Recommendation Report

India-Australia Green Hydrogen Taskforce

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Foreword by the Taskforce Co-Chairs

Scaling up in the production and use of green hydrogen so that it can become a significant contributor to global emissions reduction is a daunting task. India and Australia are stepping up to the challenge so together, we can address the climate change crisis and provide our citizens new opportunities to capitalise on the energy transition.

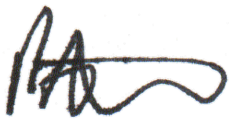
For this reason, we were honoured to be asked by Prime Minister Modi and Prime Minister Albanese to gather a group of hydrogen experts from our respective nations to come up with tangible, measurable and realistic recommendations on how India and Australia can work together to grow our respective green hydrogen industries.

Our Taskforce members, hailing from research and development, the private sector and financial consulting have been an invaluable asset towards providing both our nations a framework of recommendations to build on the exciting synergies which already exist. We thank them for their service, knowledge and contribution in this important endeavour.

As the executive summary will show, the Taskforce came up with five priority sectors which provide our respective governments with a toolset to mainstream green hydrogen in a range of key sectors.

This report could not have been possible without the support of our dedicated support staff at the Australian Department of Climate Change, Energy, the Environment and Water, the Indian Ministry of New and Renewable Industry, the Australian Commonwealth Scientific and Industrial Research Organisation, the Indian Council of Scientific & Industrial Research and many others too numerous to individually acknowledge. To each and every person that has contributed to this report, we give our wholehearted thanks.

We look forward to seeing this report strongly contribute to the crucial energy and industrial relationship between India and Australia, and we will follow its impact on the bilateral relationship with great interest in years to come.



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Executive summary

On 11 March 2023, the Prime Minister of Australia, the Hon Anthony Albanese MP, and the Prime Minister of India, Shri Narendra Modi, released a joint statement noting their intention to establish the India-Australia Green Hydrogen Taskforce to foster cooperation between our two nations on this important aspect of energy transition.

Both India and Australia have identified the development of hydrogen industries as a key component of their energy transition plans. Australia's first National Hydrogen Strategy was published in November 2019, and significantly updated and published in September 2024. India's National Green Hydrogen Mission was published in January 2023.

The Prime Ministerial announcement followed the signing of a Terms of Reference establishing the Taskforce by Secretary David Fredricks of the Australian Department of Climate Change, Energy, the Environment and Water and Secretary Bhupinder Singh Bhalla of the Indian Ministry of New and Renewable Energy in May 2023. A secretariat was also established by both governments to support the work of the taskforce and assemble its membership under the guidance of the Australian and Indian Co-Chairs.

The taskforce met throughout 2023 and 2024 and agreed on priority opportunities for collaboration. Members of the taskforce then undertook a range of studies of the specific opportunities which were identified as being of agreed importance to both countries. This resulted in the Taskforce prioritising five areas for India and Australia's focus and recommendations:

1. **Hydrogen technology co-development and manufacture**
    a. Recommendation 1.1: Facilitate electrolyser co-development and technology translation of electrolyser systems, components and manufacturing processes.
    b. Recommendation 1.2: Accelerate the co-development and commercialisation of hydrogen storage technologies (particularly low-cost high-pressure hydrogen tanks and emerging liquid hydrogen storage technologies) to support local hydrogen industry development and capture a portion of the growing global market.
2. **Green Minerals and Metals**
    a. Recommendation 2.1: Support the development of green iron and steel value chains in both countries through industry and research knowledge sharing and joint pilot projects.
    b. Recommendation 2.2: Support the development of green alumina and aluminium value chains in both countries through industry and research knowledge sharing leading to joint pilot projects.
3. **Green fuels & supply chains**
    a. Recommendation 3.1: Engage in collaborative projects that have the potential to help displace fossil fuel based methanol production and use with green fuels based on methanol and derivatives.
    b. Recommendation 3.2: Identify and support analysis underpinning enabling infrastructure for green shipping fuels (including ammonia).

4. Skills and workforce development

a. Recommendation 4.1: Facilitate joint programs for skills development and training in hydrogen technologies, including expanding mobility arrangements between countries in this area

5. Knowledge sharing

a. Recommendation 5.1: Support knowledge sharing initiatives between India and Australia in the areas of hydrogen research, development and innovation, including industrial developments.

b. Recommendation 5.2: Support hydrogen knowledge sharing initiatives between India and Australia in the area of policy, standards and regulation

On the topic of technology co-development, the Taskforce recommended reducing the high costs of electrolyser systems by co-developing electrolyser technology, leveraging Australia's innovation and India's manufacturing strengths. They also focused on enhancing hydrogen storage technologies, particularly for high-pressure and liquid hydrogen tanks. Collaboration between Australia's expertise in carbon fibre composites and India's manufacturing capabilities aimed to accelerate commercialisation and reduce reliance on imported materials.

The taskforce also discussed non-electrolysis based approaches to hydrogen production, including biomass based technologies which are a particular focus for India. The taskforce noted that there is also emerging interest in these technologies in Australia, and that this could be a longer term focus for collaboration between the countries.

In the area of hydrogen utilization, a number of options were discussed, including hydrogen use in augmenting electricity systems and transportation, however a near term focus on the scale up of industrial uses of hydrogen was adopted. In this area, the Taskforce recommended strengthening industrial hydrogen value chains in sectors like green iron and steel, and green alumina and aluminium. They discussed joint efforts in techno-economic modelling, co-developing green iron production, and establishing green iron export supply chains. In the alumina sector, where hydrogen was seen as a decarbonisation pathway, the Taskforce recommended extending the India-Australia Green Steel Partnership model into the alumina / aluminium sector to foster joint pilot projects and industry-research partnerships.

