

New Energy Quarterly

Sustainable Fuels

December 2024



Contents

Editorial	1
Watt’s Happened at Hamilton Locke	3
Market Insights	4
Market Recognition	5
New Starters at Hamilton Locke	6
Spotlight: Marni Riley	7
Rising Star: Eamonn Carpenter	8
Watt is ARENA Funding?	9
Hamilton Locke New Energy Team	11
Sustainable Fuels 101: Types of Sustainable Fuel and Importance	13
Sustainable Fuels 102: Current Applications, Challenges and Future Outlook	17
Bridging the Commercial Gap: Australia’s 2024 National Hydrogen Strategy	21
Fueling the Fleets	25
Can Hydrogen Fuel Cell Vehicles compete with Electric Vehicles in the Light Passenger Vehicle Market?	27
Hydrogen Trains: Revolutionary or Overhyped?	29
Global Approaches to Sustainable Fuels – What can Australia Learn from Other Countries?	31
Insights: The Future of Alternative Marine Fuels for Sustainable Shipping	33
Insights: Fuelling the Future: Australia’s Path to Net Zero Transportation	37
Insights: Decarbonising Aviation: The Flight Plan to a Low Carbon Future	41
New Energy Expert Insights: Retrofitting BESS on Solar PV Projects with Joanna Leigh – Qantas Australia	45
New Energy Associates Network - NEAN	48
New Energy Quarterlies	49
Expert Insights	50

Editorial

As the world grapples with the urgent need to decarbonise, sustainable fuels are emerging as a vital pillar of the global energy transition. While renewable energy technologies like solar and wind have captured much attention, it is the rise of sustainable fuels – such as hydrogen, biofuels and synthetic fuels – that offers an essential piece of the decarbonisation puzzle, particularly in hard-to-abate sectors like aviation, shipping and heavy industry.

In recent years, the development of sustainable fuels has gained unprecedented momentum, with governments, industries and investors increasingly recognising its potential. As part of this shift, Australia has positioned itself at the forefront of innovation, with initiatives aiming to capitalise on its vast renewable energy resources, existing infrastructure and strong export capabilities.



Sustainable fuels are not just an environmental necessity but also an economic opportunity. Investment, innovation and collaboration will be essential as Australia seeks to balance decarbonisation with economic growth. As we look to the future, the question is not whether sustainable fuels will play a role in the energy transition, but how fast we can scale these technologies to meet the demands of a low-carbon world.

Hydrogen, particularly green hydrogen produced using renewable energy, is rapidly emerging as a key solution in the race to achieve net-zero emissions. Its ability to power fuel cells makes it an attractive clean energy option for sectors like transportation. Hydrogen-powered vehicles – ranging from cars to buses to trucks – are already being developed as sustainable alternatives to traditional combustion engines.

For hydrogen to realise its full potential, substantial investment in infrastructure is essential. Developing robust supply chain, pipeline and storage facilities remains a challenge. While fuel cell technology is becoming more efficient and cost-effective, it still faces competition from cheaper combustion engines.¹ To scale the hydrogen industry, strong collaboration between industry, governments and financiers is critical to overcoming these hurdles and accelerating its adoption.

Biofuels, particularly those derived from waste materials, continue to offer a practical and immediate solution for reducing emissions in the transportation industry. Advanced biofuels, such as those produced from agricultural residues and waste oils are helping reduce reliance on fossil fuels. The focus is now on accelerating the development of next-generation biofuels, which offer higher sustainability credentials.

Sustainable aviation fuel (SAF) is offering a viable solution to decarbonising the aviation industry. SAF as an alternative to traditional aviation fuels has been embraced by airlines globally.²

However, scaling up production remains a challenge due to high costs and the need for large-scale feedstock supply. Policies supporting SAF adoption will be crucial for reducing costs and expanding production capabilities in the years ahead.

This publication provides a comprehensive overview of the different types of sustainable fuels and explores the challenges and opportunities facing the industry. The first two articles provide detailed introductions to sustainable fuels, the sectors currently utilising these fuels and the hurdles to scaling industry. The third article examines the approach of the National Hydrogen Strategy 2024 in addressing the commercial gap between production cost and the sale price of green hydrogen. Articles four to six are in-depth discussions of the role of sustainable fuels in the transportation sector, the seventh article explores the global approach to sustainable fuels and articles eight to ten consider the future outlook of sustainable fuels.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](tel:+61459900080)



Marni Riley
Special Counsel
[+61 450 821 836](tel:+61450821836)



Michael Liu
Lawyer

¹World Economic Forum, ‘Why green hydrogen could play a major role in powering our sustainable future’ (Online Article, 7 December 2023) <<https://www.weforum.org/agenda/2023/12/why-hydrogen-is-the-fuel-of-the-sustainable-future/>>.

²International Air Transport Association, ‘Net Zero 2050: Sustainable Aviation Fuels’ (Fact Sheet, May 2024) <<https://www.iata.org/en/iatarepository/pressroom/fact-sheets/fact-sheet---alternative-fuels/>>.

Watt’s Happened at Hamilton Locke



► **First Nations & The Energy Transition Forum**
Matt Baumgurtel, Margot King, Ching Yee Tan, Janice Lau, and Ryan Atkinson attended the First Nations & Energy Transition Conference in Perth.

Matt and Margot presented on the topic 'Navigating the legal landscape of renewable energy projects: implications for indigenous communities'.

Learn more about Matt and Margot’s presentation [here](#) and our key takeaways [here](#).



► **Australian Institute of Energy panel discussion**
The Hamilton Locke New Energy team hosted the Australian Institute of energy’s panel discussion on Affordability, flexibility or efficiency: are electricity tariffs delivering for consumers? (Challenges and responses for networks, retailers and consumers)



► **Hamilton Locke New Energy: Cheers to you!**
The Hamilton Locke New Energy Team hosted the Cheers to you event at Taylor’s Rooftop in Sydney. The event was attended by our teams in Sydney, Brisbane, and Perth, as well as over 70 clients and friends.



► **Energy Infrastructure & Community Engagement Conference**
Matt Baumgurtel, Michael Liu, Christine An, Lachlan Stagoll, and Lily Clements-Markham attended the Energy Infrastructure & Community Engagement Conference in Sydney. Matt presented on the legal aspects of community engagement as a part of renewable energy projects.

Learn more about Matt’s presentation [here](#) and key takeaways from other speakers [here](#).



► **All Energy Australia Conference**
Matt Baumgurtel, Jo Ruitenber, Marni Riley, William Ryan, Ally Frizelle, and Lachlan Stagoll attended both days of the All Energy Australia Conference in Melbourne.

Matt Baumgurtel and Marni Riley presented on the role of hydrogen as a key component in Australia’s net zero emissions strategy.

Read our key takeaways from: [Day 1](#) and [Day 2](#)



► **Hamilton Locke & Energy Vault annual networking event**
Matt Baumgurtel, Tricia Moloney, Adriaan van der Merwe, David O’Carroll, William Ryan, Perri Robinson, and Chiara Ciulli attended the annual networking event co-hosted by Hamilton Locke and Energy Vault in Melbourne.



► **Asia Pacific Hydrogen Summit and Exhibition**
Marni Riley attended the Asia Pacific Hydrogen Summit and Exhibition in Brisbane.



► **Smart Energy Council drinks**
Marni Riley attended the Smart Energy Council drinks networking event in Brisbane.



► **German-Australian Hydrogen Alliance’s Critical Aspects of Financing Hydrogen Forum**
Marni Riley attended the German-Australian Hydrogen Alliance’s Critical Aspects of Financing Hydrogen Forum in Brisbane.

Learn more about our key takeaways [here](#)

Market Insights

► On 17 December 2024, the Australian Renewable Energy Agency announced that it was providing funding totalling up to \$14.1 million from its Sustainable Aviation Fuels Funding Initiative for two separate studies being undertaken to develop renewable fuel alternatives for the airline industry.

► On the 28 November 2024, the Federal Government has **enacted** the *Future Made in Australia (Guarantee of Origin) Bill 2024 (GO Bill)* along with two supporting bills, in predominantly the same form as originally introduced into Parliament. The passing of the GO Bill marks a pivotal step in Australia’s journey toward a clean energy future. The legislation establishes the voluntary Guarantee of Origin (**GO**) Scheme, which will play a critical role in certifying low-emission products and renewable electricity.

[Read more](#)

► On 26 November 2024, Copenhagen Infrastructure Partners announced the signing of Memorandums of Understanding with key shipping companies including Færder Tankers and BW Epic Kosan to advance the development of ammonia-fuelled carriers.

► On 25 November 2024, the Federal Government introduced the Future Made in Australia (Production Tax Credits and Other Measures) Bill 2024 into the Australian Parliament. The proposed legislation will establish two key tax incentives for renewable hydrogen and critical minerals.

