ARENA INSIGHTS FORUM

SESSION SUMMARIES & KEY POINTS

SYDNEY, TUESDAY 29 NOVEMBER 2022

Australian Government
Australian Renewable Energy Agency

ARENA 10 YEARS

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INTRODUCTION

In 2018 ARENA's Knowledge Sharing Team began the Insights Forum to bring together projects and industry stakeholders to share insights from ARENA-funded projects and discuss trends across the renewable energy industry. The Forum is a free, invitation-only event that deep dives into technical topics that link to broader challenges and opportunities affecting the renewable energy industry.

The theme of the 2022 Insights Forum was positioning Australia as a green exporter, and the program focused on hydrogen and low emissions metals projects, initiatives and research. Objectives of the 2022 Insights Forum were to:

- Share knowledge from ARENA projects and other industry initiatives in a unique environment which focuses on details, insight & opportunities (real lessons without the sales pitch).
- Promote discussion and information exchange around low-emissions technologies with strong export opportunities, to support future collaboration and initiatives.
- Generate a stronger understanding of Australia's role in the emerging green export industry.

PRE-FORUM SITE VISITS

On Monday 28 November two groups of delegates departed Sydney to explore ARENA-funded projects and gain valuable insights into the emerging worlds of green steel and green hydrogen.

BLUESCOPE'S PORT KEMBLA STEELWORKS

The conversation on green steel started with a full-day trip to BlueScope's Port Kembla Steelworks (PKSW) – a 760-hectare industrial site, including the iron and steelmaking facilities, producing approximately 3.2 million tonnes of steel with more than 2,600 employees.

Image 1: Delegates at BlueScope's Port Kembla Steelworks

Key features of the day included:

1. BlueScope and University of Wollongong joint presentation on the PKSW Renewables and Emissions Reduction study being supported by ARENA, with 17 technology areas being identified, detailed and assessed, resulting in 11 Prioritised Options selected for further assessment
2. Update on pilot testing conducted to investigate the opportunity of adding biochar to the current pulverised injection of coal into the Blast Furnace at PKSW
3. Site tour of PKSW with stops to see major equipment and operations, including:
   - The Coke Ovens, where coal is converted to coke - attendees watched an oven being pushed on Coke Plant II;
   - The Pulverised Coal plant, where the biochar will be added to the coal;
   - The Blast furnace tuyere level, where the coal/biochar mix will be injected into the furnace; and
   - The Basic Oxygen Furnace, where iron is converted to steel - attendees watched as scrap and iron were charged into the vessel and the oxygen being blown into the furnace.

JEMENA'S WESTERN SYDNEY GREEN HYDROGEN HUB

Thirty delegates embarked on a tour of Jemena's innovative green hydrogen demonstration site at Horsley Park, showcasing the advancements in hydrogen production and utilization technologies.

Image 2: Delegates at Jemena's Western Sydney Green Hydrogen Hub

The key features of the site are:

- Containerized hydrogen production system with one container housing power conditioning equipment, another containing water treatment systems and the final container containing a 500kW PEM electrolyser and auxiliary equipment. The system is designed for simple expansion to 1MW electrolyser capacity.
- Hydrogen storage vessel, consisting of a 340m length of steel pipe, 20 inches in diameter, that runs underground around the site. This can store 90kg of hydrogen at up to 3MPa.
- A fuel cell and a micro-turbine to generate electricity from stored hydrogen that can be used on-site or exported to the grid.

› Gas injection panel that blends a carefully controlled volume of hydrogen from the site into the local natural gas distribution network (currently maintained at a maximum of 2% by volume).

The Jemena team hosting the visit were a wealth of information and particularly generous with their time and sharing their experiences from operating one of the first sites of this kind in Australia.

PLENARY SESSION AND KEYNOTE ADDRESS

OVERVIEW AND SPEAKERS

ARENA CEO Darren Miller kicked off the morning plenary by reflecting on ARENA's ten-year anniversary; and emphasized the need for collaboration and knowledge-sharing between stakeholders. He noted that these kinds of meetings are opportunities to create impactful relationships.

Dr Alan Finkel provided the keynote address, in which he discussed the opportunity for Australia to become a green export powerhouse. Dr Finkel spoke about how Australia is a world leader in installed solar and is working to become a leading electrostate in the transition from the Industrial Age to the Electric Age.