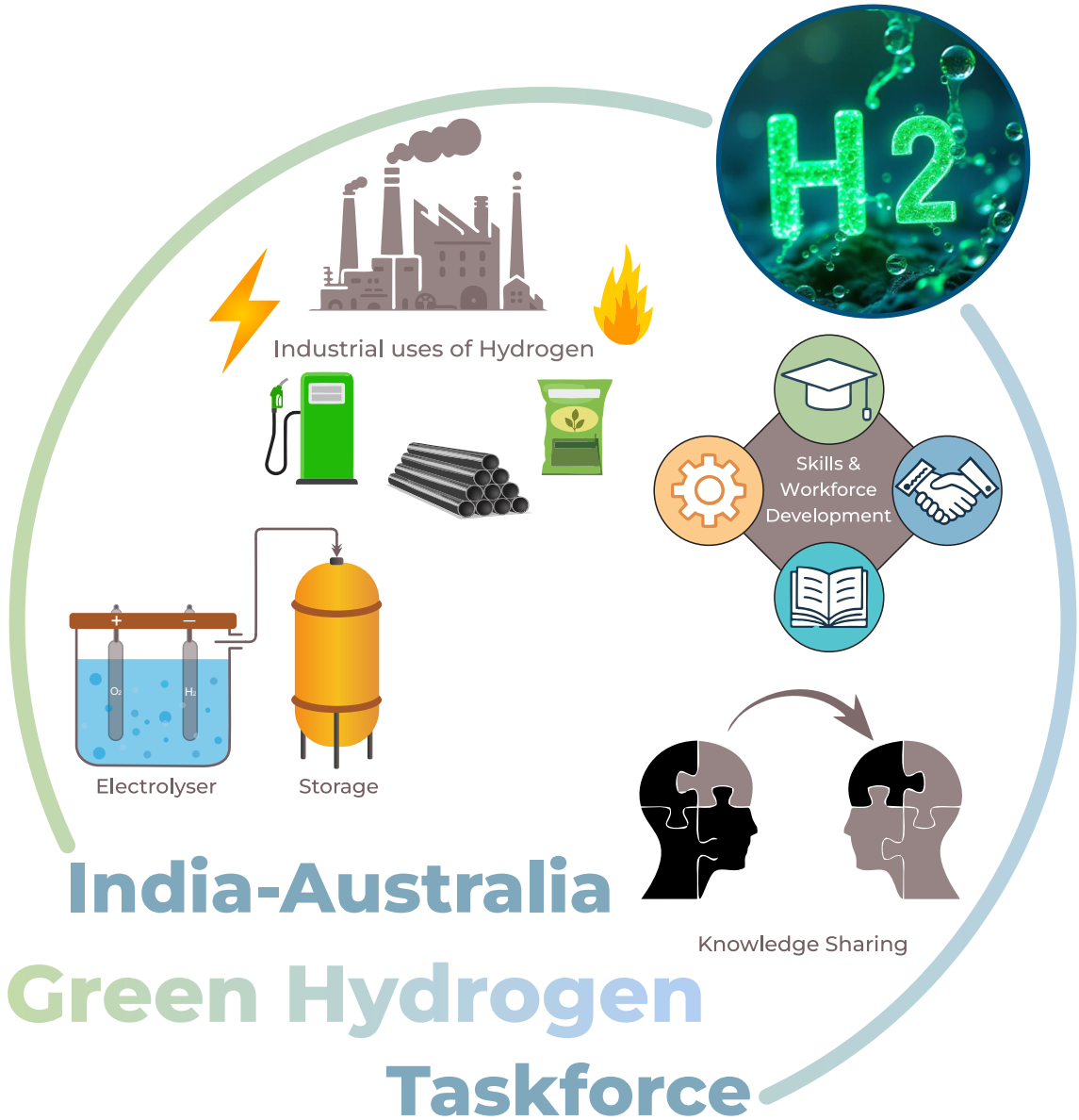
On green fuels and supply chains, the Taskforce recommended technology transfer from India to Australia on bio-methanol along with joint research and modelling initiatives, and co-development of ammonia supply chain infrastructure, and associated safety and regulatory practices with a focus on ports (eg bunkering facilities)

On skills and workforce development, the report recommends Australia and India focus on developing a skilled workforce through joint programs and expanded mobility arrangements. The Australian MATES visa scheme will allow Indian graduates and early professionals to gain experience in Australia's renewable energy and hydrogen sectors. The Taskforce also recommended mapping skill shortages, developing training standards, and creating vocational and tertiary courses to ensure a skilled workforce.

On knowledge sharing, the Taskforce emphasised research collaboration through shared databases, bilateral conferences, and policy roundtables on standards, regulations, and best practices.

The Taskforce also identified knowledge sharing across all the identified areas of focus through industry round tables and conference forums as a near term opportunity to introduce and promote collaborations between industry and research stakeholders in all priority areas.

Each of these collaboration opportunities is supported with examples of near and long-term activities and projects for consideration. If accepted, the recommendations will provide a roadmap for near term engagement into the next five years.



Priority 1:
Hydrogen Technology co-development and manufacture

Recommendation 1.1: Facilitate electrolyser co-development and technology translation of electrolyser systems, components and manufacturing processes.

Both India and Australia have ambitions to become major producers of hydrogen and have identified electrolyser technology development and manufacturing as key elements within their respective hydrogen and industry strategies. Electrolyser costs are currently high, and a major contributor to the levelised cost of hydrogen production (LCOH). For example, a recent analysis by Aurecon (2024) places current PEM electrolyser capex costs in Australia in the range AUD 2750-3750 /kW/INR 1.55 lakhs – 2.1 lakhs/kW. Reduction in these costs is critical to the commercial viability of hydrogen production projects in both countries.

A collaborative effort on electrolyser technology improvement and innovative manufacturing with a focus on capital cost reduction and efficiency improvement could deliver mutual benefit to both countries. Australia has a number of electrolyser developers seeking to scale-up production and access global markets, whilst India has a larger venture capital sector and a strong manufacturing base, with ambitions to develop a large electrolyser manufacturing industry. The goals of collaboration in this area are to achieve cost reductions and increase market access and benefits from the growing global electrolyser industry. Supporting connectivity between Australian electrolyser innovators and large-scale manufacturers in India, under suitable IP sharing arrangements, is a near term opportunity for both countries.[1] [2]

The Taskforce identified the following near and long-term specific opportunities for collaboration in this priority area:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
Market Development	• Connect Australian electrolyser developers with Indian venture capitalists and manufacturers through roundtables and develop tech transfer with intellectual property sharing mechanisms	• Joint investment in electrolyser development / manufacturing innovation & commercialization (Higher TRL)
RD&I	• Co-development of enabling infrastructure for electrolyser demonstration and testing to support electrolyser commercialisation e.g. mobile electrolyser testing station (up to 1MW)	• Electrolyser systems & componentry co-development program. Include development of next gen electrolyser technologies e.g. SOEC, AEM and Membraneless electrolysers (Lower TRL) • Non-electrolyser based technologies for hydrogen production, particularly focused on biomass feedstock.

