. Moreover, in September 2022, Australia's parliament passed legislation enshrining a pledge to slash carbon emissions by 43% by 2030 and to net zero by 2050[7]. The plans set out processes to develop and rapidly deploy low-emissions technology through government investments with a focus on the following:

- Delivering low-cost, clean, and reliable energy to industry and households.
- Increasing productivity and reducing emissions from primary industries.
- Supporting regional industries and creating opportunities in new markets.
- Increasing collaboration with strategic partners overseas.

Mission Objectives

This Global Expert Mission (GEM), part of Innovate UK's Global Missions Programme, plays a vital role in building strategic partnerships with countries and overseas organisations. The mission is part of a wider effort for the UK's ambition to be the partner of choice for research and innovation. The GEM programme delivers by deep diving into the research and innovation ecosystem in the selected countries to help identify opportunities for UK innovation and shape future programmes.

The objective of a mission is to:

- Inform UK businesses and government.
- Identify opportunities and build international collaborations.
- Promote and share UK capabilities.

This mission reviewed technology and infrastructure gaps in both countries, focusing on large-scale production of blue hydrogen, green hydrogen and carbon capture and storage (CCS). The mission also captured insights into the synergies between the two countries in decarbonisation and determined the appetite for collaboration.

This mission highlighted key future market opportunities for innovative products and services to UK businesses that may be interested in collaborating with Australia. This included insights into UK research and investment, emerging market opportunities and challenges for developing innovative products and services when considering collaboration with Australia.

Research Scope (as defined by the Australia—UK Clean Technology Partnership)

Blue hydrogen: This form of hydrogen is primarily produced from natural gas via the steam methane reforming (SMR) process. The output of the process produces hydrogen with CO_2 as the by-product. The CCS process enables the environmentally sustainable production of hydrogen, as it prevents the release of CO_2 into the atmosphere. The mission explored both onshore and offshore hydrogen production and transportation with a focus on large-scale deployment.

Green hydrogen: This form of hydrogen is primarily produced through electrolysis. When the electricity used to perform this process is renewable energy, it may also be referred to as zero-carbon hydrogen. Low-carbon hydrogen will be critical to meeting net-zero targets and can play an important complementary and enabling role in decarbonising the energy system. The mission explored cutting-edge technologies and projects in the production and use of green hydrogen.

Carbon capture utilisation and storage (CCUS): This is the process of capturing CO_2 from industrial processes followed by transporting and storing in permanent carbon sequestration in a geological formation. This mission primarily focused on the large-scale deployment of CCUS technologies, alongside the transformation of captured CO_2 into chemicals and materials (CCU) to ensure it aligns with the UK's Industrial Decarbonisation Challenge strategy. This is a largely unproven technology at scale, but is a crucial part of many long-term models towards net zero.

2. Sector and Innovation Landscape

Both Australia and UK decarbonisation strategies focus on developing new technologies, such as low-carbon hydrogen which is a suitable replacement for fossil-derived fuels providing flexible energy for power, heat and transport. Both countries have a long-term strategy[8] to transition towards hydrogen production along with large-scale deployment of CCUS technologies. This will enable the decarbonisation of energy-intensive and consumer industries by utilising existing infrastructure and blending hydrogen with natural gas. There is a clear mutual benefit for both countries to engage in collaborative discussions to accelerate developments in hydrogen production and CCUS.

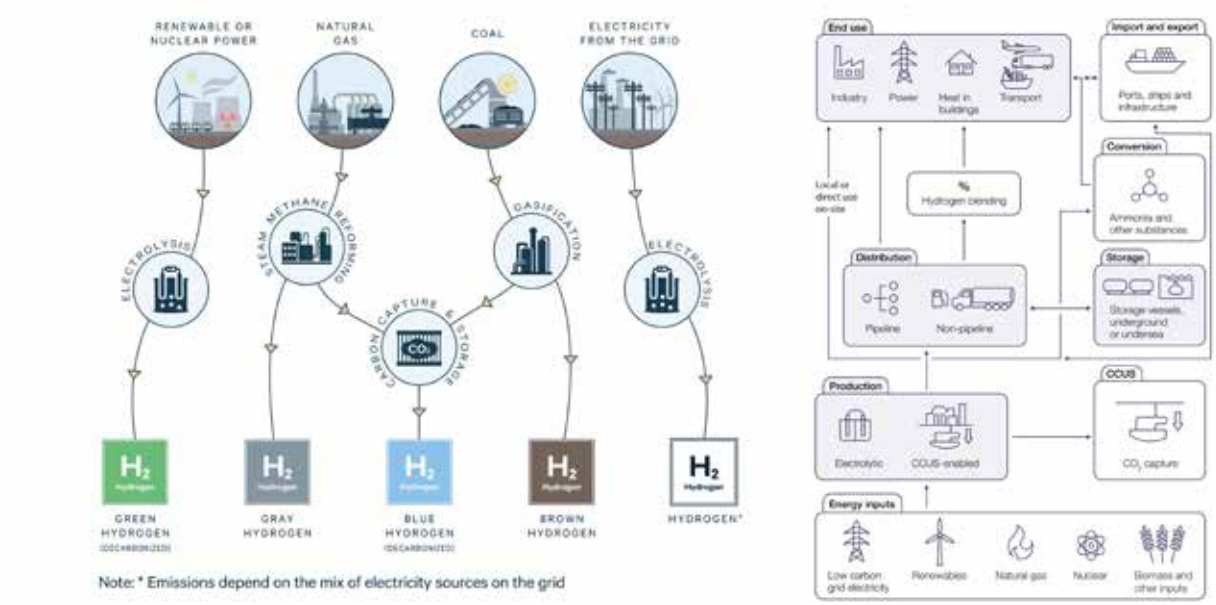

Figure 1: Illustration of the hydrogen supply chains and different types of hydrogen

2.1 Overview of the UK's Industrial Decarbonisation Strategy and Innovation Landscape

The UK is funding seven existing industrial clusters to demonstrate and implement low carbon technologies in order to transform the UK's energy supply requirements and enable key industrial regions to develop and prosper. Furthermore, there is a requirement within this industrial network to share knowledge and best practices, establish research programmes and support plans for more investment. The success of the UK's industrial cluster programme is critical to meet net zero targets by 2050.

The industrial clusters developing in the UK include many of the largest emission sites from industries such as steel, cement, refining, chemicals and fertilisers. These clusters are located near the coast, enabling them to utilise the abundant CO_2 storage opportunities in the North Sea and the Irish Sea, as well as enabling easy shipment of CO_2. Low-carbon hydrogen is also being developed and will play an important role in decarbonising industries.

The UK government is committed to £1 billion of funding to deploy CCUS networks in four industrial clusters by 2030, with at least two by the mid-2020s. The UK aims to capture and store between 20-30 million tonnes of CO_2 a year by 2030 through CCUS and low-carbon hydrogen deployment, and aims to achieve the world's first net zero industrial clusters by 2040[9].

In March 2021, UK Research and Innovation (UKRI) announced a significant milestone in decarbonisation with the award of £171 million to nine projects. This portfolio includes three offshore CO_2 storage sites and CO_2 capture and/or hydrogen production projects in the North West, Scotland, Teesside, Humberside (two projects) and South Wales. These first-of-a-kind decarbonisation projects will develop the engineering and technical requirements to decarbonise industrial clusters[10].