He spoke of the great potential for exports of energy transition materials and products, including green iron, green nitrogenous fertiliser, and synthetic aviation fuel. Australia has many advantages in this area, including experience in resource development, low sovereign risk, and policy vision/certainty from the government.

The keynote address was followed by a warm and gracious Welcome to Country from Gadigal Elder Uncle Allen Madden.

This was followed by a joint case study by Leigh Holder (Yara Clean Ammonia) and Carlos Trench (Engie). Leigh and Carlos described how Project Yuri, Australia's largest hydrogen project, was conceived, developed and reached financial close. This joint venture is an ambitious $1.8 billion investment to install 10MW electrolyser and 18 MW solar panels in Pilbara - an area which once accounted for 2% of global ammonia production. Beyond being used as bunker fuel for ships supplying trade routes from China to Japan/Korea with iron ore cargo onboard; regional collaboration agreements have enabled Project Yuri's ambitions offtake goals too.

Image 3: Dr Finkel delivering his keynote address

LOW EMISSIONS METALS STREAM

SESSION 1: GREEN STEEL: GLOBAL MARKETS & TECHNOLOGY PATHWAYS

OVERVIEW AND SPEAKERS

This session focused on exploring the global market and the technology pathways for green steel production in Australia.

Presentations: Veena Sahajwalla (University of New South Wales), Kobad Bhavnagri (Bloomberg NEF), Geoff Brooks (Swinburne University).

Facilitated by: Dr Lisa Randone (ARENA).

Image 4: Panel discussion. From left to right: Veena Sahajwalla (UNSW), Kobad Bhavnagri (BNEF), Geoff Brooks (Swinburne University).

KEY TAKEAWAYS

- There are currently four primary steel making pathways: blast furnace (BF/BOF), smelting reduction, direct reduction (DRI/EAF) and scrap recycling.
- Recycling can provide massive emissions reduction, however, even assuming 100% recycling, 58% of supply will still need to come from primary sources.
- 70% of global steel production is via BF-BOF and blast furnaces have a big role to play now and in the near future. However, the industry is transitioning to other pathways, mainly DRI/EAF.
- The quality of the ore matters - many ore mined and exported by Australia is hematite, which is well suited to BF/BOF, but less suitable for DRI/EAF. There's an opportunity for Australia to either expand magnetite ore mining or to develop new technologies to process hematite ore (e.g., HDRI-Melter-BOF).
- Focused research is needed to optimise the use and operation of Australian ores in a low carbon steel industry. Different pathways are under investigation, including molten oxide electrolysis and gangue removal in melting furnaces.
- Hydrogen is one of the most promising options for green steel making.
- Hydrogen based DRI pathways are feasible but rely on a) low-cost hydrogen (approx. USD$2/kg); b) sufficient hydrogen supply; c) high grade ore (no issues from a technical perspective, but economically challenging – might require premium price).
- Renewable materials used as feedstock - waste polymeric material (e.g. coffee, plastic and tyres) can be utilised to provide the carbon and hydrogen needed in industrial processes such as steel making.

SESSION 2: GREEN STEEL: AUSTRALIAN INITIATIVES AND LESSONS LEARNT

OVERVIEW AND SPEAKERS

This session focused on domestic progress toward the decarbonisation of iron and steel production, including an exploration of challenges, successes and lessons learnt from a variety of Australian projects.

Presentations: Michael Buckley (Rio Tinto), Phil Hodgson (Calix), Andrew McClure (BlueScope), Wayne Harris (GFG), Kylie Turner (ETI).

Facilitated by: Alison Reeve (Grattan Institute).

Image 5: Panel discussion. From left to right: Michael Buckley (Rio Tinto), Phil Hodgson (Calix), Andrew McClure (BlueScope), Wayne Harris (GFG), Kylie Turner (ETI).