[1] Noting existing cooperation already exists through the Quad Clean Energy Supply Chain Diversification Program. The aims of the Program include helping to strengthen, diversify, and accelerate development of hydrogen electrolyser supply chains in the Indo-Pacific. More information at https://business.gov.au/grants-and-programs/quad-clean-energy-supply-chain-diversification-program

[2] A number of organisations are available to assist with technology co-development in India and Australia, including but not limited to CSIRO, ARENA and CSIR.

Recommendation 1.2: Accelerate the co-development and commercialisation of hydrogen storage technologies (particularly low-cost high-pressure hydrogen tanks and emerging liquid hydrogen storage technologies) to support local hydrogen industry development and capture a portion of the growing global market.

Indian and Australian stakeholders have recognised a strong need to control the costs related to hydrogen storage and transportation to affordably offer green hydrogen to consumers.

An example of a hydrogen storage collaboration area relates to the use of composites to create carbon fibre-based storage tanks. India is already aiming to improve its carbon fibre production technology capability in the short term.[3] Further, under the India's National Technical Textile Mission, CSIR is developing novel carbon fibres and recyclable storage tanks with participation of several Indian research and industrial organisations. Australian industry and research organisations have a rich history of research with carbon fibre technology development. This includes start-ups and industry that are advancing cost-effective carbon fibre technologies and manufacturing methods, and leading applied research from a broad range of institutions.

Australian prowess in composite technology development in conjunction with the large-scale manufacturing capabilities in Indian companies present an opportunity to symbiotically accelerate the development and commercialisation of cost-effective carbon fibre cascades and storage tanks.

CASE STUDY: Joint India-Australia Research Programs and centres

IIT Madras and Deakin University in Australia have had a long running and productive research collaboration centred on materials science and engineering research. In 2023, they partnered to form the IIT Madras- Deakin University Research Academy. The two institutions also partnered in 2022 to launch the Australia–India Centre for Energy, and in 2018 were jointly awarded a prestigious Australia–India Strategic Research Fund grant, enabling India's first bilateral Centre of Excellence in Advanced Materials to be established. Of relevance to this collaboration area, Deakin University has also established the Carbon Nexus research facility at its campus in Victoria, which now lies at the heart of a carbon fibre and composites manufacturing cluster.

RMIT University in Australia has partnered with the Academy of Scientific & Innovative Research (AcSIR) in India for a joint PhD research program to foster collaborations with leading research institutions in India to achieve research excellence and innovation. AcSIR works in conjunction with the Council of Scientific and Industrial Research (CSIR), the largest research and development organisation in India.

[3] https://economictimes.indiatimes.com/industry/telecom/telecom-news/india-to-begin-producing-t100-carbon-fibre-in-2-5-years-v-k-saraswat/articleshow/109978486.cms?from=mdr

Over time, such collaboration could also help to reduce both countries reliance on imported carbon fibre materials.[4,5]

The taskforce also identified co-development and manufacturing of hydrogen storage technologies related to liquid hydrogen and hydrogen derivatives as an emerging opportunity, with a particular emphasis on long distance transport of hydrogen. This includes both the transport of hydrogen and derivatives for export, and the domestic distribution of hydrogen to underpin hydrogen refuelling station networks. Both of these are active areas of Australian and Indian research and industry activities.

The Taskforce identified the following near and long-term opportunities for collaboration:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
Market Development	• Jointly evaluate opportunities for materials supply chain & manufacturing development (e.g. fibre precursors, polymer resins, processing technologies)	• Co-development of pilot manufacture and testing facilities for high pressure / liquid hydrogen tanks • Joint development of carbon fibre supply chains between India and Australia
RD&I	• Promote joint carbon fibre / composite research programs e.g. Deakin University's Carbon Nexus and CSIR's carbon fiber program under National Technical Textiles Mission Managing boil off gas in liquid hydrogen transport	

[4] https://www.firstpost.com/india/india-carbon-fibre-manufacturing-13755165.html

[5] https://dataportal.arc.gov.au/NCGP/Web/Grant/Grant/DP230101204#:~:text=The%20hybrid%20composites%20are%20expected,global%20supplier%20of%20green%20energy.

Priority 2:
Green Minerals and Metals

Recommendation 2.1: Support the development of green iron and steel value chains in both countries through industry and research knowledge sharing and joint pilot projects

CASE STUDY: Joint India-Australia Research Programs and centres

CSIRO in Australia has established the India-Australia Green Steel Partnership (IAGSP) with the Indian Ministry of Steel. The IAGSP is set to execute various research, technology, and commercialisation projects over the next 3.5 years, with the goal of accelerating the decarbonisation of the iron-steel value chain in both India and Australia. These partnerships are gaining traction, and the India-Australia Minerals Scholars Network has emerged as a specific initiative within the IAGSP framework.

The Taskforce identified the benefit of India and Australia building on existing collaboration efforts to facilitate the production of green iron and steel using hydrogen and syngas produced from various feedstocks including biomass. This would help support decarbonisation as well as position the countries for long-term and mutually beneficial trade and export opportunities. [6]

Hydrogen has potential to decarbonise ironmaking through two main avenues.

The first relates to the use of hydrogen as a reducing agent for the production of direct reduced iron (DRI),[7] where it could be used to replace fossil fuels entirely from the process. The second is the injection of hydrogen into a conventional blast furnace[8] to offset current fossil fuel usage in ironmaking. To support these two avenues, a cost competitive and large-scale hydrogen supply chain must be developed.

India is currently the world's largest producer of DRI, the majority of which comes from coal based DRI.