[Read more](#)

► On 15 November 2024, the *Constitution Amendment (SEC) Act 2024 (Vic)* came into effect, enshrining the State Electricity Commission in Victoria’s constitution.

[Read more](#)

► On 11 October 2024, the CER announced that a new Unit and Certificate Registry capable of connecting with other platforms and exchanges will replace the existing Australian National Registry of Emissions Units.

[Read more](#)

► On 27 September 2024, the Department of Climate Change, Energy, the Environment, and Water, and the Australian Renewable Energy Agency, announced funding in relation to a \$600 million project in Townsville Queensland which will convert bioethanol from domestic agricultural by-products into both sustainable aviation fuel and diesel.

[Read more](#)

► On 26 September 2024, the Australian Energy Market Commission released a draft determination and draft rule to amend the National Electricity Rules. The Draft Rule aims to confirm and clarify the Australian Energy Market Operator’s role and responsibility in managing cyber security risks affecting the National Electricity Market.

[Read more](#)

► On 25 September 2024, AEMO released its draft determination and draft methodology on amendments to the Inertia Requirements Methodology which took effect from 1 December 2024. The Inertia Requirements Methodology is the process AEMO uses to determine the inertia requirements of each region of the National Electricity Market for the maintenance of a steady grid frequency.

[Read more](#)

► On 13 September 2024, the Australian Government released its 2024 National Hydrogen Strategy and its vision for a “clean, innovative, safe and competitive hydrogen industry that benefits Australia’s communities and economy, enables our net zero transition, and positions us as a global hydrogen leader”.

[Read more](#)

Market Recognition

► Matt Baumgurtel was recognised by Lexology as a legal influencer. Read more	► William Ryan has been named a finalist in the 'Projects, Energy and Resources' category of the 2024 Lawyers Weekly 30 under 30 Award. Read more
► Hamilton Locke has received multiple recognitions in the 2024 IFLR1000 guide, notably: - Matt Baumgurtel was recognised as 'highly regarded' in Project Development: Energy. - Margot King was recognised as 'notable practitioner' in Real Estate, Project Development: Energy and Infrastructure. - David O'Carroll was recognised as 'rising star' for Project Development: Energy. Read more	► Hamilton Locke shortlisted in the 2024 Energy Storage Investment Awards: - William Ryan was shortlisted for rising star of the year. - Hamilton Locke's New Energy team was shortlisted for Legal Advisory of the Year. - Hamilton Locke's role in financing and formation of Birdwood Energy's distributed energy platform in partnership with Aware Super was shortlisted for M&A Deal of the Year. Read more
► New Energy Partner and Lead Matt Baumgurtel Named a Dealmaker of the Year Australian Lawyer and NZ Lawyer's inaugural Dealmakers of the Year list celebrates the top 25 dealmakers from Australia and New Zealand's legal profession, chosen based on quantity, quality, importance and innovation of their deal involvements. We are thrilled to see Matt recognised for his ongoing dedication to the sector! Read more	► Matt Baumgurtel named as the winner for Energy and Natural Resources in Mondaq's Spring 2024 Thought Leadership Awards. Read more
► The Hamilton Locke New Energy team contributed to the latest edition of Lexology In-Depth Renewable Energy Law in Australia. Read more	► Marni Riley joined Hamilton Locke New Energy team Hamilton Locke's New Energy team continues its growth with the appointment of Marni Riley as Special Counsel in our Brisbane office. Marni has significant experience in project development and M&A transactions in both Australia and internationally, with a specific focus on the energy and resources sectors. Read more
► Hamilton Locke Advises European Energy on 56MW Mokoan Solar Farm The project is a significant step for renewable energy in Australia. The Mokoan Solar Farm will supply over 15,000 households while reducing carbon emissions by over 85,000 tonnes. The Hamilton Locke team is proud to have supported European Energy every step of the way in this important transaction. Read more	► Hamilton Locke advises Energy Vault on ACEN's New England BESS Project The project will deploy two BESS systems at ACEN Australia's 720MW New England solar and battery project (the largest solar farm in NSW). The project will have a capacity of 200MW/400MWh. Read more
► Hamilton Locke Continues to Top National ECM and M&A Rankings! We have received top rankings in the 2024 Australian ECM and M&A rankings recently released in LSEG and Mergermarket for our work advising on deals for issuers and lead managers for the first half of 2024. Read more	► William Ryan promoted to Senior Associate The New Energy team is proud to announce the promotion of a key member, William Ryan to Senior Associate. Since joining the Hamilton Locke, Will has been an invaluable asset to our team, clients, and the entire firm. We look forward to Will's continued success. Read more

New Starters at Hamilton Locke

Partner Luke McShane Gaynor Tracey Madeleine Kulakauskas	Graduate Lachlan Stagoll Tom Lewsey	Operations Assistant Abby Gonzales Jamie-Lee Bubb
Special Counsel Chris Deeble Ben Lenihan	Paralegal Nidhi Prakash Rachael Chow Lachlan Murrell Matt Lamprecht Lily Clements-Markham Grace Mudge Bernice Lum Stefania Maxwell Jasper Wong Maria Hakim Alex Crowhurst Bishoy Basanty Theo Whittaker Rheanna Gibson Michael Kinsella Ariana Farahani Asha Nayer Sophie Nankivell Cory Johnson	Legal Knowledge Manager Ross Davis
Senior Associate Amy Whyte Eve Bramley		Consultant Daiki Yamagami Anna Mouat Tim McAlpine-Scott
Lawyer Lachlan Chapman Jackson Price Molly Kemp Chanse Soth Minji Kim Adam Nguyen Mahoney Maria Zaia		Vacation Clerk Abbey Higgins Jack Duncan Lara Lindenberg Matt Simich Ethan Seah Thomas Atkinson Emily Belladonna



SPOTLIGHT

Marni Riley



Marni Riley
Special Counsel
+61 450 821 836
marni.riley@hamiltonlocke.com.au

What was your journey to becoming a lawyer?

Throughout high school I fostered a deep sense of justice and always wanted to become a lawyer. Although, having now been one for 20 years, I realise it is not at all like it was portrayed in the movies and the books!!! I have a passion for complex problem solving (my teachers wanted me to be an actuary) and saw the law as having a nice balance between interacting with people and being engaged in complex problem solving.

I completed my articles at Minter Ellison in their corporate practice and enjoyed the complexity and variety of corporate law so much I never left. I found my passion for energy and resources work fairly early on in my career when I was involved in the development of a desalination facility. I moved to Allens to pursue an energy and resources specialisation and after a few years was approached to work in Baker McKenzie London's energy and resources practice. During my time in London I had the opportunity to act as the Head of Legal for Ecora Resources, a global mining royalty and streaming company.

After 9 years living in London, taking every opportunity to explore Europe and having added a couple of gorgeous daughters to our family, my husband and I decided to move back to Australia. I was delighted on my return to Australia to join Clayton Utz as a Special Counsel in its energy and resources team. While there, I was approached by Hamilton Locke with an exciting opportunity to lead and grow the New Energy practice in Brisbane.

Tell us about your specialisation (include information on what excites you about current market developments)

I specialise in New Energy, with a particular sector focus on sustainable fuels. I feel privileged to be able to use my legal education and knowledge to assist both clients and the community more broadly to achieve their energy transition goals. With the global push to net zero, it is a particularly interesting time to be a New Energy lawyer – there is plenty of variety and innovation in all of the matters that we are seeing. It is an exciting time!

What are your career highlights?

I have been very fortunate throughout my career to work with some amazing people on some very interesting, career-changing projects. Whilst not a specific highlight, one of the most rewarding aspects of my career has been the variety of the matters that I have worked on, in a variety of industries. No two matters are ever the same and every single one brings its own unique challenges and learnings.

Why did you join Hamilton Locke?

Hamilton Locke presented an attractive proposition – a truly collaborative and supportive culture in which I was provided with the opportunity to lead and grow the Brisbane New Energy practice, with the support of Matt Baumgurtel. I met with a number of partners before deciding to join Hamilton Locke and I was impressed with what I saw – genuinely lovely people that excelled in their legal specialisations and were supportive of developing the careers and practices of one another.

RISING STAR

Eamonn Carpenter



Eamonn Carpenter
Lawyer
+61 2 8072 8271
eamonn.carpenter@hamiltonlocke.com.au

What are you most proud of in your career to date?

Besides working in New Energy, I would say that I'm proudest of the work I was able to do recently with Energy Vault on their New England BESS. I had the opportunity to assist shortly after coming to Hamilton Locke and was able to get involved while I was settling into a new-city and new firm. They are a terrific client which encourages junior lawyers to stay involved in any negotiations and discussions so we can learn and understand their business. It was a real privilege to get to know the Energy Vault team during that matter and to work on such an important project shortly after joining Hamilton Locke.