KEY TAKEAWAYS

- Rio Tinto is progressing its low-carbon iron making process (BioIron) using ores sources from Pilbara mines. BioIron involves the use of raw biomass, as an alternative to metallurgical coal, as a reductant and microwave energy. This will convert iron ore to metallic iron in the steelmaking process.
- Partnership between Rio and BlueScope explores the opportunity of adding an electric melter into the DRI-EAF process. The melter removes gangue and enables the use of low grade ore.
- Calix has developed the Zero Emissions Steel Technology (ZESTY), which uses hydrogen to reduce iron ore within a renewable powered electric calciner. The technology delivers efficient electrification of iron ore processing, minimises the amount of hydrogen required in the process and removes the need for ore pelletisation pre-processing.
- BlueScope has conducted a systematic study to investigate the technical and economic feasibility of renewable energy and decarbonisation technology pathways that have the potential to decarbonise the steelmaking process at the Port Kembla Steelworks (the report will be available on ARENA's website shortly). BlueScope is also conducting trials to inject biochar, mixed with pulverised coal, into the blast furnace.
- GFG's Whyalla green steel transformation project involves a DRI/EAF facility. Their magnetite iron ore expansion program is underway and the first batch of DR grade pellets has been produced.
- Key enabling factors to support the decarbonisation pathway include: power & network, natural gas, hydrogen, water supply, labour force, industry partnerships, funding and investment, government framework.
- The Australian Industry ETI has identified that a 1.5°C aligned future could be possible for Australia, including for heavy industry supply chains. However, it is also extremely challenging and the key measures required to achieve this pathway are not yet in place.

SESSION 3: GREEN ALUMINA: DECARBONISING ALUMINA REFINING IN AUSTRALIA

OVERVIEW AND SPEAKERS

This session discussed the pathway to decarbonise alumina refining in Australia, including some emerging technologies currently investigated by the industry.

Presentations: Elizabeth Boylan (Deloitte), Ray Chatfield (Alcoa), Sreeraj Balachandran (Rio Tinto).

Facilitated by: Zoe Von Batenburg (ARENA).

Image 6: Panel discussion. From left to right: Elizabeth Boylan (Deloitte), Ray Chatfield (Alcoa), Sreeraj Balachandran (Rio Tinto).

KEY TAKEAWAYS

- Australia is one of the world's largest exporters of alumina, and a key player in the global alumina refining industry, which is highly energy and emissions intensive;
- ARENA has recently released the "**Roadmap for Decarbonising Australian Alumina Refining**"[1]. The report was prepared by Deloitte in consultation with Alcoa, Rio Tinto and South 32;
- The Roadmap serves as a call to action for public and private sectors to collaboratively transition a hard-to-abate sector into an industry at the forefront of the transition to net zero;
- The following technologies, coupled with renewable energy, offer a pathway to reduce on-site alumina refining emissions by up to 98 per cent: Mechanical Vapour Recompression (MVR), electric boilers, electric calcination and hydrogen calcination; and
- Thermal storage is an important enabling technology in supporting the transition to variable renewable power sources.

Alcoa is looking at strategies to decarbonise the key steps of alumina refining and their feasibility studies have shown that MVR is a technically and commercially viable technology that can strongly contribute to the decarbonisation of the Bayer process. Alcoa's Calcination Pilot will test the feasibility of electric calciners powered by renewable energy to decarbonise the calcination process.

- Rio Tinto is looking at decarbonising the calcination process by displacing natural gas with renewable hydrogen;
- There is no one-size-fits-all approach and different refineries will require different combinations of technologies to achieve net zero due to the specific barriers and opportunities of individual refineries; and
- Key enabling factors to decarbonise alumina refining include firmed energy supply, transmission infrastructure, large-scale renewables, storage, coordination, partnerships and collaboration.

1 arena.gov.au/knowledge-bank/a-roadmap-for-decarbonising-australian-alumina-refining/

GREEN HYDROGEN STREAM

SESSION 1: GREEN HYDROGEN: SCALING UP TO EXPORT

OVERVIEW AND SPEAKERS

This session explored the pathway to scaling up green hydrogen projects from the current ~10MW scale to large and potentially export scale. Three project proponents for large-scale renewable hydrogen projects shared learnings and insights from their development journey to date. The growth of Australia's liquefied natural gas (LNG) domestic and export industry was analysed to draw comparisons on how Australia might similarly foster the growth of a renewable hydrogen industry.

Presenters: Mike McKensie (Macquarie GIG), Alex Dronoff (Fichtner Australia), Rachel Langford-Ely (FFI) and Phil Richardson (Stanwell).

Facilitated by: Alex McIntosh (ARENA).

Image 7: Panel discussion, from left to right: Alexandra McIntosh (ARENA), Mike McKensie (Macquarie GIG), Alex Dronoff (Fichtner Australia), Rachel Langford-Ely (FFI) and Phil Richardson (Stanwell).