Hydrogen based DRI processes use a shaft furnace which is currently an active area of technology and research effort in both countries and will continue to require investment. Further, both Australia and India have significant hematite/goethite iron ore resources which require upgrading (beneficiation) prior to DRI processing.[9] The joint development of clean beneficiation technologies and approaches, and greater operational knowledge sharing can help India and Australia rapidly expand their respective green iron and green steelmaking industry.

The Taskforce identified the following near and long-term opportunities for collaboration:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
Market Development	• Joint development and demonstration of hydrogen based DRI in India with a view to tech translation to Australia (incentivise industry in both countries)	• Green Iron export supply chain between Australia and India

[6] This will build on existing trade links. Australia exported AUD 400 million of iron ore to India in 2023. See https://www.dfat.gov.au/sites/default/files/inia-cef.pdf

[7] World Steel Association. Hydrogen (H2)-based ironmaking. https://worldsteel.org/wp-content/uploads/Fact-sheet-Hydrogen-H2-based-ironmaking.pdf

[8] Nippon Steel. Development Hydrogen Injection Technology into Blast Furnace. https://www.nipponsteel.com/en/news/20230804_200.html

[9] (61.9-61.5% for Australia and 62.2-63.0% for India) Calculated based on data from the Mineral Commodity Summary (United States Geological Survey). https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-iron-ore.pdf

RD&I	• Joint supply chain technoeconomic modelling • Development of a thorough understanding of the behaviours or hematite goethite ores in shaft furnaces and co development of novel processing / production technologies accordingly • Co-development and testing of a pilot end-to-end demonstration of green iron production from Australian and Indian hematite-goethite ores)	• Review existing program and consider opportunities for extension / expansion

Recommendation 2.2: Support the development of green alumina and aluminium value chains in both countries through industry and research knowledge sharing leading to joint pilot projects

Both Australia and India have globally significant bauxite mining, alumina refining and aluminium smelting industries. Australia is the largest producer of bauxite, the largest exporter of alumina, and sixth largest producer of aluminium in the world. Australia is a large exporter of alumina to India. India is the world's third largest producer of aluminium, an importer of aluminium scrap and a net-importer of alumina. Some 38% of India's alumina imports are from Australia.

The Taskforce identified strong alignment between India and Australia's alumina and aluminium sectors. Alumina refining is an emission intensive step in the aluminium production chain. Multiple decarbonisation pathways are being explored in alumina, with hydrogen identified as having potential and currently under investigation in Australia.Given the scale and value of the alumina sectors in both countries, India and Australia have an incentive to collaborate on decarbonisation of this process step. This could both support industry decarbonization objectives and strengthen longer term trade outcomes between the countries.

The taskforce identified industry and research knowledge sharing in this area as a priority, and the potential to draw on the collaborative model adopted by the existing Australia-India Green Steel Partnership (see earlier case study) to accelerate the development of green alumina and green aluminium in both countries. Such a partnership could focus on incentivising hydrogen pilot plants and technology development between the countries.

The Taskforce identified the following near and long-term opportunities for collaboration:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
Market Development	• Extend or establish an equivalent forum as the existing India – Australia Green Steel Partnership to look at Alumina & Aluminium	• Development of a low-carbon alumina supply chain from Australia to India • Co-development of novel alumina / aluminium production and processing technologies such as hydrogen calciners for alumina
RD&I	• Joint supply chain technoeconomic modelling across aluminium production decarbonisation pathways to understand cost competitive technology options and identify collaborative R&D priorities • Establish Industry / Research round tables to share knowledge and explore joint R&D opportunities • Embed alumina / aluminium research in joint research programs e.g. Australia-India Strategic Research Fund(AISRF).	• Joint pilot projects in Australia / India

Priority 3:
Green Fuels, Feedstocks & Supply Chains

Background to Priority

The taskforce identified two main areas for potential collaboration under this priority: green methanol-based fuels and enabling infrastructure for the storage & bunkering of fuels including ammonia. A key focus identified by the taskforce was the development of enabling infrastructure such as bunkering to support the increased utilisation of these low carbon fuels in marine applications, and their global trade as green hydrogen carriers.

Recommendation 3.1: Engage in collaborative projects that have the potential to help displace fossil fuel based methanol production and use with green fuels based on methanol and derivatives

India is the world's second largest importer of methanol, and anticipates growing demand in the chemicals and transportation sectors in coming years. Methanol and its derivatives such as Dimethyl Ether (DME) are clean burning fuels which are used extensively in transport and domestic applications, either as standalone fuels or blending additives. India is also targeting increased production of methanol and its derivatives to reduce reliance on import supply chains. Current methanol supply is reliant on fossil fuel based production. There is considerable work underway looking at low emissions alternatives, particularly green methanol production and making use of existing waste streams of biogenic feedstock (biomethanol).

Australia is a small net importer of methanol but is host to a number of projects seeking to produce biomethanol for export. However, the lack of established supply chain partnerships represents a barrier to commercialisation for these projects. Australian researchers are also actively investigating novel direct methanol synthesis approaches, and opportunities to leverage methanol to derive various chemicals, plastics, and fuels (i.e. 'Methanol-to-X').

There is also a history of Australia – India research and development collaboration in this area. Further collaboration between partner countries could provide new opportunities for decarbonisation of existing methanol usage in India, as well as the potential to develop new and diversified green methanol supply chains between the countries.

The Taskforce identified the following near and long-term opportunities for consideration:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
Market Development	• Technology transfer from India to Australia on bio-methanol. • Joint supply chain technoeconomic modelling	• Development of green methanol export supply chain from Australia to India • Green methanol fuelled shipping corridor between Australia and India (for various commodities)
RD&I	• Establish a joint Australia-India Sustainable fuels (including biomethanol) research partnership that considers areas such as development of direct methanol synthesis and methanol-to-X processes (either through process intensification or miniaturisation), catalyst development, and energy efficiency	• Joint pilot project(s) demonstrating jointly developed technologies in areas such as biomethanol, sustainable aviation fuels, green olefins

Recommendation 3.2: Identify and support analysis underpinning enabling infrastructure for green shipping fuels (including ammonia)

India and Australia have both identified the use and export of hydrogen derivatives such as ammonia as key elements of their respective hydrogen strategies, but storage and bunkering of ammonia and other hydrogen derivatives such as liquid hydrogen and liquid organic carriers are yet to be established at scale.