The seven clusters focusing on CCUS and hydrogen in the UK are:

- HyNet (onshore) and HyNet (offshore)
- Humber Zero
- South Wales Industrial Cluster
- Zero Carbon Humber
- Net Zero Teesside
- Northern Endurance Partnership
- Scotland's Net Zero Infrastructure (onshore and offshore).

HyNet

HyNet plans to develop a full-chain hydrogen project in the North West of England including repurposing old oil and gas assets for CO_2 transport and storage.

https://hynet.co.uk/

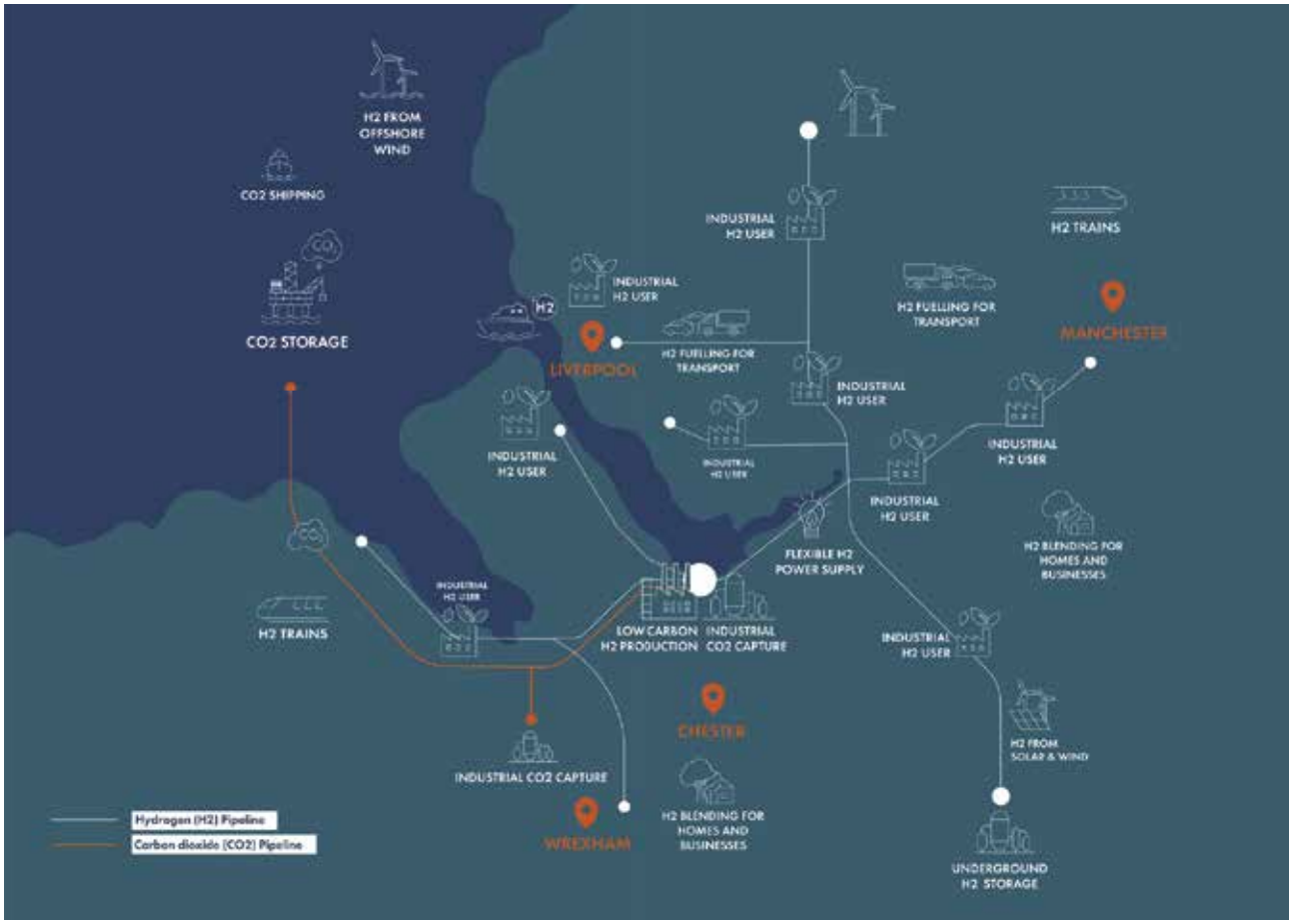

Figure 2: Schematic of the HyNet project
UKRI Funding award: £19.5 million onshore, £13.3 million offshore.
UK Partner organisations: Cadent, CF Fertilisers, Essar, Eni, Castel Cement, Inovyn, Progressive Energy and the University of Chester.

Humber Zero

Humber Zero is a project to decarbonise the regional industrial complex at Immingham, representing approximately 8 $MtCO_2$ per year emissions by the late 2020s via a combination of technology pathways.