KEY TAKEAWAYS

- Fortescue Future Industries (FFI) in partnership with Incitec Pivot Limited (IPL) are looking to develop 500 MW of electrolysis at IPL's existing Gibson Island (QLD) ammonia synthesis facility and to convert this facility to utilise renewable hydrogen.
- The emissions of FFI's parent, mining firm FMG, are equivalent to those of France. FFI is aiming for net zero emissions by 2040 and the organisation has been instructed to assume there will be no diesel fuel available by 2030.
- Customers across Europe, America and Asia are expressing strong demand for green hydrogen.
- Stanwell, in conjunction with an Australian and international consortium, is developing the Central Queensland Hydrogen Project (CQH2) - a large-scale renewable hydrogen production facility focused on export to Asia, possibly as renewable ammonia.
- Scale is critical for feasibility, developed in phases to manage technology and commercial risks.
- Four key project aspects for success are a) site with excellent proximity to power, water and transport but without competing issues; b) renewable electricity supply - capacity, price and flexibility; c) strategic project partners across the supply chain; and d) offtakers.

- Macquarie's Green Investment Group (GIG) in partnership with the Port of Newcastle is exploring the feasibility of developing a renewable hydrogen and ammonia production facility at the Port of Newcastle.
- Significant opportunity for large-scale green hydrogen developments, with ammonia likely to be the dominant transport vector. Projects developed in the near-term are likely to be focussed on domestic use cases until international supply chains with clear pricing and volume requirements emerge.
- Initial plans were scaled-up from a 40MW electrolyser to a capacity of between 150MW and 200MW to achieve feasibility.
- Australia has excellent conditions for green hydrogen production, however we face stiff and increasing competition from countries with similar advantages that also have greater government support, such as the US with their Inflation Reduction Act (IRA).
- The development of Australia's LNG industry offers some valuable perspective and lessons for the hydrogen industry.
- It was 10 years from when the WA government decided to under-write the first LNG project, by Woodside, to the point of the first LNG export shipment. Twenty five years later and Australia has become the world's biggest LNG exporter.
- A critical lesson from the LNG industry is to avoid duplicating infrastructure.
- Big plans and investments were made for LNG to be used for trucks in Australia, but this eventually failed due to gas prices rising, and lack of trucks and OEM support locally.

SESSION 2: GREEN HYDROGEN: HEAVY TRANSPORT

OVERVIEW AND SPEAKERS

Heavy transport is a critical part of any export supply chain and is notoriously hard to decarbonise, particularly in Australia with challenging geography and climate. Speakers at this session included two organisations that have established Hydrogen Refuelling Stations (HRS), and two that are currently implementing projects involving HRS as well as a range of Fuel Cell Electric Trucks (FCET), including the largest in the world.

Presenters: Daniel Hamel (Ark Energy), Chris Dolman (BOC), Matt Macleod (Toyota) and Rhys Moore (Viva Energy).

Facilitated by: Andrew Williamson (ARENA).

Image 8: Panel discussion, from left to right: Andrew Williamson (ARENA), Daniel Hamel (Ark Energy), Chris Dolman (BOC), Matt Macleod (Toyota) and Rhys Moore (Viva Energy).

KEY TAKEAWAYS

- Engineering capacity for these types of hydrogen projects is limited in Australia. Projects benefit from the early involvement of an owner's engineer.
- International OEMs are not aware of all the relevant mandatory Australian standards and requirements must be carefully and repeatedly communicated.
- Projects in Queensland require the involvement of a Registered Professional Engineer of Queensland (RPEQ).
- Installing the electrolyser is the easy part but making the whole system work is hard.
- 50% of the project cost is the electrolyser but the rest includes dispensers, storage, pipeline, and electrical connections. Engineering is required to make these projects work.
- The project relies on a global supply chain, which has been significantly disrupted by the war in Ukraine. The electrolyser is from Vietnam, compressors are from the US, high-pressure storage vessel come from Germany and low-pressure buffer tank from Australia.
- A small budget was allocated to the electricity supply, but high fault levels on-site triggered the need for a dedicated 33kV supply and associated works.
- The project has been designed with future growth in mind (e.g.: "We're not digging trenches again"). It's expected that spare production capacity will be used for bulk sales to third parties via tube-trailers.
- The key challenge for commercial HRS is working out how to refuel consecutive vehicles economically and safely. 'Peakiness' of demand is one of the most difficult challenges.
- Understanding the customers' perspective is critical – you can't expect them to significantly change processes and behaviour.
- Understanding commercial barriers and collaboration across the value chain are critical for successful project delivery.
- Demonstration projects involving large reputable operators are critical to develop credibility and understanding.
- The development approvals process for HRS projects is difficult and lengthy, because there is no established process yet. Each project is important for education, awareness and acceptance.
- Appropriate site selection is particularly important for early projects and perception is more important than compliance, particularly with respect to safety.
- Projects need to be future proofed in the design stages as technology and standards are changing fast, for example, in terms of vehicle tank pressures.