Ports in both countries are examining the unique requirements (including safety) in different locations, however knowledge sharing in this area appears limited, and presents an opportunity to accelerate deployment. Import and export terminals will also need to be optimised depending on the hydrogen carrier in question. For example, hydrogen recovery processes such as ammonia cracking, liquid hydrogen regasification, and Liquid Organic Hydrogen Carrier (LOHC) dehydrogenation represent significant investments for an import terminal.

The Taskforce identified the following near and long-term opportunities for consideration:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
Market Development	• Establish Port roundtables to share best practice and inform modelling (includes safety, standards & regulatory aspects) • Co-development of certification mechanisms to facilitate trade in these commodities (including carbon border adjustment mechanism aspects)	• Joint pilot projects for zero-emission fuelled shipping of products from Australia to India at selected ports in both countries
RD&I	• Joint R&D initiatives to develop cost effective production and processing of green ammonia and other derivatives (e.g. LOHC, LH2, SAF)	• Joint R&D to improve hydrogen export and hydrogen recovery processes at ports to minimise energy penalties and reduce costs

Priority 4:
Skills and workforce development

Background to Priority

The scaling up of the global hydrogen industry requires the development of a skilled workforce to develop, operate, maintain and ensure the safety of hydrogen projects in both India and Australia.

Australia and India have distinct workforce capabilities that collectively span the hydrogen value chain. For example, while Australia has demonstrated expertise in renewable energy generation (wind and solar) and hydrogen production at the MW-scale, India has leading knowledge in steelmaking, industrial process engineering, and biomass utilisation. Similarly, while Australia produces a large number of Masters and PhDs in renewable energy through its rich university ecosystem, India produces one of the largest numbers of highly qualified project engineers. Existing educational and research partnerships can provide the initial basis of an exchange of expertise and facilitate bilateral skill development opportunities to accelerate each country's hydrogen industry (refer MATES program case study below). But there may be a need to develop new channels to ensure the mobility of talented individuals educators, students, and other professionals (e.g. safety specialists).

Recommendation 4.1: Facilitate joint programs for skills development and training in hydrogen technologies, including expanding mobility arrangements between countries in this area

To support hydrogen industry development, the Taskforce identified four activities that would aid skills and workforce development:

Mapping of skill requirements: Identification of the specific skill shortages and capabilities (occupational profiles) for the development of hydrogen projects should form the basis of certification, training, and migration priorities (for example, see the Clean Energy Generation Workforce Needs for a Net Zero Economy (Australia) report and Skill Gap Assessment Across Green Hydrogen Sector in India report). These profiles range from engineers, managers, technicians, and so on, with specific hydrogen-related competencies, and can be quantified based on the size of workforce requirements.

Standards and Certifications: Training standards for the areas identified in the skills mapping should be developed.

Vocational training: A range of vocational education offerings should be established, taking into account courses that are designed to re-skill previously trained professionals, as well as entry-level training for school leavers. Particular attention should be placed on hands-on training in the field to supplement classroom education. An Australian Technical and Further Education (TAFE) like model can be expanded to offer hydrogen-specific

CASE STUDY: Mobility Arrangement for Talented Early-professionals (MATES) Scheme

The MATES scheme is an example of an established bilateral collaboration and visa pathway that could be leveraged to support hydrogen industry development.

MATES will give Indian university graduates and early career professionals the opportunity to live and work in Australia for up to two years, and to gain employment and valuable experience in their areas of expertise. The scheme will also benefit Australian industry sectors and businesses by enhancing their access to some of India's most talented graduates with in-demand knowledge and skills. Eligible fields will include renewable energy, mining, engineering, information and communication technology, artificial intelligence, financial technology, and agricultural technology. MATES will commence as a pilot with 3,000 places for primary applicants per program year.

training and form part of the educational offerings under mobility arrangements. In India, the Pradhan Mantri Kaushal Vikas Yojana (PMKVY 4.0, Prime Minister Youth Training Program) and the National Institute of Solar Research (NISE) are offering training programs for hydrogen technologies under the NGHM.[10] Similar course structures can be further adopted in India at already existing network of skill development institutes such as the Industrial Training Institutes (ITI).

Tertiary & Higher degree training: While a range of university degrees exist which enable graduates to engage with the renewable energy and hydrogen industry, there is opportunity to tailor course curriculum to address skill shortages. Both India and Australia can harness world leading expertise from the Group of Eight (Go8) universities in Australia and IIT/IISc/IISER/AcSIR/NIT institutions in India to create tailored offerings and opportunities for student and educator exchange.

The Taskforce identified the following near and long-term opportunities for consideration:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
Market Development	• Knowledge sharing on skills mapping • Co-development of training standards & training certification • Co-development of vocational & tertiary hydrogen training courses / approaches (examples exist in both countries) • Leverage existing mechanisms e.g. MATES for hydrogen skills mobility	• Expansion of mobility arrangements Joint training facilities • Additional course offerings (online, graduate / postgraduate)
RD&I	• Hands on training on hydrogen technologies via research, development and demonstration collaboration projects Co-funding of higher degree (eg PhD) student mobility program	

[10] *See https://sscgj.in/training/ and https://training.nise.res.in/Trainings*

Priority 5:
Knowledge sharing

Background to Priority

Both India and Australia recognise the need to partner internationally to accelerate hydrogen industry development globally. Knowledge sharing between countries is a key pillar of bilateral and multilateral collaboration and provides mutual benefits in terms of acceleration of innovation, identification and mitigation of risks, and skills development. These are all critical inputs into adaptive government policy development and optimisation of industry investments.
The Taskforce identified two specific areas to focus efforts:

- knowledge sharing in relation to research, development and innovation (including industrial innovation), with the goal of improving industry and research collaboration outcomes, and
- knowledge sharing related to policy, standards and regulation, with the goal of accelerating the uptake of best practice.