https://www.humberzero.co.uk/

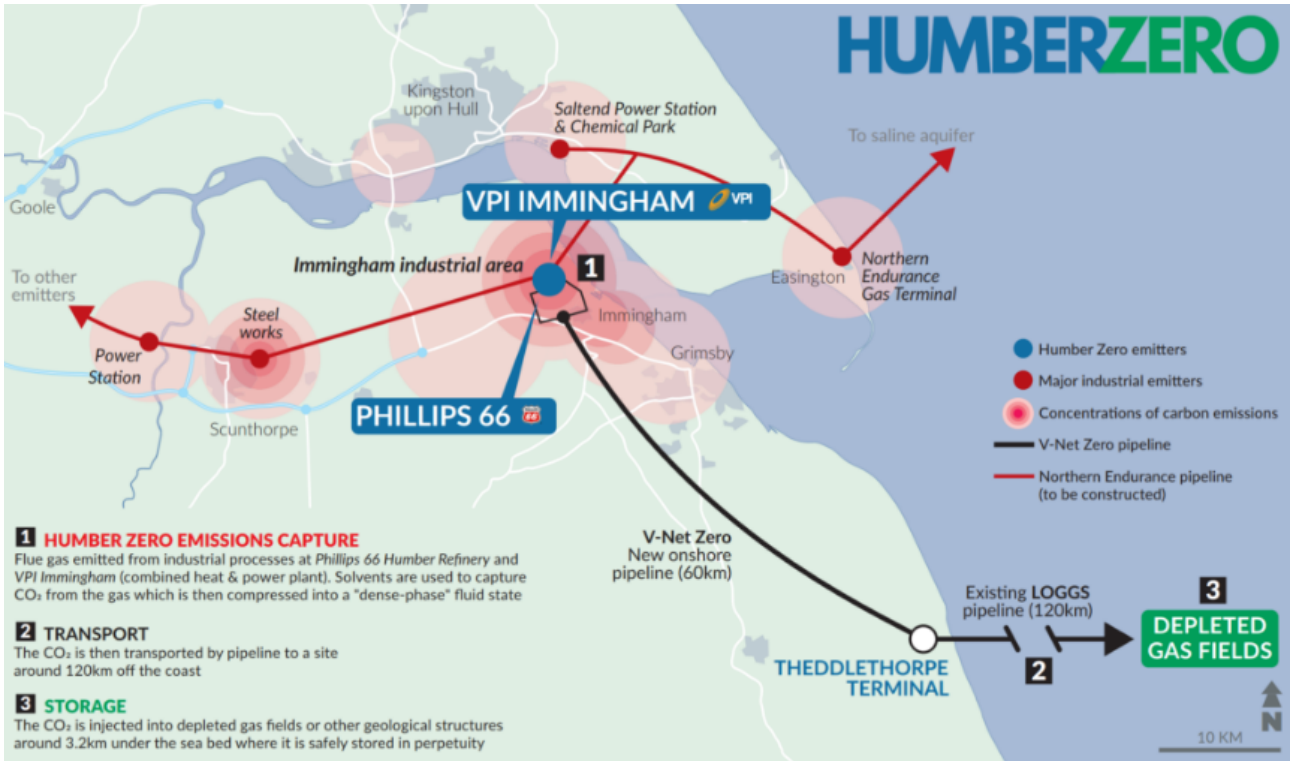

Figure 3: Schematic of the Humber Zero project
UKRI Funding award: £12.7 million.
UK Partner organisations: Vitol, Phillips 66.

South Wales Industrial Cluster

The South Wales Industrial Cluster plans to provide the UK with lower-carbon steel and reduced-carbon cement products to benefit the wider UK infrastructure.

https://www.swic.cymru/

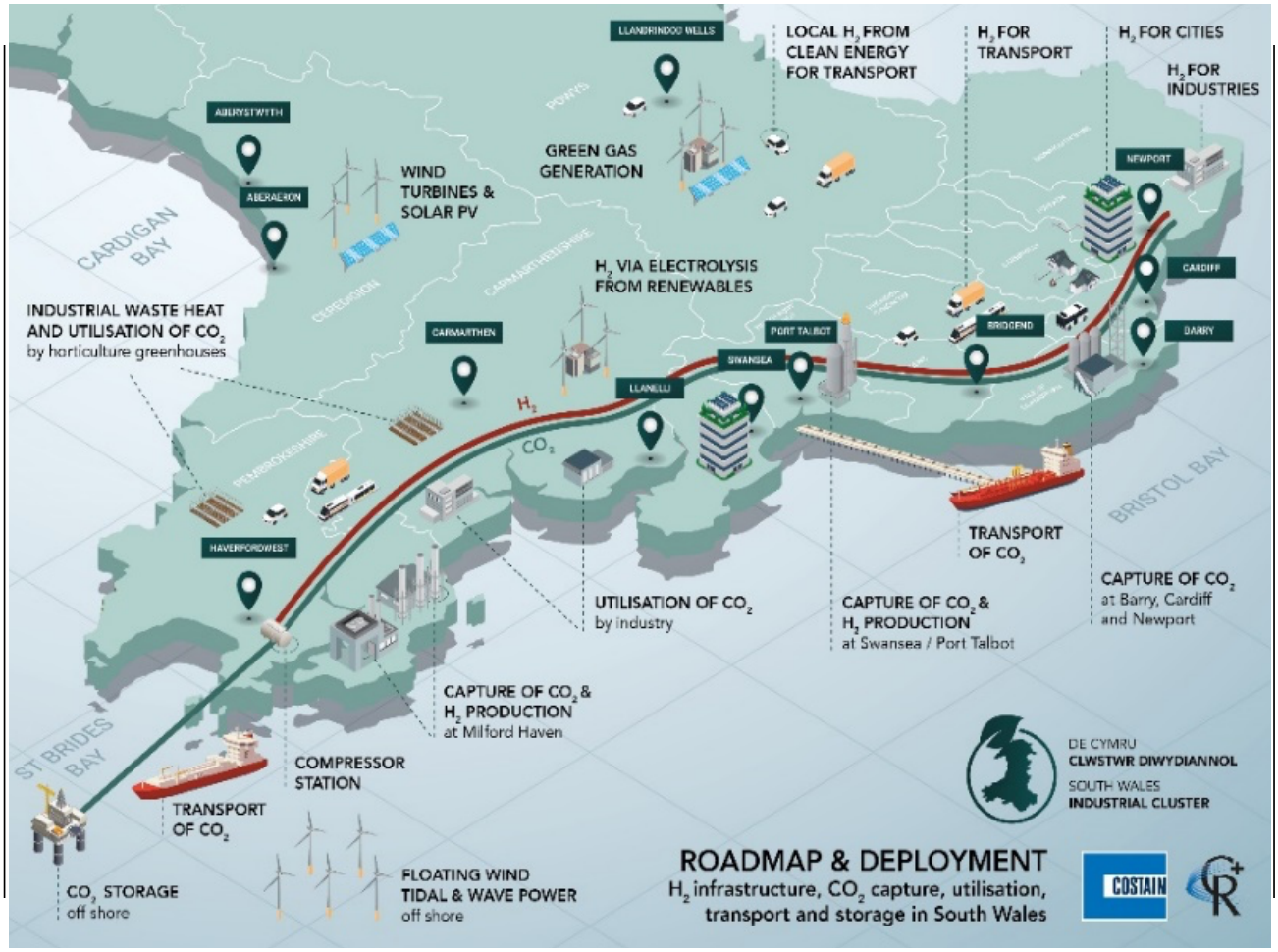

Figure 4: Schematic of the South Wales Industrial Cluster project
UKRI Funding award: £20 million.
UK Partner organisations: Costain, Tarmac, Tata Steel, Valero Energy, Shell, BP, University of South Wales, Progressive Energy, Milford Haven Port Authority, RWE, CR Plus, Capital Law, Associated British Ports, Sector Development Wales Partnership, Simec Uskmouth Power, Lanzatech.

Zero Carbon Humber

Zero Carbon Humber will deliver low-carbon infrastructure, comprising CO_2 and hydrogen transmission pipelines linking the region's major emitters. A 600 MW autothermal reformer will provide low carbon hydrogen to the Saltend Chemicals Park.