What do you enjoy about working in the legal industry?

Besides being a bit of a nerd and solving a problem, I love the people in this industry. The law is brimming with people who not only love the law, but who are incredibly passionate, and often have amazing stories about how they got here.

What do you enjoy most about Hamilton Locke?

The emphasis on the people and how everyone here makes time to invest in each other. It's a place where people look to hold themselves accountable for the success of others, and importantly, that success is not work alone but the whole experience they have. Two phrases come to mind which I've heard said to clients and colleagues repeatedly since I joined: "What does success mean to you" and "how can I make your life better".

In your opinion, how does HPX Group empower communities?

The HPX Group empowers communities by staying true to its people-first approach. It's not just about serving clients; it's about creating a positive ripple that goes beyond the work.

Favourite movie and why?

Moneyball – it has it all: an underdog story, mathematics vs intuition, the search for meaning, and, how can you not be romantic about baseball?

Favourite music album

El Camino by the Black Keys, it was the first album I used to sit down and just listen to fully, start to finish. After moving to Sydney, my first major personal buy was a copy of the 10-year anniversary vinyl.

What's a place in your hometown that you love visiting?

In Adelaide there is a beautiful café called Cielo in Adelaide Arcade, it's just a place brimming with warmth, character, and passion. It also helps that with Adelaide being what it is, you're bound to see a friendly face or two while you're sitting down there for a coffee.

Watt is ARENA Funding?

Program	Summary	Funding available	Closing Date
Hydrogen Headstart Round 2	Hydrogen Headstart Round 2 was announced in the May 2024 Federal Budget. The Program will provide up to \$2 billion of revenue to support large-scale renewable hydrogen production projects. Further information on Hydrogen Headstart Round 2 will be made available in the coming months.	AUD \$2 billion	In development Applicants can register their interest to get updates on information about Hydrogen Headstart Round 2 when it becomes available.
Battery Breakthrough Initiative	The Battery Breakthrough Initiative was announced in the May 2024 Federal Budget. The program will provide \$523.2 million to promote the development of battery manufacturing capabilities in Australia.	AUD \$523.2 million	In development. Applicants can register their interest to get updates on information about Battery Breakthrough Initiative when it becomes available.
Solar Sunshot	The Solar Sunshot program will support Australia’s photovoltaic (PV) manufacturing capabilities. The program aims to support innovative manufacturing facilities in Australia across the solar PV supply chain. The solar PV supply chain includes polysilicon production, production of ingots, wafers, solar PV cells and solar module assembly. The program may also support complementary aspects of the solar PV supply chain such as solar glass, module frames, deployment technology and other innovation or manufacturing elements required for solar deployment. ¹	AUD \$1 billion	Ongoing. Round 1 funding launched in August 2024, with Round 1A Expression of Interest due on 10 December 2024 and Round 1A Full Applications due on 30 April 2025.
Advancing Renewables Program (ARP)	The ARP awards grants to a range of projects that seek to: • optimise the transition to renewable electricity; • commercialise clean hydrogen; and • support the transition to low emission metals.	Up to AUD \$50 million	Ongoing.
Powering the Regions Industrial Transformation Stream	The Industrial Transformation Stream seeks to support existing industrial facilities, and new clean energy developments, in regional areas to reduce their emissions, in line with Australia’s 2030 targets and in support of reaching net zero by 2050.	AUD \$400 million	Ongoing.

¹Australian Renewable Energy Agency, *Solar Sunshot* (Web Page). <<https://arena.gov.au/funding/solar-sunshot/>>.

Program	Summary	Funding available	Closing Date
National Industrial Transformation Program	A range of technology solutions targeting industrial emissions abatement may be supported, from electrification and energy efficiency to fuel switching and zero emissions vehicles. Enabling technologies such as energy storage, demand management and critical infrastructure supporting onsite decarbonisation will also be considered. Projects can range from studies to scale demonstration and deployment.	AUD \$40 million National Industrial Transformation Program	Ongoing.
Regional Microgrids Program (RMP)	The Regional Microgrids Program (RMP) aims to support the development and deployment of renewable energy microgrids across regional Australia that contribute to the Program Outcomes. Funding has been allocated across two Streams under the Program, each with its own Outcomes: 1. Stream A – Regional Australia Microgrid Pilots – to fund Projects that contribute to the innovation and/or acceleration of developing and deploying equipment that enables the coordinated use of distributed renewable energy technologies, improving the resilience and reliability of electricity supply in regional areas and addressing barriers to deployment of microgrid solutions. 2. Stream B – First Nations Community Microgrids – to fund Projects that contribute to the provision of cleaner, cost effective and reliable energy in First Nations Communities and empowering these Communities to participate in electricity supply arrangements and the development of energy infrastructure.	Total AUD \$125 million Stream A - \$50 million Stream B - \$75 million	19 December 2025.
Driving the Nation Program	The Program is focused on accelerating the uptake of Zero Emission Vehicles (ZEVs). ZEVs include Battery Electric Vehicles, Hydrogen Fuel Cell Vehicles and biofuel vehicles. The Program has various focus areas that will be funded (Focus Areas). The current Focus Area for funding is projects which encourage uptake of battery electric vehicles by supporting innovation in the deployment and use of charging infrastructure that accelerates the adoption of managed charging. ²	AUD \$500 million	Ongoing.
Clean Energy Innovation Fund (CEIF)	Seeks to fund emerging Australian technologies and businesses to speed the nation’s transition to a renewable economy.	Up to \$200 million ³	Ongoing.

²Australian Renewable Energy Agency, *Driving the Nation* (Web Page) <<https://arena.gov.au/funding/driving-the-nation-program-2/>>
³Clean Energy Finance Corporation Investment Mandate Direction 2023 subsection 16(1).

Hamilton Locke New Energy Team

Partners



Matt Baumgurtel
Partner, New Energy Lead
+61 459 900 080





Veno Panicker
Partner, Construction & Infrastructure
+61 409 495 242





Brit Ibanez
Partner, Litigation
+61 421 355 503





Michael Boyce
Partner, Mining & Resources
+61 400 142 494





Tricia Moloney
Partner, Finance
+61 434 154 180





Margot King
Partner, Property
+61 406 056 651





James Simpson
Partner, Employment
+61 407 061 641





Alistair Newton
Partner, Competition and Consumer
+61 2 8072 8271





Andrew Vincent
Partner, Finance
+61 417 544 925





Jo Ruitenberg
Partner, Corporate
+61 427 182 390





Amelia Prokuda
Partner, Planning and environment
+61 410 032 358





Seema Sandhu
Partner, Tax
+61 2 8072 8271





Timothy Zahara
Partner, Employment
+61 7 3036 7886



Special Counsel



Adriaan van der Merwe
Special Counsel
+61 403 120 410





Eliza Buchanan
Special Counsel
+61 2 8072 8271





Marni Riley
Special Counsel
+61 450 821 836





Kaday Conteh
Special Counsel
+61 439 335 094



Senior Associates



Hannah Jones
Senior Associate
+61 450 584 149





David O'Carroll
Senior Associate
+61 421 497 311





Ching Yee Tan
Senior Associate
+61 863 119 160





Cormac Foley
Senior Associate
+61 2 8072 8271





Gareth Howard
(Consultant admitted in South Africa, not admitted in Australia)
+41 424 372 390





William Ryan
Senior Associate
+61 402 655 538





Tariq Alardah
Senior Associate
+61 2 8072 8271



Lawyers



Minji Kim
Lawyer
+61 2 8072 8271





Matthew Dean
Lawyer
+61 2 8072 8271





Tim McAlpine-Scott
Consultant, admitted in Scotland, not admitted in Australia
+61 2 8072 8271





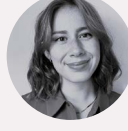
Raymond Deng
Lawyer
+61 430 813 873





Sally Yang
Lawyer
+61 2 8072 8271





Anna Mouat
Consultant, admitted in Scotland, not admitted in Australia
+61 2 8072 8271





Eamonn Carpenter
Lawyer
+61 2 8072 8271





Megan Chau
Lawyer
+61 2 8072 8271





Ally Frizelle
Lawyer
+61 2 8072 8271





Christine An
Lawyer
+61 8 6311 9160





Lachlan Stagoll
Lawyer
+61 8 6311 9160





David Wan
Lawyer
+61 2 8072 8271



Graduates



Kusum K C
Graduate
+61 2 8072 8271





Lana Knaggs
Graduate
+61 2 8072 8271





Sam Poulsen
Graduate
+612 8072 8271



Paralegals



Lily Clements-Markham
Paralegal
+61 2 8072 8271





Suwathie Rajeswaran
Paralegal
+61 2 8072 8271





Sinead Kelly
Paralegal
+61 2 8072 8271





Rheanna Gibson
Paralegal
+61 2 8072 8271





Theo Whittaker
Paralegal
+61 2 8072 8271





Michael Kinsella
Paralegal
+61 2 8072 8271





Cory Johnson
Paralegal
+61 7 3036 7886



Operations



Perri Robinson
Executive Business Partner
+61 435 015 487





Abby Gonzales
Practice Assistant
+61 2 8072 8271



Sustainable Fuels 101: Types of Sustainable Fuel and Importance

Authors: Matt Baumgurtel, William Ryan, David O’Carroll, Sally Yang and Lily Clements-Markham

Sustainable fuels are derived from renewable materials, offering a cleaner alternative to the fossil fuels that have powered our industries and transportation for centuries. They include biofuels, drop-in sustainable fuels, and hydrogen-based fuels.¹

As the global demand for decarbonisation intensifies, sustainable fuels are increasingly regarded as a practical and effective solution to support this transition. Indeed, McKinsey identifies sustainable fuels as one of 12 technologies that, when implemented collectively at scale, have the potential to reduce global anthropogenic greenhouse gas (GHG) emissions by up to 90 per cent.²

As sustainable fuels gain prominence in decarbonisation discourse, the sector’s complexity – arising from the diversity of fuel types, technological pathways, and feedstocks – presents challenges for stakeholders in comprehensively evaluating their potential benefits and limitations.