Recommendation 5.1: Support knowledge sharing initiatives between India and Australia in the areas of hydrogen research, development and innovation, including industrial developments.

Keeping pace with the rapid developments in hydrogen technology and industry priority settings globally presents a major challenge for government, industry and the community. Solving this challenge requires industry and research experts to work together to identify and communicate key findings. Effective communication can also be important in combatting the spread of unreliable disinformation, which can lead to adverse public opinion.

Both India and Australia have invested in building foundational activities that could serve as the basis for greater industry and research collaboration. For example, both countries have readily accessible online databases of hydrogen industry projects, published reports on hydrogen research and development priorities and activities.[11][12] There is also potential to leverage existing energy related bi-lateral and multi-lateral forums where hydrogen industry information can be exchanged. For example, the Australia India Renewables Dialogue (AIRD), International Partnership on Hydrogen and Fuel Cells in the Economy (IPHE), Mission Innovation, and the Clean Energy Ministerial.

The Taskforce identified the following near and long-term opportunities for consideration:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
Market Development	• Promote connectivity between government agencies and industrial partners associated with Indian and Australian Hydrogen Hubs schemes.	• Explore Mechanisms for co-development of synergistic national research and development priorities

[11] e.g. MNRE Project Database (India) https://nghm.mnre.gov.in/project.php , CSIRO Hyresource Database (Australia) https://research.csiro.au/hyresource/.

[12] MNRE India's "R&D Roadmap for Green Hydrogen Ecosystem in India" and CSIRO Australia's 'Hydrogen Research Development & Demonstration: Priorities and opportunities for Australia" – as well as CSIRO's Hyresearch database also comprises a comprehensive listing of hydrogen research and development projects in Australia https://research.csiro.au/hyresearch/;

	• Share best practice and lessons learned by supporting establishment of joint industry forums & working groups in specific areas e.g. project delivery, technical working groups, standards & regulations, environmental impacts • Funding for Joint India – Australia Hydrogen Research bilateral conferences • Ongoing support for an Australia – India Green Hydrogen Taskforce or similar as the 'convening entity' for joint knowledge sharing activities between the countries	• Joint design / development of knowledge sharing databases
RD&I	• Develop & share research, development and industry databases in both countries to continue refining areas for collaboration • Support bilateral research conferences / workshops to connect researchers and stimulate RD&I collaborations	

Recommendation 5.2: Support hydrogen knowledge sharing initiatives between India and Australia in the area of policy, standards and regulation

In the drive to meet net zero emissions commitments, many countries around the world (including India and Australia) are formulating and implementing policy incentives to stimulate hydrogen value chains. Examples include the Inflation Reduction Act and Bipartisan Infrastructure Law in the US, and the European Green Deal. A recent example from Australia is the announcement of a hydrogen production tax incentive (HPTI) in the May 2024 federal budget, which complements the Hydrogen Headstart scheme delivered by the Australian Renewable Energy Agency. Similarly, India's green hydrogen Production Linked Incentive (PLI) scheme provides incentives for the production of green hydrogen as well as manufacturing of electrolsyers.

Given the rapid pace of policy development in the hydrogen space, Australia and India could collaborate on global hydrogen policy, standards and regulation with a key focus on interoperability and hydrogen certification through existing international networks such as QUAD, IPHE, World Economic Forum, Mission Innovation and/or IEA. This could build on work Australia has begun with its Guarantee of Origin Scheme.[13] Coordination would allow discussion of best practice and lessons learned and help accelerate the development of 'fit for purpose' policy, regulations and standards between the two countries and key export partners.

[13] The GO scheme includes a product-based emissions accounting framework. This framework measures and tracks emissions and associated information for products across the value chain. It will provide a streamlined process for reporting emissions information based on robust internationally aligned emissions accounting methodologies. The scheme would enable producers to make credible low emissions claims about their products. This will unlock opportunities for trade, decarbonisation and investment. More information is available at https://www.dcceew.gov.au/energy/renewable/guarantee-of-origin-scheme

The Taskforce identified the following near and long-term opportunities for consideration:

Theme	Near Term Opportunities	Longer Term / Aspirational Opportunities
	• Establish policy round tables to share initiatives and develop best practice via paper co-authorship • Establish standards & regulatory round tables to share initiatives and develop best practice via paper co-authorship	• India and Australia to co-fund study on interoperability of respective certification regimes.
RD&I	• Support joint policy research initiatives • Identify and share best practice in research and development governance models	

Glossary

AcSIR	Academy of Scientific & Innovative Research
AEM	Anion exchange membrane electrolysis
AIRD	Australia India Renewables Dialogue
AISRF	Australia-India Strategic Research Fund
ARENA	Australian Renewable Energy Agency
AUD	Australian Dollar
Capex	Capital expenditure
CEM	Clean Energy Ministerial
CSIR	Council of Scientific & Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DME	Dimethyl Ether
DRI	Direct reduced iron
FCEV	Fuel cell electric vehicle
GO Scheme	Australian Guarantee of Origin Scheme
Go8	Group of Eight Universities
H2ICE	Hydrogen Internal Combustion Engine
H2T	India's Hydrogen Technology Program
HPTI	Hydrogen production tax incentive
IAGSP	India-Australia Green Steel Partnership
IEA	International Energy Agency
IISc	Indian Institute of Science
IISER	Indian Institutes of Science Education and Research
IIT	Indian Institute of Technology
INR	Indian Rupees
IP	Intellectual property
IPHE	International Partnership on Hydrogen and Fuel Cells in the Economy
ITI	Industrial Training Institutes
LCOH	Levelised cost of hydrogen production
LH2	Liquid hydrogen
LOHC	Liquid Organic Hydrogen Carrier
MATES	Australian Mobility Arrangement for Talented Early-professionals Scheme
MI	Mission Innovation