https://www.zerocarbonhumber.co.uk/

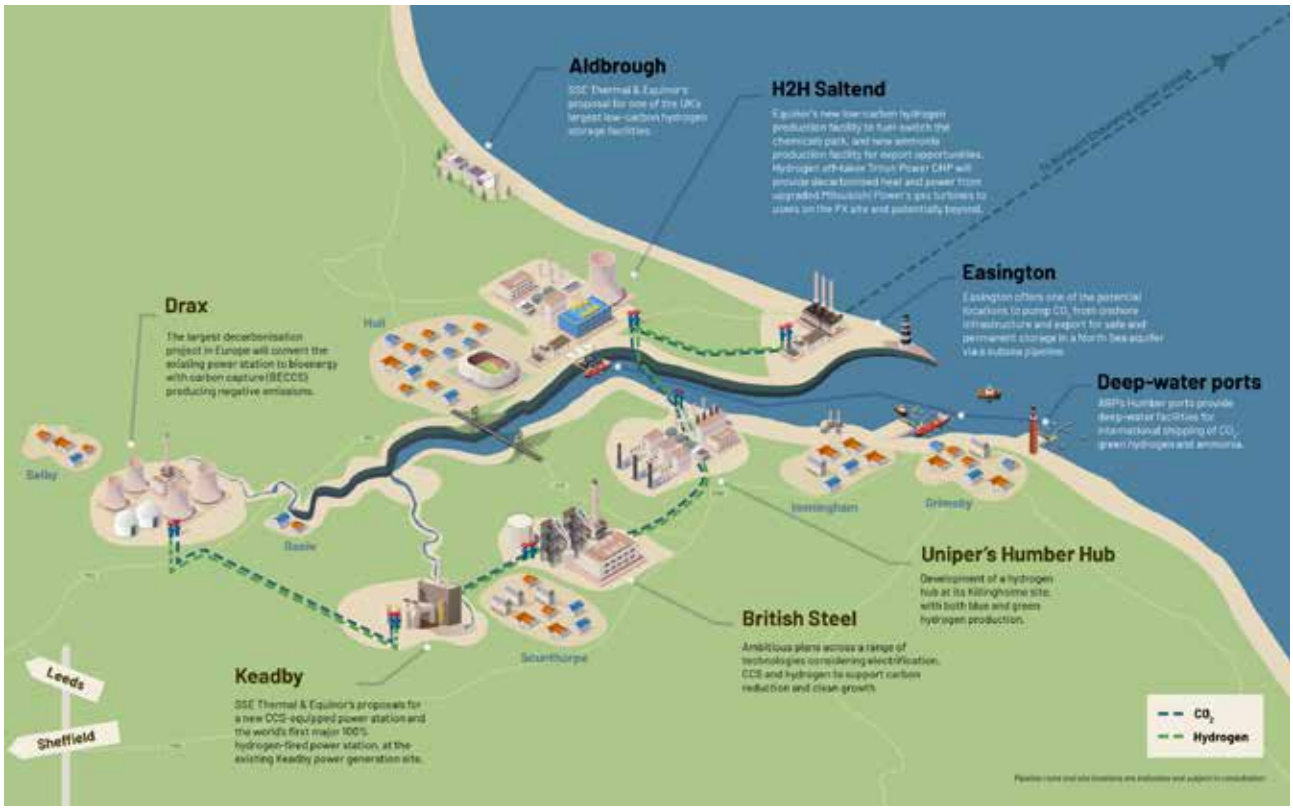

Figure 5: Schematic of the Zero Carbon Humber project
UKRI Funding award: £21.5 million.
UK Partner organisations: Equinor, British Steel, National Grid, Centrica, Drax, Uniper, Mitsubishi, SSE, Associated British Ports, University of Sheffield, Saltend Cogeneration Company, PX.

Net Zero Teesside

Net Zero Teesside will create the world's first flexible gas power plant with CCUS, decarbonising 750 MW of dispatchable power. CO_2 will be safely stored under the North Sea.

https://www.netzeroteesside.co.uk/

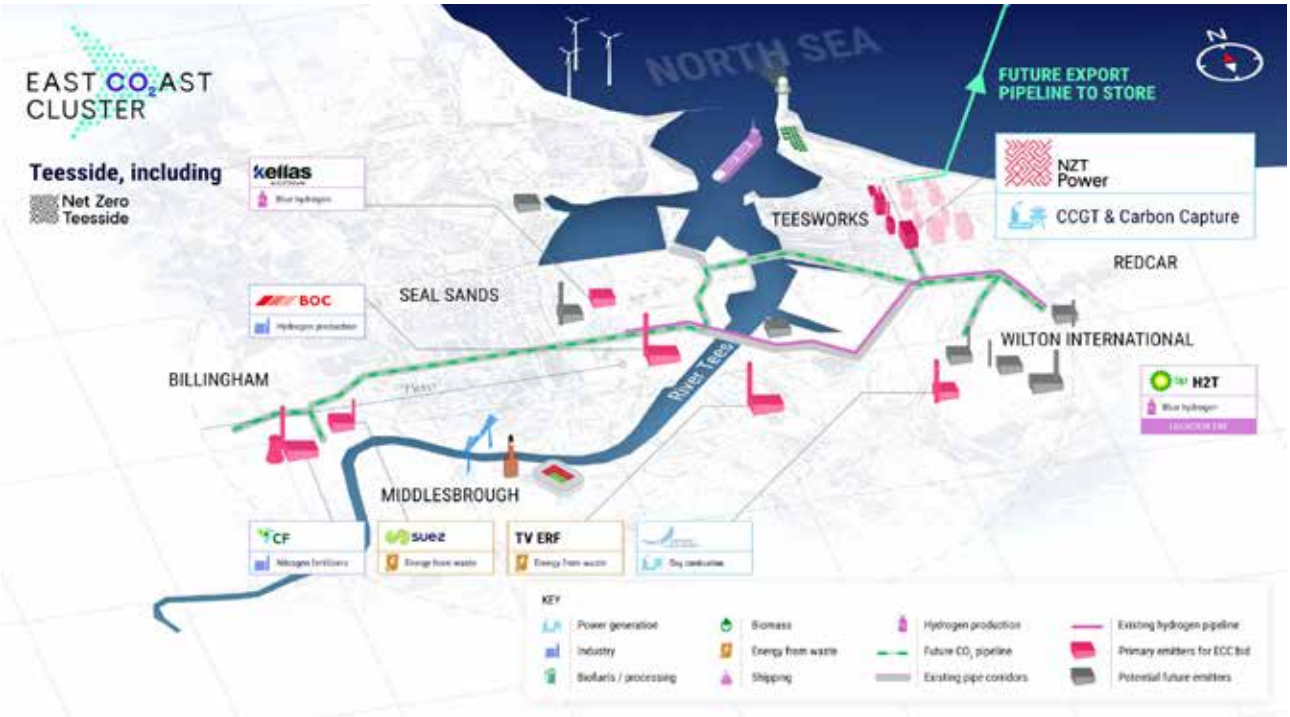

Figure 6: Schematic of the Net Zero Teesside project
UKRI Funding award: £28 million.
UK Partner organisations: BP, Sembcorp, Shell, CF Fertilisers, Eni, National Grid, Total, Tees Valley Combined Authority, Boc, the North East of England Process Industry Cluster.

Northern Endurance Partnership

The Northern Endurance Partnership will create an offshore CO_2 transport and storage system connecting two innovative onshore capture projects into one initial geological store.

https://www.netzeroteesside.co.uk/northern-endurance-partnership/

Figure 7: Schematic of the Northern Endurance Partnership project
UKRI Funding award: £24 million.
UK Partner organisations: BP, Shell, Eni, Equinor, National Grid, Total.