We explore the sustainable fuels landscape, the different types, their applications and their role in decarbonisation.

Types of sustainable fuel

Sustainable fuels are renewable energy carriers well-suited for transport and industrial applications, offering significant sustainability advantages – particularly in reducing emissions – compared to traditional fuels.³ These fuels come in various forms, including:

(1) Biofuels

Biofuels are renewable energy sources derived from organic matter. They are typically produced in two main forms, though they span across first to fourth-generation biofuels.

(a) First-generation biofuels

First-generation biofuels, primarily bioethanol and biodiesel, are produced using food crops as feedstock, raising important questions about their sustainability and impact on global food supply. **Bioethanol** is the most widely produced first-generation biofuel,

derived from the microbial fermentation of starch-and sugar-rich crops such as corn and sugarcane.⁴ Commercially used strains, such as *Saccharomyces cerevisiae* and *S. pombe*, are employed to ferment the C5 and C6 sugars (mostly xylose and glucose) into bioethanol.⁵ The bioethanol is then distilled and refined for use as a fuel or fuel additive.

Biodiesel, also known as fatty acid methyl ester (**FAME**), is produced from food-grade oils or animal fats such as rapeseed, soy, or palm oil. Unlike bioethanol, the production of biodiesel involves a chemical process known as transesterification. In this process, lipids are reacted with short-chain alcohol, typically methanol, in the presence of a catalyst, usually potassium hydroxide, to produce biodiesel.

While both bioethanol and biodiesel offer viable alternatives to fossil fuels, their dependence on food crops and extensive agricultural land use poses significant sustainability challenges.⁶ These concerns have spurred growing interest in ‘second-generation’ biofuels.

(b) Second-generation biofuels

Second-generation biofuels, in contrast, are derived from non-food biomass, such as agricultural residues (e.g., corn stover or bagasse), forestry waste, and other lignocellulosic materials – plant-based biomass that includes tough, fibrous components like lignin, cellulose, and hemicellulose.⁷ This type of biofuel is produced using more complex processes, often involving the conversion of fibrous non-edible material called cellulose or hemicellulose into fuel.⁸ Second-generation biofuels are considered more sustainable, as it utilises waste products and does not compete directly with food production, though it often involves more advanced and expensive technology.⁹

Biomethanol is another type of second-generation biofuel derived from agricultural residues, woody biomass, or byproducts from pulp mills.¹⁰ It is produced through the gasification of biomass to create syngas, which is then converted into methanol.¹¹ Similarly, biogas is produced through the anaerobic



digestion of organic waste, including manure, food scraps, and wastewater.¹² Microbes break down the organic matter in the absence of oxygen, producing biogas, primarily composed of methane and carbon dioxide.¹³

Third and fourth-generation biofuels are also in the early stages of development. These next-generation biofuels build on prior advances by utilising new feedstocks, such as algae or engineered microorganisms, and offer the potential for greater efficiency and carbon reduction. These cutting-edge developments will be explored in more detail below.

(2) Drop-in sustainable fuels

Drop-in sustainable fuels are engineered to be fully compatible with existing internal combustion engines (**ICE**), allowing them to be used without any modifications to current infrastructure.¹⁴ These fuels can be produced from either edible biomass or residue biomass sources, using low-carbon hydrogen or synthesising carbon captured from sustainable sources combined with low-carbon hydrogen.¹⁵ Their seamless integration with conventional fuel systems has made them viable replacements for diesel, jet fuel, and natural gas, offering a practical solution for industries seeking to lower carbon emissions without overhauling their energy infrastructure.¹⁶ Drop-in fuels are particularly valuable in sectors where electrification or alternative energy sources are less feasible, such as aviation, shipping, and heavy industry.

(3) Synthetic or e-fuels

Synthetic fuels, or e-fuels, are produced by combining captured carbon with hydrogen generated from low-carbon electricity sources. The hydrogen used in these fuels, often produced through electrolysis, is referred to as either liquid or gaseous hydrogen, depending on its state. Electrolysis, powered by renewable energy, separates water into hydrogen and oxygen, with the hydrogen being used in the fuel production process while the oxygen is released back into the atmosphere.¹⁷

When this low-carbon hydrogen is combined with captured CO2 from the atmosphere or industrial processes, it forms e-fuels such as e-methanol or e-ammonia.¹⁸ These synthetic fuels can be used in sectors that are difficult to electrify. While not yet widely available, e-fuels and hydrogen-based fuels are being tested in pilot projects,¹⁹ offering a promising pathway for reducing emissions in hard-to-abate sectors and contributing to a carbon-neutral future.

Why are sustainable fuels important?

Sustainable fuels are set to play a pivotal role in reaching decarbonisation targets.²⁰ The benefits of sustainable fuels lie in their ability to recycle carbon in a closed loop system, absorbing carbon during production and releasing it upon use, thus minimising net emissions. By contrast, fossil fuels, which have sequestered carbon underground for millions of years, release previously stored carbon into the atmosphere when burned, thereby introducing additional CO2 and contributing to an overall increase in atmospheric carbon levels.²¹

Their importance is particularly pronounced in sectors where electrification is not yet feasible or efficient due to infrastructure, weight, or range requirements.²² These sectors include high-energy industries such as aviation, maritime transport, and heavy manufacturing which demand energy-dense fuels that are difficult to replace with electrification. In these hard-to-abate sectors, sustainable fuels emerge as vital alternatives, enabling emissions reductions without compromising the energy output required for large-scale operations.

Moreover, sustainable fuels offer the distinct advantage of being compatible with much of the existing supply infrastructure. Biofuels, for example, can be blended with conventional fuels and used in current combustion engines,²³ while SAF can be utilised in jet engines without requiring any significant modifications. Additionally, the production and distribution of these fuels can leverage existing industrial facilities and rely on locally sourced raw materials, further supporting the circular economy.²⁴ This high level of compatibility facilitates a smoother transition to cleaner energy sources, avoiding the need for costly infrastructure overhauls, and positioning sustainable fuels as an immediate and practical solution in the ongoing shift toward decarbonisation.

Where to next?

Even as sustainable fuels solidify their role as essential to decarbonisation, new feedstocks and production pathways are emerging, sparking innovation across the sector. Third and fourth-generation biofuels, like those derived from genetically modified microalgae, embody the latest advancements. These biofuels offer a high-yield, carbon absorbing option that does not compete with food production, as microalgae can be cultivated in non-arable regions and thrive in water unsuitable for other crops.²⁵ Advanced genetic modifications are also being used to enhance algae’s photosynthetic efficiency and lipid content, making them a high-potential feedstock for biofuel.²⁶

Next-generation sustainable fuels require significant investment and policy support. With large-scale deployment goals by 2050, the pathway forward includes both technological breakthroughs and new regulatory frameworks to ensure cost-effective, large-scale production. The next article in this series will delve into these developments, exploring current applications, remaining challenges, and the outlook for sustainable fuels as they shape the decarbonisation landscape.

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](tel:+61459900080)





William Ryan
Senior Associate
[+61 2 8072 8271](tel:+61280728271)





David O'Carroll
Senior Associate
[+61 421 497 311](tel:+61421497311)





Sally Yang
Lawyer
[+61 2 8072 8271](tel:+61280728271)





Lily Clements-Markham
Paralegal



¹McKinsey & Company, 'What are sustainable fuels?' (Online Article, 8 October 2024) <https://www.mckinsey.com/featured-insights/mckinseyexplainers/what-are-sustainable-fuels#>.