Glossary

MW	Megawatt
NGHM	Indian National Green Hydrogen Mission
NISE	National Institute of Solar Research
NTTM	India's National Technical Textile Mission
PEM	Proton exchange membrane (PEM) electrolysis
PhD	Doctor of Philosophy
PMKVY	Pradhan Mantri Kaushal Vikas Yojana (Pradhan Mantri Youth Training Program)
QUAD	Quadrilateral Security Dialogue
R&D	Research and development
RD&I	Research, development and innovation
RMIT	Royal Melbourne Institute of Technology
SAF	Sustainable aviation fuel
SOEC	Solid oxide electrolyser cell
TAFE	Australian Technical and Further Education
TPD	Temperature programmed desorption
TRL	Technology Readiness Levels
WEF	World Economic Forum

Priority Sectors for India-Australia Hydrogen Collaboration

▼Sectors |Timeline►	Near Term (3-5 years)	Mid Term (5-10 years)
Technology co-development & manufacture	I. Manufacturing of electrolyser components and systems II. Manufacturing low-cost hydrogen storage tanks	I. Biomass to hydrogen via pyrolysis route & 50-100 TPD Biomass to hydrogen/syngas via gasification II. Electrolytic ammonia
Industrial uses of hydrogen	I. Green products e.g. iron, steel, alumina & aluminium II. Green fuels and chemical feedstocks, processing, refining, and ammonia (methanol to olefins, fertilisers, not including sustainable aviation fuels)	
Enabling infrastructure	I. Storage (ammonia, methanol, liquid hydrogen (LH2), liquid organic hydrogen carriers (LOHC), sustainable aviation fuels) and pipeline facilities at ports	I. Bunkering of ammonia, methanol, LOHC, LH2 II. Common use infrastructure such as retrofitted/ repurposed natural gas pipelines III. Smart grids
Skills & workforce development	I. Mobility of talent arrangements e.g. MATES scheme II. Mobility arrangement for hydrogen educators, including trained safety professionals	
Knowledge sharing	I. Collaborative databases with India e.g. ARENA project knowledge sharing, HyResource, HyResearch II. Policies, standards, and regulations III. Sharing national R&D priorities IV. How to plan, execute, operate and learn from hydrogen hubs/valleys V. Industry awareness/trends	I. Gas blending into urban gas networks
Transportation		I. Marine Transportation II. Road vehicles (H2-ICE, FCEV) III. Refuelling infrastructure

Indian Initiatives Aligned with India – Australia Green Hydrogen Taskforce Recommendations

Name of Initiative	Date of Announcement / Commencement	Brief Summary	Link to IAGHT Recommendation Theme	Link to India's National Green Hydrogen Mission	URL
SIGHT Programme – Incentive Scheme for Electrolyser Manufacturing	28-06-2023	Domestic electrolyser manufacturing capacity of 3,000 MWPA have been awarded with maximum support of ₹4,440 Crore from the Government of India.	Recommendation 1.1: Facilitate electrolyser co-development and technology translation of electrolyser systems, components and manufacturing processes	The objective of the scheme is to maximize the indigenous electrollyser manufacturing capacity, achieving lower levelized cost of hydrogen production, ensuring globally competitive performance and quality of products, progressively enhancing domestic value addition, and supporting established and promising technologies.	https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da7739 oads/2023/07/2023072664.pdf
R&D Scheme	15-03-2025	23 R&D Projects Awarded. Funds allocated for these projects is about ₹1 15 Crore.	Recommendation 1.2 : Accelerate the co-development and commercialisation of hydrogen storage technologies (particularly low-cost high-pressure hydrogen tanks and emerging liquid hydrogen storage technologies) to support local hydrogen industry development and capture a poron of the growing global market.	The objective of the scheme is to increase the affordability of Green hydrogen production, storage, transportation, and utilization, and to enhance efficiency, safety and reliability of the relevant systems and processes, to build industry - academia-government partnerships, to facilitate scaling up and commercialization.	https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/03/20240316152774043.pdf

Pilot Projects in Steel Sector	02-02-2024	Five pilot projects have been awarded for the use of hydrogen in steel sector. Funds allocated for these projects is about ₹132 Crore.	Recommendation 2.1: Support the development of green iron and steel value chains in both countries through industry and research knowledge sharing and joint pilot projects	The objective of the scheme is to advance technologies and expertise, addressing any existing gaps in steel sector , including supporting the deployment of Green Hydrogen and its derivatives in the steel, to validate the technical feasibility and performance of Green Hydrogen and its derivatives, to evaluate economic viability, to evaluate the performance and identify the areas for improvement, to demonstrate safe and secure operations.	https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/02/20240202206 4546305.pdf
Pilot Projects in Shipping Sector	01-02-2025	For retrofitting of two vessels, Garden Reach Shipbuilders and Engineers Ltd. (GRSE) and Cochin Shipyard Ltd. (CSL) have been engaged. To develop the bunkering and refuelling facilities for Green Hydrogen and its derivatives, V. O. Chidambaranar Port Authority has awarded a project.	Recommendation 3.2: Iden tify and support analysis underpinning enabling infrastructure for green shipping fuels (including ammonia).	The objective of the scheme is to support the deployment of Green Hydrogen and its derivatives as fuel for ship propulsion, including bunkering and refueling on a pilot basis, to validate the technical feasibility and performance of Green Hydrogen and its derivatives based ship propulsion, to evaluate the economic viability, to assess the effectiveness, to evaluate the performance, and identify the areas of improvement, to demonstrate safe and secure operations.	https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/02/202402021243386059.pdf

Skill Development	16-03-2024	43 Q ualification Packs prepared; 81 master trainers and 335 trainers aligned; 6,336 technicians certified	Recommendation 4.1: Facilitate joint programs for skills development and training in hydrogen technologies, including expanding mobility arrangements between countries in this area	The objectives of the scheme is to undertake comprehensive skill gap analysis covering key areas of the Green Hydrogen ecosystem on a continuous basis, creation of a registry of skills as required by the Green Hydrogen value chain, design and develop curricular elements for use in schools, ITIs, polytechnics and HEIs, develop qualification packs, encourage private sector participation, creation of identified pool of trainers, and creation of CoEs.	https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/03/20240316172 1417787.pdf
NGHM Portal	15-03-2024	Data is maintained on the NGHM Portal and the MNRE website.	Recommendation 5.1: Support knowledge sharing ini tiatives between India and Australia in the areas of hydrogen research, development and innovation, including industrial developments.	The website contains all information related to the developments happening in the Green Hydrogen sphere in India.	https://nghm.mnre.gov.in/
Green Hydrogen Certification Scheme of India (GHCI), 2025	29-04-2025	Data is maintained on the NGHM Portal / MNRE website / BEE website.	Recommendation 5.2: Support hydrogen knowledge sharing ini tiatives between India and Australia in the area of policy, standards and regulation	All scheme guidelines are available on NGHM portal and the MNRE website. The details of projects certified under GHCI will be maintained on NGHM Po rtal or MNRE website or BEE website.	https://mnre.gov.in/en/hydrogen/ https://nghm.mnre.gov.in/