Scotland's Net Zero Infrastructure (Onshore and Offshore)

Large-scale industrial emissions will be captured at the Grangemouth industrial cluster, and the offshore project will focus on developing the Acorn storage site and associated offshore infrastructure.

https://theacornproject.uk/

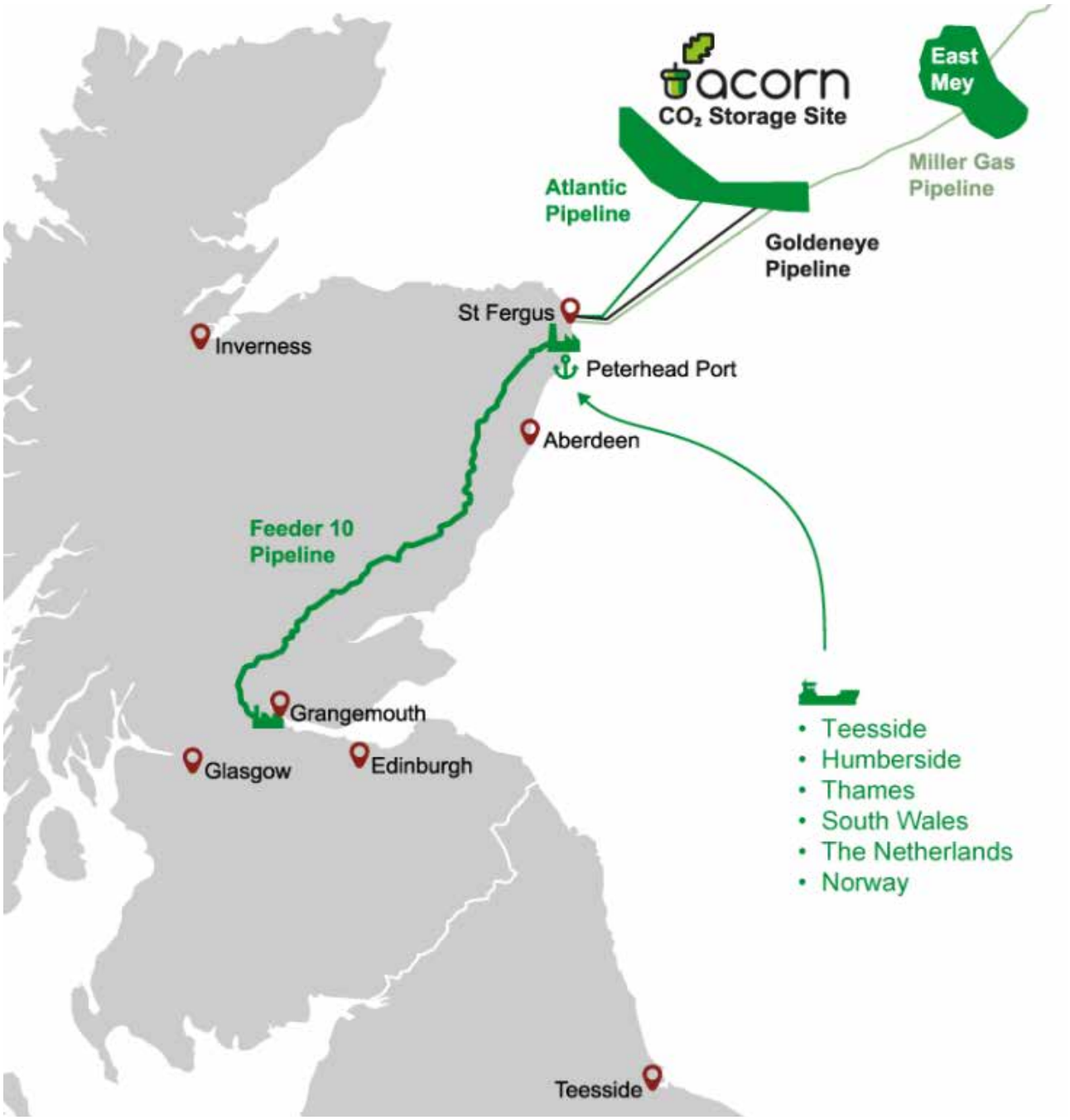

Figure 8: Schematic of Scotland's Net Zero Infrastructure project
UKRI Funding award: £20 million.
UK Partner organisations: National Grid, SSE, GBTron, Petrofac, University of Strathclyde, NECCUS, Pale Blue Dot.

Other CO_2 storage via refilling depleted gas reservoirs projects include:

Harbour Energy's V Net Zero Project

Harbour Energy's V Net Zero project to the North Sea includes working with Associated British Ports (ABP), owners of the UK's busiest port complex. This project aims to lower the cost of deployment by reusing key infrastructure and storage. V Net Zero became operational in mid-2020 and expects first storage by 2027, representing the development of a credible route to rapid deployment for at-pace capture.

Their key site selection criteria include robust containment (proven presence of regional SuperSeal, sealed by high strength with a thick layer of salt), management of legacy wells (unique knowledge as plug and abandonment operator and detailed risk assessment for each well) and benefits from 50 year+ legacy datasets. It needs low compression, has multiple depleted gas fields in the licence area and has flexibility on injection well drill timing.

The key research needs are:

- Qualification of downhole components for foreseen CO_2 service.
- Research and qualification of multi-phase CO_2 flow in pipelines.
- Development of numerical simulation techniques for coupled wellbore and reservoir management.
- Monitoring technologies for deep reservoirs for CO_2 migration conformance.
- Metering of CO_2 and robust monitoring, reporting and verification accounting for negative emissions.

This project reuses existing infrastructure and proposes a new high-capacity onshore pipeline.

Bioenergy Carbon Capture and Storage (BECCS) at Drax Power Station

Bioenergy carbon capture and storage (BECCS) is being trialled at Drax Power Station in North Yorkshire, and the public is being consulted on the proposals. BECCS is the largest decarbonisation project in Europe and has a world-leading ambition to become a carbon-negative site by 2030. BECCS is the most scalable negative emissions technology available today to remove CO_2 from the atmosphere[11].

BECCS delivers a triple benefit:

- Negative emissions are essential for fighting the climate crisis.
- Clean economic growth - BECCS at Drax will create and protect over 10,000 jobs in the Humber and beyond[12].
- Reliable renewable electricity to support the grid as more wind and solar are connected.

Gigastack

Gigastack is the UK's flagship renewable (green) hydrogen project and provides a green hydrogen solution for Humber industry. Accelerating the uptake of renewable (green) hydrogen through Gigastack is vital and will facilitate the development of a UK renewable hydrogen technology hub as well as the creation of a world-leading supply chain and highly skilled jobs across the sector[13].

Key organisations, collaborations, research coordinators and special advisors include:

The UK Industrial Decarbonisation Research and Innovation Centre (IDRIC)

IDRIC is the UKRI-funded coordinator for research challenges in hydrogen and alternative liquid fuels (UK-HyRES), driving the growth of low-carbon hydrogen and alternative liquid fuels. UK-HyRES aims to tackle the research challenges blocking the wider use of low carbon fuels in the UK.

The NW Hydrogen Alliance

The North West of England is poised to be one of the primary regions for the development of a decarbonised, hydrogen-based energy market for the UK. It already features all the necessary components to develop a hydrogen economy – a thriving industry, a skilled workforce, city regions that collaborate, as well as natural and industrial assets. A leading energy powerhouse – made up of Manchester, Liverpool, Warrington, Chester, Lancashire and Cumbria – provides a compelling destination for future investment. The alliance provides a prominent voice in the hydrogen debate through its experts and spokespeople[14].

The South Yorkshire Sustainability Centre

The South Yorkshire Sustainability Centre brings together local authorities, researchers, businesses and third-sector partners; they have steel, glass, and brick works in their vicinity, so they have a good demand for hydrogen in one place. For example, the Michelmersh Brickworks has large kilns which use gas, and they need to know if the use of hydrogen would affect the quality of bricks, whether they would require an electrolyser on-site and what new skill sets would be required to switch to hydrogen.