²Bernd Heid et al, What Would It Take to Scale Critical Climate Technologies? (Report, December 2023) 2, 5 <<https://www.mckinsey.com/~media/mckinsey/business%20functions/sustainability/our%20insights/what%20would%20it%20take%20to%20scale%20critical%20climate%20technologies/what-would-it-take-to-scale-critical-climate-technologies.pdf?shouldIndex=false>>.

³Australia’s Economic Accelerator, ‘Sustainable Fuels’ (Fact Sheet, 2023) <<https://www.aea.gov.au/download/378/aea-focus-area-sustainablefuels/224/aea-focus-area-sustainable-fuels/pdf#:~:text=Sustainable%20fuels%20are%20renewable%20energy,when%20compared%20to%20traditional%20sources>>.

⁴Philipp Cavelius et al, ‘The potential of biofuels from first to fourth generation’ (2023) 21(3) Plos Biology 1, 3.

⁵Ibid.

⁶Ibid.

⁷Amy Nagler and Selena Gerace, ‘First and Second Generation Biofuels: What’s the Difference?’, Montana State University (Working Paper) <https://waferx.montana.edu/documents/fact_sheets/1st%20v%202nd.pdf>.

⁸Ibid.

⁹Ibid.

¹⁰McKinsey & Company (n 1).

¹¹Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, ‘Bio-methanol’ (Web Page, 2024) <<https://www.zerocarbonshipping.com/energy-carriers/bio-methanol/?section=regulation>>.

¹²What are sustainable fuels (n 1).

¹³Mohammed Khaleel Jameel et al, ‘Biogas: Production, properties, applications, economic and challenges: A review’ (2024) 7 Results in Chemistry 1, 5.

¹⁴McKinsey & Company (n 1).

¹⁵Ibid.

¹⁶Ibid.

¹⁷Repsol, ‘What are Renewable Fuels?’ (Web Page, 2024) <<https://www.repsol.com/en/energy-and-the-future/sustainable-mobility/renewable-fuels/index.cshml>>.

¹⁸McKinsey & Company (n 1).

¹⁹Repsol (n 17).

²⁰Mikolaj Krutnik et al, ‘Global Energy Perspective 2023: Sustainable fuels outlook’ (Online Article, 10 January 2024) <<https://www.mckinsey.com/industries/oil-and-gas/our-insights/global-energy-perspective-2023-sustainable-fuels-outlook>>.

²¹Ibid.

²²Krutnik (n 20).

²³Repsol (n 17).

²⁴Ibid.

²⁵Min Wang et al, ‘Microalgae biofuels: Illuminating the path to a sustainable future amidst challenges and opportunities’ (2024) 17(10) Biotechnology for Biofuels and Bioproducts 1, 2-4.

²⁶Ibid 10-13.



Sustainable Fuels 102: Current Applications, Challenges and Future Outlook

Authors: Matt Baumgurtel, William Ryan, David O’Carroll, Sally Yang and Lily Clements-Markham

As global industries seek transformative solutions to reduce emissions, sustainable fuels are emerging as indispensable players across aviation, maritime shipping, and road transport. Demand for these fuels is projected to quadruple by 2050,¹ underscoring their essential role in meeting ambitious net-zero goals. We delve into the sectors currently harnessing sustainable fuels and evaluate their distinct benefits and challenges.

Beyond immediate applications, we examine the regulatory, investment, and technological hurdles to scaling sustainable fuels. We also explore how initiatives such as the Australia Future Made in Australia plan and the Guarantee of Origin (GO) scheme are establishing sustainable fuels as viable, long-term solutions in the clean energy transition.

Current applications of sustainable fuels

Sustainable fuels are already being implemented across various industries, with demand expected to quadruple by 2050 in McKinsey’s most ambitious scenario analysis.² Below are key sectors where sustainable fuels are currently applied:

(1) Aviation

Sustainable aviation fuel (SAF) represents one of the most promising advancements in reducing emissions from the aviation industry, a sector heavily reliant on carbon-intensive fossil fuels and responsible for approximately 2.5 per cent of global emissions.³ As SAF is compatible with existing aircraft engines, it provides a practical solution to reducing emissions without requiring significant changes to current aviation infrastructure. Litre for litre, SAF has the potential to reduce carbon emissions by up to 80 per cent compared to conventional fossil kerosene.⁴

Globally, major airlines have already begun integrating SAF into their fleets as part of their efforts to achieve net-zero emissions by 2050. In Australia, Qantas has pledged to include 10 per cent SAF in its fuel mix by 2030, with plans to increase this to 60 per cent by 2050.⁵

The aviation sector has been recognised as a key driver for accelerating the growth of the sustainable fuels industry. One of the biggest

hurdles to achieving commercial viability is securing enough long-term supply agreements with feedstock providers to match the demand for sustainable fuels. This is crucial for justifying the investment needed to establish production facilities. However, Australia’s aviation industry is large enough to create the demand necessary for commercial-scale refineries, provided SAF is broadly adopted as part of the sector’s transition to net-zero emissions.

To learn more about SAF, please read our previous article [Ready for take-off – Investment in Australian Sustainable Aviation Fuel with John Sheehy and Rodrigo Arias Lopez – Pottinger.](#)

(2) Maritime shipping

The shipping industry, responsible for three per cent of global CO2 emissions, is also turning to sustainable fuels as a key strategy for decarbonisation.⁶ Sustainable methanol, renewable or synthetic natural gas, and non-carbon containing hydrogen derivatives are being tested to power large vessels,⁷ offering a lower-emission alternative to traditional marine fuels, such as Heavy Fuel Oil (HFO).⁸ The International Energy Agency (IEA) projects that by 2050, ammonia could account for 44 per cent of the shipping industry’s fuel demand.⁹ Leading shipping companies, like Maersk, are embracing this shift by investing in liquefied biomethane and green methanol, with plans to introduce up to 60 vessels powered by these sustainable fuels, signalling a multifuel future for maritime transport.¹⁰

To learn more about maritime shipping and sustainable fuel alternatives, please read our previous article [The Future of Alternative Marine Fuels for Sustainable Shipping.](#)

(3) Road transport

Sustainable fuels are already widely used in road transportation with the sector expected to represent the largest share of future demand.¹¹ This is largely due to the established market, bolstered by government policies that support the production and consumption of biodiesel and bioethanol, alongside the growing momentum for decarbonisation efforts within the industry.¹²

While the road transport sector has ambitious goals for electrification, the demand for sustainable fuels is projected to increase, as the transition to zero-emission vehicles may not occur rapidly enough to meet the stringent decarbonisation targets set by governments.¹³ Consequently, sustainable fuels are anticipated to play a complementary role alongside electrification, particularly in the short to medium term, helping bridge the gap in achieving emissions reductions.

Challenges facing sustainable fuels

While sustainable fuels hold great promise for reducing emissions and contributing to decarbonisation goals, several challenges have been identified to hinder their widespread adoption and production. These key barriers include:

- 1. Uncertainty of Demand:** A major challenge in the sustainable fuels sector is the lack of consistent, predictable demand.¹⁴ Without clear and stable market signals, it becomes difficult for producers to attract long-term investment.¹⁵
- 2. International Competition and Subsidies:** Australia faces competition in attracting production investment for sustainable fuels, particularly from countries that benefit from extensive government subsidies.¹⁶ International subsidies in regions like the United States and Europe make it challenging for Australia to compete for investment, despite its potential to produce some types of sustainable fuels at a lower cost than overseas jurisdictions.¹⁷

- 3. Policy Clarity and Regulation:** Another key barrier to advancing sustainable fuel production is the lack of clarity around enabling policies and regulatory frameworks.¹⁸ In particular, uncertainty regarding how the emissions associated with sustainable fuels will be tracked and verified makes it difficult for industry players to align with long-term government objectives.
- 4. Support for Emerging Technologies:** Many of the technologies needed to produce next-generation sustainable fuels, such as advanced biofuels and e-fuels, are still in the early stages of development. These nascent technologies require significant research, development, and commercialisation support before they can become economically viable at scale. Currently, the level of financial and institutional support available for these emerging pathways is insufficient to drive the innovation needed to bring them to market.¹⁹

The future of sustainable fuels

Despite the challenges, the outlook for sustainable fuels remains promising, bolstered by ongoing advancements in production technologies and growing government support. Under the Future Made in Australia plan, the Government is accelerating efforts to build a robust local renewable fuels industry, supporting the entire supply chain – from farm and feedstock to fuel distribution.²⁰ This initiative aims to make the aviation, heavy vehicle, rail, and maritime sectors more sustainable.



A key component of current industry support is the Australian Government’s \$1.7 billion Future Made in Australia Innovation Fund, which offers essential funding to support the deployment of innovative technologies and infrastructure within key sectors, including sustainable fuels.²¹ This investment is specifically aimed at advancing the development and commercialisation of emerging sustainable fuel technologies, addressing a critical challenge in the industry related to insufficient support for nascent technologies.²² By facilitating the exploration of new feedstock sources and fostering advancements in production processes, this initiative seeks to enable the sustainable fuels sector to scale and compete more effectively in the global market.²³ For more information on the first allocation of funding under this initiative, read our recent bulletin [Sustainable Aviation Fuel Funding Takes Off](#).