Australian Initiatives Aligned with India- Australia Green Hydrogen Taskforce Recommendations

Name of Initiative	Date of Announcement / Commencement	Brief Summary	Link to IAGHT Recommendation Theme	Link to Australia's 2024 National Hydrogen Strategy	URL
Hydrogen Electrolyser Manufacturing Report (CSIRO)	December 2024	CSIRO's report outlines Australia's potential to lead in hydrogen electrolyser manufacturing, projecting $1.7 billion in revenue and 4,000 jobs by 2050.	Recommendation 1.1 – electrolyser co-development and manufacturing scale-up.	Hydrogen Production Tax Incentive and Hydrogen Headstart programs support early movers in electrolyser and hydrogen production. Future Made in Australia Innovation Fund and ARENA funding target RD&D in electrolyser and storage technologies. Strategy Action 1, 2, 10, 11, 13, 14 directly support co-development and manufacturing innovation.	https://www.csiro.au/en/work-with-us/services/consultancy-strategic-advice-services/CSIRO-futures/Energy/Hydrogen-Electrolyser-Manufacturing-Report
Rio Tinto Yarwun Hydrogen Calcination Pilot	July 2023	ARENA funded $32.1 million for Rio Tinto and Sumitomo to trial hydrogen calcination at the Yarwun Alumina Refinery to reduce emissions.	Recommendation 2.2 – green alumina and aluminium pilot projects.	Green metals are a priority industry under the Future Made in Australia agenda. Strategy Action 15 supports hydrogen use in green iron, steel, and alumina. Hydrogen incentives aim to reduce input costs for these sectors. Expansion of the Guarantee of Origin scheme to include green metals.	https://arena.gov.au/news/world-first-hydrogen-pilot-for-low-carbon-alumina/
Fortescue Green Iron Metal Project	2025 (expected production)	Located in WA's Pilbara, this project uses green hydrogen to produce sponge iron and green iron metal to decarbonise steelmaking.	Recommendation 2.1 – green iron and steel value chain development.		https://www.fortescue.com/en/what-we-do/our-growth-projects/green-metal-project

Bell Bay Powerfuels Project (ABEL Energy)	Feasibility study completed in 2023	A $2 billion green methanol facility in Tasmania using biomass gasification and electrolysis to produce 360,000 tonnes annually.	Recommendation 3.1 – biomethanol and green methanol supply chain development.	Strategy Action 17 and 18 support hydrogen use in transport and energy storage. Maritime Emissions Reduction National Action Plan and NHIA include bunkering infrastructure. Hydrogen Headstart supports ammonia-based export projects. Strategy Action 9 and 30 address port readiness and certification for green fuels.	https://research.csiro.au/hyresource/abel-energy-bell-bay-powerfuels-project/
WAH2 Ammonia Bunkering Project (NH3 Clean Energy)	MoU signed in 2024	Development of ammonia bunkering infrastructure at Port of Dampier to decarbonise iron ore shipping.	Recommendation 3.2 – enabling infrastructure for ammonia bunkering.		https://www.bcinsight.crugroup.com/2025/07/21/low-emission-ammonia-bunkering/
Mobility Arrangement for Talented Early-professionals Scheme (MATES)	December 2024	Bilateral visa program allowing 3,000 Indian graduates annually to work in Australia's renewable energy and hydrogen sectors.	Recommendation 4.1 – hydrogen workforce mobility and skills exchange.	Strategy Action 12 supports workforce development across all levels of government. MATES scheme and Hydrogen Worker Training Centres are highlighted. Jobs and Skills Australia and National Energy Workforce Strategy are key enablers.	https://immi.homeaffairs.gov.au/visas/getting-a-visa/visa-listing/temporary-work-403/mates
Victorian Hydrogen Hub (VH2) – Hydrogen Skills Roadmap	Feb 2021 – Sep 2022	Led by Swinburne University, VH2's roadmap identifies training needs across Australia's hydrogen value chain.	Recommendation 4.1 – hydrogen training standards and course development.		https://research.csiro.au/hyresearch/victorian-hydrogen-hub-vh2-hydrogen-skills-roadmap/

CSIRO Hydrogen Knowledge Centre (HyResource & HyResearch)	July 2022	Consolidates Australian hydrogen research, projects, and policy data to support collaboration and transparency.	Recommendation 5.1 – bilateral knowledge sharing in hydrogen RD&I.	Strategy Action 14 and 31 promote international RD&D partnerships (e.g. HyGATE, QUAD, IPHE). Strategy Action 21–24 support codes of best practice, safety forums, and voluntary industry conduct. Annual State of Hydrogen Report and 5-year reviews ensure transparency and shared learning.	https://research.csiro.au/hyresource/
Guarantee of Origin Scheme (GO Scheme)	December 2024	Certifies emissions intensity of hydrogen and renewable electricity to support trade and policy alignment.	Recommendation 5.2 – hydrogen certification and standards interoperability.		https://www.dcceew.gov.au/energy/renewable/guarantee-of-origin-scheme
Technology Commercialisation Challenge	March 2025	Supports Australian research and Indian renewable energy manufacturers to form mutually beneficial partnerships to advance commercialisation of cutting edge technology.	Recommendation 5.1 bilateral knowledge sharing in hydrogen RD&I.	Strategy Action 14 and 31 promote international RD&D partnerships	The Technology Commercialisation Challenge - CSIRO

Catalysing Innovation

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