2.2 Overview of Australia's Industrial Decarbonisation Strategy and Innovation Landscape

Australia has identified industrial decarbonisation as a national priority. It has initiatives such as the Race for 2030, an industry-led collaborative research centre established in 2020, and sets out to accelerate the transition to reliable, affordable, clean energy. Race for 2030 have AUS $68.5 million of Commonwealth funding; the remainder of their resources come from their 70+ partners who cover the whole value chain, technology companies, governments, and many of Australia's leading energy researchers. Over ten years, they will invest AUS $350 million to catalyse lower energy costs and substantially reduce carbon emissions[15].

Reiterating this, Dr Alan Finkel AO, Special Adviser to the Australian Government on Low Emissions Technologies, stated at the UK-Australia Clean Energy Workshops (part of UK-Australia CTP) on 2 February 2022:

"We must replace, not accumulate and we must transform our use of energy by replacing coal, oil and gas with zero emissions renewable and nuclear electricity. Each of our priority technologies is accompanied by a financial stretch goal. When the financial stretch goal is reached, the low emissions technology will logically displace the high emission incumbents."

ARENA (Australian Renewable Energy Agency), established in 2012, is the Australian government's national renewable energy agency and is on a mission to support the global transition to net zero emissions by accelerating the pace of pre-commercial innovation for the benefit of Australia[16]. ARENA's strategic priorities are to optimise the transition to renewable energy, commercialise clean hydrogen and scale up CCUS.

In June 2021 ARENA announced the backing of six new carbon capture projects to accelerate the development of the technology in Australia, boosting its role in reducing emissions and supporting new economic opportunities and job creation. The Minister for Energy and Emissions Reduction, Angus Taylor, said the overwhelming demand for funding through the CCUS Development Fund was further proof of the viability and importance of carbon capture technologies[17]. Its focus on clean hydrogen is to reduce the cost of hydrogen produced from renewable energy and focus on research and development to demonstrate technologies that address technical challenges along the rest of the hydrogen value chain and prove the technical feasibility and commercial viability of hydrogen use cases. The latest statistics show that ARENA has committed AUS $190 million to 38 projects valued at AUS $377 million to seed Australia's hydrogen industry. ARENA supported previous investments (2012 to 2021) in technology, as shown below (Fig 9).

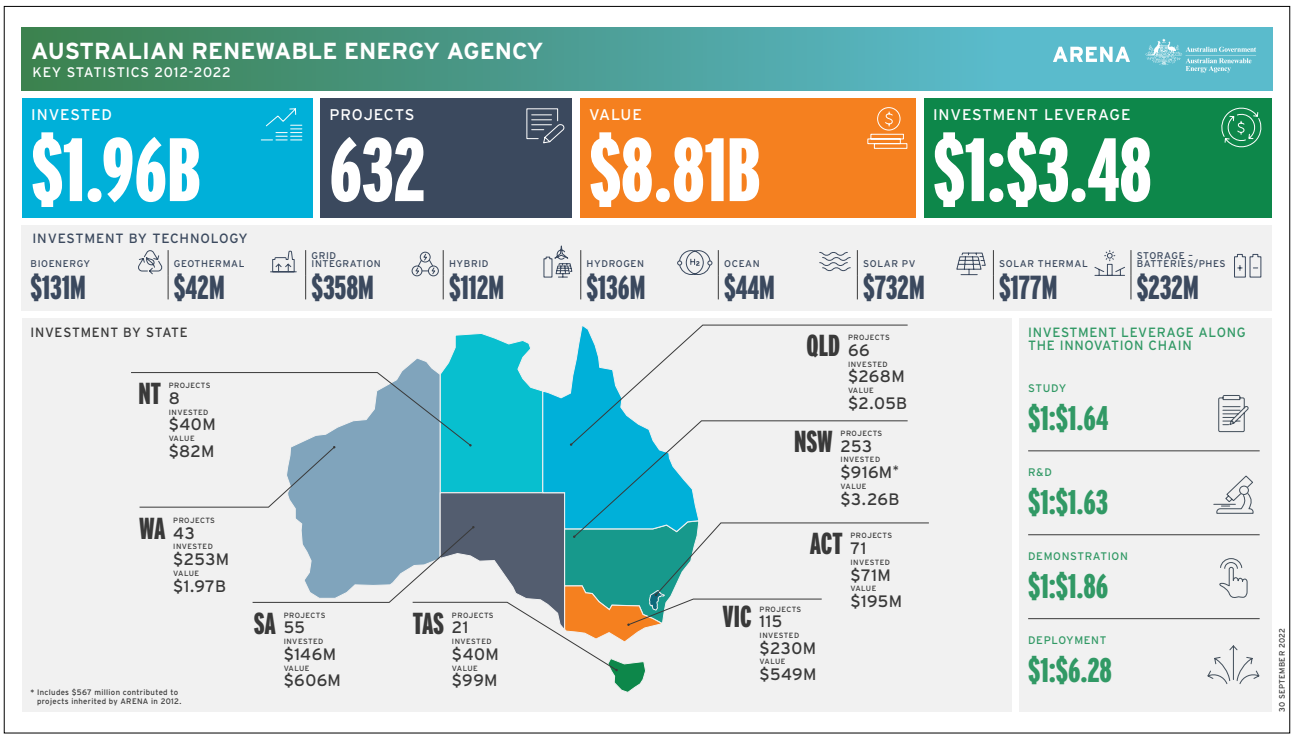

Figure 9: Key statistics 2021-2021 for the Australian Renewable Energy Agency[18]

CCUS is also supported by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), an Australian government agency responsible for scientific research, which works with leading organisations around the world. Facilities include the National Geosequestration Laboratory (NGL), a collaboration between CSIRO, the University of Western Australia and Curtin University, which builds on the successes of the Western Australian Energy Research Alliance (WA:ERA). NGL provides critical research to develop innovative solutions that will minimise risk and uncertainty regarding the long-term underground storage of carbon dioxide.

During the mission, CSIRO highlighted where CCUS is underway in Australia, as well as the GHG21 permit areas[19], which relate to five locations across three sedimentary basins in Commonwealth waters offshore of Western Australia and the Northern Territory as illustrated below (Fig 10):

Figure 10: CCUS project overview in Australia in 2022[20]

The Peter Cook Centre for Carbon Capture and Storage Research (GeoCquest 1 and GeoCquest 2) at the University of Melbourne conducts research on geological CO_2 storage in conjunction with/supported by GeoCquest, CO_2 Cooperative Research Centre (CO2CRC), BHP (an Australian multinational mining, metals, natural gas petroleum public company, formerly known as BHP Billiton), Stanford University and the University of Cambridge. They are also working towards predicting $C0_2$ storage capacity and efficiency.

The hydrogen sector in Australia is still in its infancy as it is expensive; further government support is needed to kickstart the industry. While there are no large-scale blue hydrogen projects, there are some green hydrogen feasibility projects which include:

- The Stanwell Central Queensland Hydrogen Project, funded by ARENA, investigates the technical and commercial viability of a proposed green hydrogen export project at Gladstone, Queensland.
- The Yara Pilbara Renewable Ammonia Project, funded by ARENA, is a feasibility study leading to funding approval for the deployment of a renewable hydrogen and renewable ammonia production and export facility using a 10 MW electrolyser.