Moreover, the GO scheme will allow sustainable fuel producers to certify the emissions content of their fuels, increasing transparency and driving demand for these products. This will enable Australian producers to capture a ‘green premium’ for their low-emissions fuels.²⁴ For more information regarding the GO certification scheme, please read our recent article [Pressing GO! on Clean Energy Certification: Understanding the Future Made in Australia \(Guarantee of Origin\) Bill 2024](#).

The above initiatives provide clear market signals that are essential for driving investment decisions in the sustainable fuels industry. By offering greater clarity and certainty, they boost confidence in the long-term viability of sustainable fuels, making it easier to attract the capital required to scale production. Australia is well-positioned to support a competitive domestic sustainable fuels sector, with its

vast landmass, favourable climate, advanced agricultural practices, access to renewable feedstocks, and established supply chains. By 2030, a domestic SAF industry alone could contribute an additional \$10 billion to Australia’s annual GDP and generate up to 26,200 jobs,²⁵ underscoring the immense future value at stake in this market.

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](#)





William Ryan
Senior Associate
[+61 2 8072 8271](#)





David O'Carroll
Senior Associate
[+61 421 497 311](#)





Sally Yang
Lawyer
[+61 2 8072 8271](#)





Lily Clements-Markham
Paralegal



¹ Mikolaj Krutnik et al, ‘Global Energy Perspective 2023: Sustainable fuels outlook’ (Online Article, 10 January 2024) <<https://www.mckinsey.com/industries/oil-and-gas/our-insights/global-energy-perspective-2023-sustainable-fuels-outlook>>.

² Ibid.

³ Deloitte, ‘Catalysing Sustainable Aviation Fuel (SAF) in Australia’ (Report, November 2023) 2 <https://www.statedevelopment.qld.gov.au/_data/assets/pdf_file/0025/85480/SAF-sust-aviation-fuel-report-summary.pdf>.

⁴ Ibid.

⁵ Ibid.

⁶ Takahiro Furusaki and Mette Asmussen, ‘Reducing barriers to maritime fuel projects is key to decarbonising shipping’, World Economic Forum (Online Article, 18 April 2024) <<https://www.weforum.org/agenda/2024/04/why-reducing-barriers-for-maritime-fuel-projects-is-key-to-progressing-ondecarbonization/>>.

⁷ Krutnik (n 1).

⁸ Department of Climate Change, Energy, the Environment and Water, ‘Maritime Transport’ (Web Page, 2024) <<https://www.energy.gov.au/business/sector-guides/transport/maritime-transport>>.

⁹ International Energy Agency, Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach (Report, 2023) 94 <https://iea.blob.core.windows.net/assets/4ad26550-05c4-4495-9891-98e588cd0be8/NetZeroRoadmap_AGlobalPathwaytoKeepthe1.5CGoalinReach-2023Update.pdf>.

¹⁰ Dominic Ellis, ‘Maersk commits to Bio-LNG and methanol in large order’, Gas World (News Article, 8 August 2024) <<https://www.gasworld.com/story/maersk-commits-to-bio-lng-and-methanol-in-large-order/2142549.article/>>.

¹¹ Krutnik (n 1).

¹² Ibid.

¹³ Ibid.

¹⁴ Department of Infrastructure, Transport, Regional Development, Communications and the Arts and Department of Climate Change, Energy, the Environment and Water, A Future Made in Australia: Unlocking Australia’s Low Carbon Liquid Fuel Opportunity (Consultation Paper, 12 June 2024) 13 <<https://www.infrastructure.gov.au/sites/default/files/documents/low-carbonliquid-fuels-consultation-paper.pdf>> (‘Consultation Paper’).

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ Ibid 15.

¹⁸ Ibid 13.

¹⁹ Ibid.

²⁰ Minister for Infrastructure, Transport, Regional Development and Local Government, ‘Australia’s Own Renewable Fuels Industry is Forging Ahead’ (Media Release, 30 July 2024) <<https://minister.infrastructure.gov.au/c-king/media-release/australias-own-renewable-fuels-industry-forging-ahead>>.

²¹ Ibid.

²² Consultation Paper (n 14).

²³ Ibid.

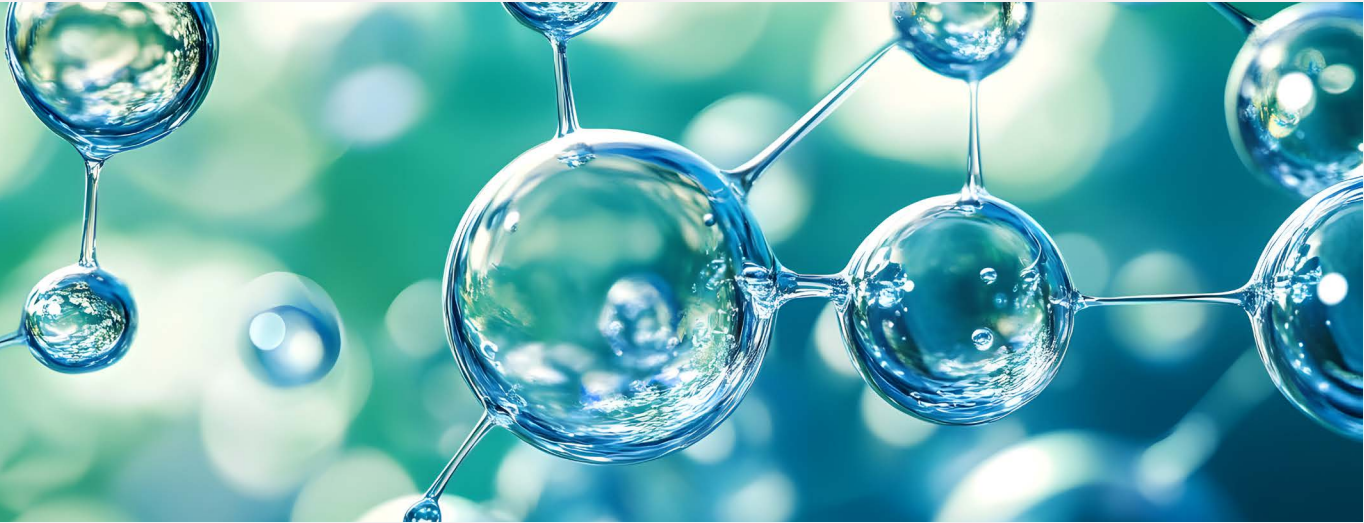
²⁴ Ibid.

²⁵ ARENA, Australia’s Bioenergy Roadmap (Report, November 2021) 4 <<https://arena.gov.au/assets/2021/11/australia-bioenergy-roadmap-report.pdf>>.



Bridging the Commercial Gap: Australia’s 2024 National Hydrogen Strategy

Authors: Matt Baumgurtel, Marni Riley, David O'Carroll, Eamonn Carpenter and Suwathie Rajeswaran



The [National Hydrogen Strategy 2024](#) (the **Strategy**), developed by the Federal Government, aims to position Australia as a global leader in hydrogen production and export.¹ The Strategy supports Australia’s transition to net zero and seeks to capitalise on the significant economic opportunity renewable hydrogen presents globally.²

Our previous [Bulletin](#) sets out a summary of the Strategy’s key objectives in supporting Australian hydrogen production, including:

1. Establishing a globally cost-competitive hydrogen industry.
2. Identifying and supporting the most prospective hydrogen demand sectors.
3. Ensuring communities are aware of, and realise the benefits of, hydrogen.
4. Establishing trade at scale and leveraging purposeful partnerships.³

This article explores in more detail whether the Strategy successfully addresses one of the fundamental barriers to establishing Australia’s hydrogen industry: the commercial gap between production costs and the sale price of green hydrogen (or its derivative products).

Challenges in developing the renewable hydrogen industry

The hydrogen market is still in its early stages, not just in Australia but internationally, with many countries still developing their hydrogen strategies.⁴ Due to its infancy, there is no established ecosystem to support the production, storage, distribution and use of hydrogen.⁵ There is no accepted market practice for determining the price of green hydrogen, which presents challenges for hydrogen project proponents and offtakers alike.⁶

In order to obtain financing, it will be crucial that a hydrogen project has a bankable offtake arrangement in place.⁷ However, even with the continual rising of gas prices, the cost of producing green hydrogen is higher than prospective offtakers are willing to pay.⁸ The cost of production is approximately \$5-6 per kilogram, and it is estimated that it needs to fall below \$2 for hydrogen to be commercially viable and competitive with fossil fuels.⁹ This creates a ‘chicken-and-egg’ situation where the development of the hydrogen industry is dependent on bankable offtake agreements, but it is difficult to negotiate those agreements without a stable market to trade hydrogen.¹⁰ In saying this, the cost of production is expected to fall as technology matures and economies of scale are achieved.¹¹ However, this will be contingent on the establishment of a comprehensive regulatory framework and the securing of long-term investments.¹²

Key initiatives under the Strategy

The Strategy sets out hydrogen production and export targets, supported by all the initiatives, incentives and policies project proponents may be able to access. We outline some of the key initiatives under the Strategy below.