SESSION 3: CERTIFICATION OF GREEN HYDROGEN AND DERIVATIVES

OVERVIEW AND SPEAKERS

Green hydrogen is currently expensive and customers need a good reason to pay a premium for what is physically identical to more carbon-intensive hydrogen, and in some ways less convenient than natural gas. This session learnt about two certification programs being developed in Australia, and the perspectives of a firm planning to sell green ammonia to global buyers.

Presenters: Leigh Holder (Yara Clean Ammonia), Cameron Mathie (Clean Energy Regulator) and Manuel Weirich (NSW Treasury - Greenpower).

Facilitated by: Fiona Simon (Australian Hydrogen Council).

Image 9: Panel discussion, from left to right: Fiona Simon (Australian Hydrogen Council), Leigh Holder (Yara Clean Ammonia), Cameron Mathie (Clean Energy Regulator) and Manuel Weirich (NSW Treasury – Greenpower).

KEY TAKEAWAYS

- The Clean Energy Regulator (CER) is developing an Australian Guarantee of Origin (GO) Scheme that aims to build confidence in a range of low emission products, starting with green hydrogen. Consumers throughout the value chain should be able to rely on the scheme's certification without additional due diligence.
- The CER's activities are in parallel and in-sync with a wide range of international activities.
- CER are aiming for legislation to be in place by the end of 2023, and ready to issue certificates by early 2024.
- Twenty-three companies representing all parts of the value chain are participating in a trial to see how a certificate may work to meet their needs.
- For the scheme to be successful, it must have high integrity and be trusted. It will also need to be consistent with international markets and standards to enable trade. One challenge is balancing integrity and transparency against costs of participation.
- Several complex issues have emerged, such as the treatment of upstream emissions, and the risk of gaming and misrepresenting emissions.
- Today there is no globally agreed definition of what constitutes clean ammonia, but a colour code based on production pathways linked to hydrogen is widely used.
- Customers' requirements and preferences differ across markets (e.g. between Japan, Korea, Germany and France).

› International gas swap mechanisms, like what's done in the natural gas markets, may be important for developing markets and managing transport costs.
› Greenpower renewable gas certification pilot covers biomethane, biogas, and hydrogen (with a focus on blending) and may add other fuels.
› It's hoped this scheme will accelerate development of the supply of renewable gas and will also help existing gas users to identify and obtain a renewable gas supply.

CLOSING PLENARY

OVERVIEW

The final session for the day asked participants to reflect on lessons learnt and future actions.

Image 10: Facilitated by Kate O'Callaghan, ARENA

Participants discussed the need to better manage supply chains, introduce steel recycling and scale renewable energy to decarbonise industries. Common themes included the importance of running demonstrations or pilots before big capital investments take place, as well as identifying gaps in knowledge that could be addressed through research.

There remain notable opportunities for research and development, namely:

› minimising total cost of ownership for heavy transport vehicles;
› how to introduce Sustainable Aviation Fuel and Direct-Air Capture technologies into the market;
› Direct Reduced Iron using green hydrogen technology;
› domestic uses of liquid hydrogen, as well the gaseous hydrogen produced by boil-off during transport and storage; and
› the challenges presented by sourcing appropriate and sufficient water supply for hydrogen production cannot be underestimated.

Australia faces an urgent challenge to scale up renewable energy and decarbonise our economy. Electrolyser availability and strengthened transmission commitments are key components of this effort, as well as responding to international policy developments such as the Inflation Reduction Act. Partnerships and collaboration were seen as fundamental to accelerating Australia's efforts.

Further information is available at
arena.gov.au

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