The Scaling Green Hydrogen Cooperative Research Centre's (CRC) rationale for scaling green hydrogen, states that while mass electrification is underway, not everything can be directly electrified, particularly chemicals, heavy long-distance transportation, energy exports and steel. Green hydrogen and derivatives will be critical as chemical carriers of green electrons, and green hydrogen production will lead to a massive increase in renewable electricity demand. Existing domestic electricity and water systems are not ready for this scale up. Australia will need a sovereign manufacturing and service capability to realise domestic and export production potential, and create a global hydrogen, equipment, technology and services (HETS) sector in its own right. There is no clear pathway for moving from 0+ TW to 1 TW of installed electrolyser capacity.

The Centre for Clean Energy Technology, Faculty of Science, University of Technology Sydney, NSW Australia, has knowledge of alkaline electrolysers, alkaline anion exchange membrane electrolysers, proton exchange membrane electrolysers (PEMELs) and single-atom catalysis, and device innovation for PEMELs, which includes the development of low cost and corrosion-resistant current collectors and separator plates to improve long term stability/durability of all components.

Other projects, capabilities and facilities comprising the Australian landscape include:

- The CarbonNet project, in development for ten years with a storage capacity of over 31Gt, has conducted successful tests of injection of H_20.
- The Hydrogen Energy Supply Chain (HESC) Project has a vision to produce carbon-neutral hydrogen from a mix of Latrobe Valley coal and biomass, capturing and storing $C0_2$ via CarbonNet and optimising efficiency in the HESC.[21]
- The University of Newcastle (Australia) - Newcastle Priority Research Centre for Frontier Technologies and Utilisation; Prof Moghateri's group consists of ten postdoctoral research fellows, four technical and general support staff and 24 PhD students. They have an extensive array of laboratories and equipment worth AUS $22 million and have secured grants to the value of AUS $44 million since 2013.

CO2CRC's Otway International Test Centre is a world leader in applied CCUS research. Here they perform research and commercially relevant demonstrations in CCUS applications, build and operate first-of-a-kind plant and equipment, develop technology options with the industry and provide consultancy services to the CCUS industry.

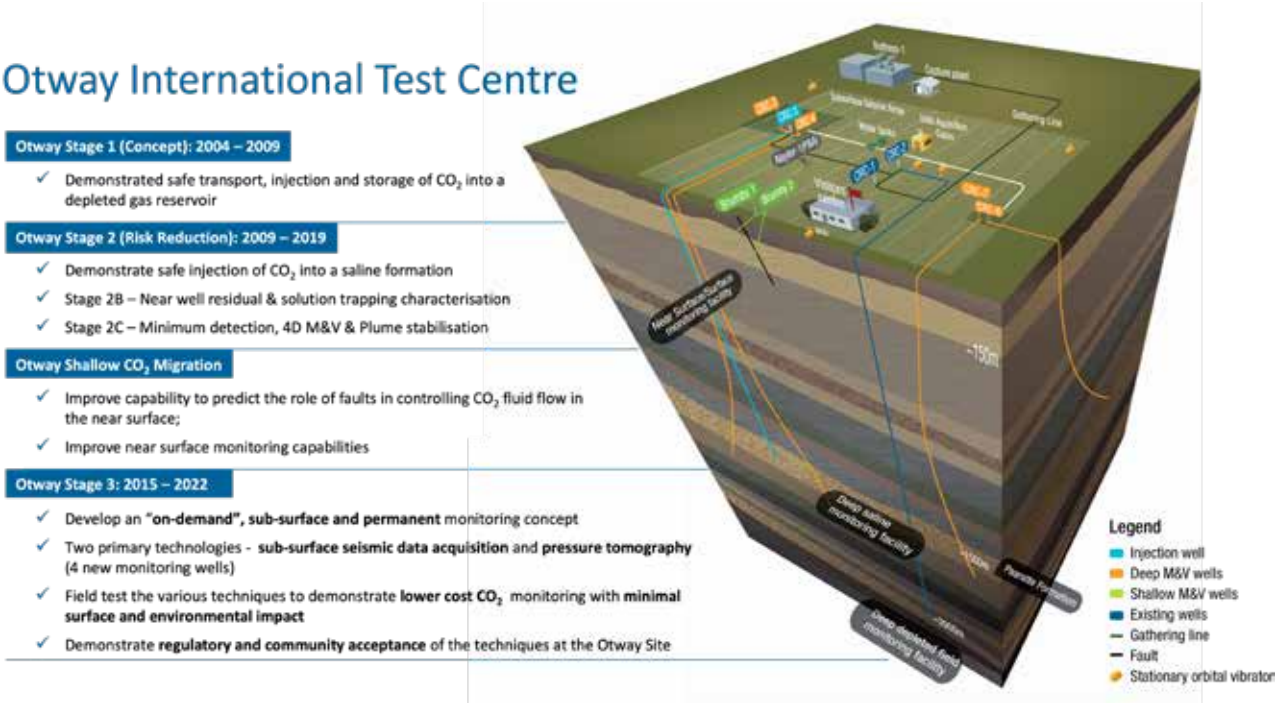

Figure 11: Otway road map for the development of the international test centre[22]

Priority industries highlighted by the Heavy Industry Low-Carbon Transition Collaborative Research Council (HILT CRC) include iron and steel, alumina and aluminium, cement and lime. Active organisations also include the Future Fuels Cooperative Research Centre (Future Fuels CRC), which works in the arena of long-term industry-led collaboration between 100 industry, government and academic organisations. Co-funded by the Australian government, it works towards enabling the decarbonisation of Australia's energy networks.

Australian participants included:
Heavy Industry Low-Carbon Transition Collaborative Research Council (HILT CRC); Australia's leading collaboration in the net-zero transition for heavy industry with some 50 industrial and seven Australian research partners. Its remit is to de-risk the transformation of the iron/steel, alumina/aluminium and cement/lime industries through the development and demonstration of new technologies, including electrification, hydrogen, CCUS and new circular-economy pathways, together with broader interdisciplinary support for the transformation of the sector[23].

The University of Adelaide's Centre for Energy Technology; specialises in the net-zero transition for heavy industrial processes, together with sustainable fuels, power and networks. It is the leading research partner in HILT CRC and a leading research partner in the Future Fuels CRC.

The Future Fuels Cooperative Research Centre, an industry-focused research, development and demonstration (RD&D) partnership funded through federal grants, focused on accelerating the decarbonisation of Australia's energy network, works with partners in a collaborative and connected research community embracing the industry, academia and government.

The Scaling Green Hydrogen CRC aims to become the largest single initiative focused on supporting the scaling up of the emerging Australian green hydrogen sector. It will provide much-needed resources, capabilities, linkages and partners that can accelerate and de-risk the developing green hydrogen industry and related projects[24].

The Global CCS Institute helps identify opportunities for CCS. They state that there are over 140 CCS projects in various stages of development and there are encouraging indicators that the investment environment for CCS is improving significantly and may be entering a period of sustained growth.

3. Collaboration Opportunities

The mission identified clear opportunities for UK and Australian companies to work together. The UK and Australia have complementary technologies and markets which can be leveraged for valuable and effective collaboration and partnership opportunities.