Hydrogen Production Tax Incentive

Announced under the 2024-25 Federal Budget and introduced into Parliament on 25 November 2024 through the *Future Made in Australia (Production Tax Credits and Other Measures) Bill*, the Hydrogen Production Tax Incentive (**HPTI**) offers a short-term and uncapped tax offset system to eligible hydrogen producers, with support over the 10 year period being estimated at AU\$6.7 billion.¹³ The offset is set at \$2 per kilogram of eligible hydrogen produced and is designed to reduce the cost of production.¹⁴ The HPTI is available for hydrogen produced between 2027-28 and 2039-40, with support provided to projects that reach final investment decision by 2030.¹⁵ Each facility can access the HPTI for a maximum of 10 years from the start of production.¹⁶ To ensure broader benefits, recipients must comply with the Community Benefit Principles, aimed at sharing economic opportunities with local workers, industries and communities.¹⁷ To learn more about the background to the HPTI, please read our previous article [Hydrogen on the Horizon: Unpacking Australia’s New Hydrogen Production Tax Incentive](#).

Hydrogen Headstart

The \$2 billion Hydrogen Headstart program also offers revenue support to large-scale renewable hydrogen projects over a maximum 10-year period.¹⁸ This program targets early-mover projects, aiming to assist them in achieving final investment decisions and bridge the commercial gap.¹⁹ In December 2023, six projects, representing a total electrolyser capacity of 3.5GW, were shortlisted and invited to submit a full application for the next stage of the program.²⁰

Renewable energy cost-reduction initiatives

The cost of renewable energy is a significant component of the cost of producing renewable hydrogen, representing around 70 per cent of total production costs.²¹ The \$20 billion [Re-wiring the Nation](#) initiative supports the expansion and

modernisation of electricity grids to facilitate the integration of renewable energy.²² The [Capacity Investment Scheme](#) also aims to drive down the cost of renewable energy through competitive tender bids for renewable energy generation and storage products.²³ These initiatives will be crucial in driving production costs down.

Guarantee of Origin Scheme

On 28 November 2024, the Federal Government enacted the *Future Made in Australia (Guarantee of Origin) Bill 2024* and supporting legislation, establishing the voluntary Guarantee of Origin Scheme (**GO Scheme**). The GO Scheme will certify low-emission products and renewable electricity, including green hydrogen, through digital certificates.²⁴ The GO Scheme enhances transparency and competitiveness, supports initiatives like the Capacity Investment Scheme, and will help determine eligibility for the HPTI.²⁵ The GO Scheme is expected to launch in 2025.²⁶ To learn more about the GO Scheme, please read our previous article [Pressing GO! on Clean Energy Certification: Understanding the Future Made in Australia \(Guarantee of Origin\) Bill 2024](#).

Bridging the commercial gap: Is it enough?

As discussed previously in our [article](#) on the announcement of the HPTI, while the HPTI aims to build scale to reduce production costs over time, some argue that a 10-year support window may not be sufficient for producers.²⁷ Instead, this short window may increase ‘pressure on supply chains through competition for workers, equipment and services, in turn driving inflation of project delivery costs’.²⁸

Furthermore, the practical accessibility of the Hydrogen Headstart program is up for question. An eligibility requirement for the program is for the facility to include a 50 MW minimum electrolysis single-site deployment.²⁹ The reality is that this will only benefit a short list of hydrogen producers, leaving many smaller producers without support from the program.

The focus of the Strategy and the Government incentives on scaling up large-scale hydrogen production projects is a step in the right direction, but further support could be provided to assist small-scale production to build industry. Smaller projects can be instrumental in supporting the development of the domestic hydrogen industry, as well as educating the community and developing a skilled workforce.

While the HPTI and Hydrogen Headstart program are vital to help bridge the commercial gap by focusing on reducing the cost of production, it is likely that additional support and funding sources will be required, and the Government may need to bring forward demand-side policies to meet these needs.³⁰

In order to provide demand-side support it has been suggested that the adoption of a contract for difference (CfD) style scheme would incentivise production.³¹ CfDs offer a practical solution to financing emerging technologies by establishing a stable and predictable long-term revenue profile.³² The success of CfDs has been proven in other renewable technologies, for example, in Europe, where 33-50 per cent of new capacity from offshore wind projects has been financed through CfDs over the past 15 years.³³

The Strategy lays essential groundwork to position Australia as a global hydrogen leader and to support the transition to net zero. Key initiatives like the HPTI and Hydrogen Headstart program address production cost barriers, but whether they sufficiently bridge the commercial gap and provide the necessary support to accelerate the development of a hydrogen industry in Australia remains uncertain. Ultimately, Australia’s commitment to overcoming these challenges will be crucial to positioning itself as a global hydrogen leader and driving a sustainable, renewable future.

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](tel:+61459900080)





Marni Riley
Special Counsel
[+61 450 821 836](tel:+61450821836)





David O'Carroll
Senior Associate
[+61 421 497 311](tel:+61421497311)





Eamonn Carpenter
Lawyer
[+61 2 8072 8271](tel:+61280728271)





Suwathie Rajeswaran
Paralegal
[+61 2 8072 8271](tel:+61280728271)



¹ Department of Climate Change, Energy, the Environment and Water (DCCEEW), National Hydrogen Strategy 2024 (Government Strategy, 13 September 2024) 7 <<https://www.dcceew.gov.au/sites/default/files/documents/national-hydrogen-strategy-2024.pdf>> ('The Strategy').

²Ibid 37.

³Ibid 7.

⁴Tom Monaghan, 'Australia's Green Hydrogen Ambitions: Soldiering On Despite Adversity', Australian Energy Council (Article, 17 October 2024) <<https://www.energycouncil.com.au/analysis/australia-s-green-hydrogenambitions-soldiering-on-despite-adversity/>>

⁵Australian Hydrogen Council, 'Closing the financial gap for hydrogen in Australia' (LinkedIn, 13 October 2023) <<https://www.linkedin.com/pulse/closing-financial-gap-hydrogen-australia-kj9zc/>>.

⁶Green Hydrogen Organisation, 'Key considerations for green hydrogen offtake agreements' (Briefing Paper, 1 May 2024) 36 <https://gh2.org/sites/default/files/2024-05/GH2_Considerations%20for%20Hydrogen%20Offtake%20Agreements_2024.pdf>.

⁷PwC, 'Getting H2 right: Success factors for Australia's hydrogen export industry' (Report, 2022) <<https://www.pwc.com.au/important-problems/integrated-infrastructure/PwCAU-Getting-H2-Right.pdf>>.

⁸Australian Hydrogen Council (n 5).

⁹Monaghan (n 4).

¹⁰Green Hydrogen Organisation (n 6) 6.

¹¹University of Western Australia, 'Australia's Green Hydrogen Vision: Shaping a New Market', (Article, 28 November 2024) <<https://www.uwa.edu.au/news/article/2024/november/australia-green-hydrogen-visionshaping-a-new-market>>.

¹²Ibid.

¹³Matt Baumgurtel et al., 'Hydrogen on the Horizon: Unpacking Australia's New Hydrogen Production Tax Incentive', Hamilton Locke (Article, 24 July 2024) <<https://hamiltonlocke.com.au/hydrogen-on-the-horizonunpacking-australias-new-hydrogen-production-tax-incentive/>>.

¹⁴The Strategy (n 1) 9.

¹⁵Ibid (n 1) 47.

¹⁶Ibid (n 1) 47.

¹⁷Marni Riley and Lily Clements-Markham, 'New Energy Bulletin: Future Made in Australia (Production Tax Credits and Other Measures) Bill introduced to Parliament', Hamilton Locke (Article, 28 November 2024) <<https://hamiltonlocke.com.au/new-energy-bulletin-future-made-in-australia-production-tax-credits-and-other-measures-bill-introduced-toparliament/>>.

¹⁸The Strategy (n 1) 47.

¹⁹Ibid (n 1) 46.

²⁰DCCEEW, 'Hydrogen Headstart applicants are potential world leaders' (Article, 21 December 2023) <<https://www.dcceew.gov.au/about/news/hydrogen-headstart-applicants-are-potential-world-leaders>>.

²¹The Strategy (n 1) 46.

²²Ibid.