This mission identified the following technology areas as opportunities for Australia-UK collaboration:

Development of deblending technologies

Blending is a step-by-step approach to encourage H_2 production and transport on the gas networks in the short and medium term until dedicated H_2 transport infrastructure becomes economically viable. However, current blending technologies do not offer a standard blend, and customers sensitive to gas quality fluctuations need to receive a consistent hydrogen blend. In such cases, deblending technology is a useful technology that could shield specific customers from receiving a fluctuating hydrogen blend.

CCUS

The design of essential infrastructure and CO_2 storage is part of the UK's and Australia's initiatives to achieve net zero. The CO2CRC Otway Project is Australia's most advanced storage project and the world's largest research and geo-sequestration demonstration project. It aims to become the best CO_2 storage testing facility in the world and to achieve CO_2 storage at under AUS $20 per tonne. It has overcome a number of regulatory, organisational and stakeholder challenges and is now well-placed to lead efforts to dramatically cut the cost of CCS[25].

Notably, during the mission, it was also mentioned that there are many depleted or depleting gas reservoirs, and fewer oil-filled reservoirs in Australia. Enhanced oil recovery (EOR) is a difficult challenge that could benefit from international collaboration on how EOR could aid the stubborn dilemma around liquid hydrocarbons.

Ammonia

Ammonia's potential as a carbon-free fuel, hydrogen carrier, and energy store represents an opportunity for renewable hydrogen technologies to be deployed at an even greater scale. As the demand for ammonia grows, there is a strong need for more and bigger plants.

The Yara Pilbara Renewable Ammonia Project[26] is a good example of how Australia is working on developing a commercial demonstration plant, considering the application of a 10 MW electrolyser powered by a dedicated solar photovoltaic farm of approximately 18 MW peak.

The UK's use of blue hydrogen for ammonia production might offer a quicker and cheaper route to an ammonia economy, whether to play a role as a transition industry or as part of the long-term energy mix.[27]

This area represents a space for further investigation, and a collaborative approach could create a significant opportunity in ammonia production at scale, supply chain development, storage, distribution, and business models[28].

Hydrogen

Blue hydrogen technology is being deployed and is well-advanced in the UK. Australia has potential sites and pilot projects such as the HESC project but does not have a major blue hydrogen project and, given its climate, does not yet have a domestic heat market.

Bioenergy with carbon capture and storage

Bioenergy with carbon capture and storage (BECCS) is the process of capturing and permanently storing carbon dioxide (CO_2) from biomass (organic matter) energy generation. BECCS uses a post-combustion carbon capture process, where solvents isolate CO_2 from the flue gases produced when the biomass is combusted. The captured CO_2 is pressurised and turned into a liquid-like substance so it can then be transported by pipeline[29].

Development of the modularisation of hydrogen technology

Modularisation can enable plants to be built more cheaply and use a smaller plot space. Modularisation uses a plug-and-play model where units are built where the labour is located and then shipped to the site to be assembled. This can address some of the challenges of the standard approach, including labour mobilisation and logistics in remote locations, or climatic conditions, particularly in very hot, cold or wet climates, where construction is difficult or impossible for several months of the year[30]. These can be particular challenges for projects in Australia, so modularisation could be a key enabler for projects to move forward[31].

Annex 1 – List of UK Participants

Drax Power Station
Energy Systems Catapult
Eni
Equinor
Flexergy
Harbour Energy (V Net Zero)
Henry Royce Institute
The UK Industrial Decarbonisation Research and Innovation Centre (IDRIC)
Johnson Matthey
National Grid Ventures
NECCUS
NW Hydrogen Alliance/University of Chester
Phillips 66
Phillips 66 (Gigastack project)
UKRI
University of Sheffield

Annex 2 – List of Australian Stakeholders

Arup Brisbane
Australian Hydrogen Council
Australian Renewable Energy Agency (ARENA)
Centre for Clean Energy Technology, University of Technology Sydney
CO2 Cooperative Research Centre (CRC) Ltd
Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Department of Jobs, Precincts and Regions CarbonNet Project
DP Energy
Emerging Energy Technologies, Department of Environment, Land, Water and Planning (DELWP) Victoria
Future Fuels Cooperative Research Centre (Future Fuels CRC)
Global CCS Institute
Heavy Industry Low-Carbon Transition Collaborative Research Council (HILT CRC)
Hunter Hydrogen Technology Cluster NewH2
Hydrogen Energy Supply Chain Pilot Project - Hydrogen Engineering Australia (HEA)
HySupply, University of New South Wales Hydrogen Energy Research Centre
Newcastle Priority Research Centre for Frontier Technologies and Utilisation
Peter Cook Centre for Carbon Capture and Storage at the University of Melbourne
Scaling Green Hydrogen Cooperative Research Council (CRC)

References

1 https://www.minister.industry.gov.au/ministers/taylor/media-releases/australia-uk-partnership-drive-low-emissions-solutions

2 UK-Australia Technology Partnership

3 https://www.gov.uk/government/publications/industrial-decarbonisation-strategy

4 Source https://www.ukri.org/what-we-offer/our-main-funds/industrial-strategy-challenge-fund/clean-growth/transforming-foundation-industries-challenge/

5 Australia Long-Term Emission Reduction Plan

6 Technology Investment Roadmap for Australia

7 https://www.bbc.co.uk/news/world-australia-62829709

8 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1011283/UK-Hydrogen-Strategy_web.pdf

9 https://www.gov.uk/government/publications/cluster-sequencing-for-carbon-capture-usage-and-storage-ccus-deployment-phase-1-expressions-of-interest/october-2021-update-track-1-clusters-confirmed

10 https://www.ukri.org/news/ukri-awards-171m-in-uk-decarbonisation-to-nine-projects

11 Source https://www.drax.com/about-us/our-projects/bioenergy-carbon-capture-use-and-storage-beccs/

12 Source https://www.drax.com/back-beccs-at-drax-for-future-humber-jobs/

13 For more information on the Gigastack project, see: https://www.youtube.com/watch?v=97lA75HocBw

14 www.nwhydrogenalliance.co.uk

15 Source https://www.racefor2030.com.au/

16 Overview was partly given by Jody Herley, Australian Renewable Energy Agency (ARENA)

17 Source https://www.minister.industry.gov.au/ministers/taylor/media-releases/412-million-new-investment-carbon-capture-projects

18 Source: ARENA.

19 Source https://www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/acreagerelease/ghg

20 Source CSIRO

21 Source https://www.hydrogenenergysupplychain.com/about-hesc/

22 Source CO2CRC.

23 Source https://www.hiltcrc.com.au/

24 Research and Innovation | NewH2. https://www.newh2.net.au/project/innovation

25 https://CO2crc.com.au/

26 https://research.csiro.au/hyresource/yara-pilbara-renewable-ammonia/

27 https://cen.acs.org/business/petrochemicals/ammonia-fuel-future/99/i8

28 Sources include the Energy Research Institute, University of Chester.

29 Source https://www.drax.com/northamerica/carbon-capture/what-is-bioenergy-with-carbon-capture-and-storage-beccs/

30 Source https://www.crown.co.za/latest-news/mechchem-africa-latest-news/18135-modular-plant-green-hydrogen-and-the-future-focus-of-tk-uhde-sa

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