²³Ibid 14.

²⁴DCCEEW, 'New Guarantee of Origin Scheme to support low-emission industries' (Media Release, 12 September 2024) <<https://www.dcceew.gov.au/about/news/new-guarantee-origin-scheme-support-low-emissionindustries>>.

²⁵The Hon Chris Bowen MP and the Hon Josh Wilson MP, 'Pressing GO on a future made in Australia' (Media Release, 28 November 2024) <<https://minister.dcceew.gov.au/bowen/media-releases/pressing-go-future-madeaustralia>>.

²⁶Ibid.

²⁷Baumgurtel (n 13).

²⁸Ibid.

²⁹Australian Renewable Energy Agency, Hydrogen Headstart Guidelines (Guidelines, October 2023) 5 <<https://arena.gov.au/assets/2023/10Hydrogen-Headstart-Guidelines.pdf>>.

³⁰Baumgurtel (n 13).

³¹Australian Hydrogen Council (n 5).

³²Agnieszka Ason and Julio Dal Poz, 'Contracts for Difference: The Instrument of Choice for the Energy Transition' (Research Paper ET34, Oxford Institute for Energy Studies, April 2024) 2 <<https://www.oxfordenergy.org/wpcms/wp-content/uploads/2024/04/ET34-Contractsfor-Difference.pdf>>.

³³Ibid.



Fueling the Fleets

Authors: Matt Baumgurtel, Adriaan van der Merwe, David O’Carroll and Megan Chau



Introduction

The Australia Institute reports that Australia is reliant on imports for 91 per cent of its fuel consumption, which means that the country’s fuel supply is exposed to international price fluctuations and supply chain constraints.¹

Under the Long-Term Emissions Reduction Plan to achieve net zero emissions by 2050, the Australian Government introduced the \$250 million Future Fuels Fund to provide co-investment for innovative charging and refuelling infrastructure projects. The Fund is supplemented by the 2021 Future Fuels and Vehicles Strategy which aims to encourage the uptake of electric, hydrogen, biofuelled or hybrid vehicles.

Electric

As noted in our article [Driving it Home: How Australia Can Make the Switch to Electric Vehicles](#), various stakeholders are working towards a smooth transition to electric-fuelled vehicles (**EVs**). This includes the development of critical infrastructure, financial incentives and other policy instruments at both the State and Federal level.

The private sector is heavily invested in this transition. For example, Janus Electric recently unveiled what it claims to be Australia’s first

electric prime mover fleet comprised of four heavy haulage vehicles. The key feature of the company’s technology is its ability to take existing vehicles and convert them into EVs as opposed to purchasing new vehicles. This circumvents the high upfront purchase price of EVs.

In Victoria, Volgren released two fully electric buses for the Department of Transport and bus operator, Kinetic. A further 34 buses will be rolled out over the next three years. Kinetic has also contracted with the Melbourne Bus Franchise (**MBF**) to replace more than half of its fleet with low or zero-emission models.

The New South Wales government recently committed \$219 million to achieve an 8,000-strong, zero emission public bus fleet by 2047. This would lead to a 78 per cent reduction of Transport for NSW’s current emissions.²

Hydrogen

Another key focus area of the Future Fuels and Vehicles Strategy is the commercialisation of hydrogen as a transport fuel. To achieve this goal, the program will support projects developing renewable hydrogen transport solutions, particularly fuel cell electric vehicles (**FCEV**) which operate using a fuel cell powered by hydrogen.

For example, Emerald Coaches, based in Queensland, recently committed to convert 120 vehicles from diesel fuel to hydrogen fuel by 2040 at an estimated cost of \$100 million.

Substantial progress is also being made to scale up the production and supply of renewable hydrogen as a source of fuel. Hydrogen Fuels Australia intends to develop Australia’s first modular hydrogen production and integrated FCEV refuelling operation in Truganina, Victoria. Projected to become operational in the third quarter of this year, the site will initially produce 60-90kgs of green hydrogen from its own solar array, enough to fuel up to 3 vehicles per day. Eventually, the plan is to scale up the site to supply up to 3,000kg of hydrogen daily, with capacity to refuel 100+ vehicles per day.

Biofuels

Liquid fuels (including biofuels) are one of the more commonly used fuels in the heavy freight, shipping and aviation industries due to its high-density energy and ease of storage and transportation compared to electricity and hydrogen. Furthermore, biofuels can more easily be substituted for traditional fuels. Many vehicles designed to run on conventional diesel, for example, will have no problem running on biodiesel alternatives without the need to convert the vehicle.

Biofuels however have high manufacturing and energy costs, and the focus of future developments will be on making biofuels more cost-effective and economically viable. Pilot programs are underway to produce the next generation of commercial biofuels, including the Northern Oil Advanced Biofuels Laboratory project and the Oceania Biofuels renewable diesel and sustainable aviation fuel biorefinery in Gladstone, Queensland.

Funding

To support the above, the Australian Renewable Energy Agency (ARENA) recently launched Round 2 of the Future Fuels Program with \$127.9 million in funding to support commercial fleets to shift to zero emissions vehicle technology by 2026.

The Clean Energy Finance Corporation offers additional funding to clean energy projects on behalf of the Australian government, having invested over \$450 million in projects and funds aimed to reduce emissions in the transport sector. The Corporation also partners with external organisations to facilitate co-financed projects.

Funding at the State-level is also available, such as the Hydrogen Industry Development Fund in Queensland that contributed to the Emerald Coaches hydrogen project mentioned above. In New South Wales, the Electric Vehicle Strategy offers a cash rebate of \$3,000 on 25,000 eligible vehicles to encourage the greater uptake of EVs.

Western Australia has allocated \$60 million to accelerate the use of zero emission vehicles in the 2022-23 State Budget. This funding includes:

- A \$3,500 rebate for Western Australians if they purchase an electric or hydrogen fuel-cell vehicle; and
- \$22.5 million towards charging infrastructure.

The Future

Australia has a renewed focus on securing readily available sources of fuel for its domestic transport needs – specifically via electricity, hydrogen and biofuels. While the transition to renewable fuels is a work in progress, an increase in the number of renewable energy projects, available funding and other incentives for both developers and consumers means there has never been a better time to ‘fuel’ a more sustainable transportation industry in Australia.

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](#)





Adriaan van der Merwe
Special Counsel
[+61 40 312 0410](#)





David O’Carroll
Senior Associate
[+61 421 497 311](#)





Megan Chau
Lawyer
[+61 2 8072 8271](#)



¹ Liam Carter, Audrey Quicke and Alia Armistead, ‘Over a Barrel: Addressing Australia’s Liquid Fuel Security’, The Australia Institute (April 2022) https://australiainstitute.org.au/wp-content/uploads/2022/04/P1036-Over-a-barrel_liquid-fuel-security-WEB.pdf.

²Michael Mazengarb, ‘Kean Goes Deep Green with Budget that Links Climate Action with Future Prosperity’ (21 June 2022) <https://reneweconomy.com.au/kean-goes-deep-green-with-budget-that-links-climate-action-with-future-prosperity/>.

Can Hydrogen Fuel Cell Vehicles compete with Electric Vehicles in the Light Passenger Vehicle Market?

Authors: Matt Baumgurtel, William Ryan and Michael Liu



Transportation is the second largest source of global CO2 emissions (after energy generation), and in 2022 produced almost 8 gigatonnes of CO2.¹ Transport sector emissions are predominantly attributable to road transport vehicles, which produced 5.87 gigatonnes of CO2 in 2022.²

Accordingly, investment in green road transport vehicles – particularly light passenger vehicles – represents an important step in the global transition to net-zero emissions.

Industry have advanced two possible solutions: battery powered electric vehicles (**EVs**)³ and hydrogen fuel cell vehicles (**HFCVs**).

Hydrogen Fuel Cell Vehicles

Much has been said about EVs. By contrast, HFCVs – being vehicles running on electricity produced from hydrogen fuel cells – are relatively unknown to the public.

Vehicle manufacturers, by contrast, are demonstrating interest in HFCVs and companies such as BMW, Honda, Hyundai, and Toyota have invested in this emerging technology.⁴ For instance, BMW and Toyota announced a partnership in September 2024 to develop a hydrogen fuel cell powertrain technology which can be used in future car models from both companies.⁵

Despite these investments, the feasibility of hydrogen as a fuel source for road transport has been questioned, particularly in the context of light vehicles (as opposed to heavy vehicles). For example, the Grattan Institute has advised that investment in hydrogen powered light passenger vehicles is futile as EVs present a much more compelling economic case and already dominate market share.⁶

This raises the question of whether there is a place for hydrogen as a fuel source for any future mix of light passenger vehicle transport (or road transport more broadly).

The Advantages of Hydrogen Fuel Cell Technology

The key advantages of hydrogen fuel cell technology are that it allows for faster refuelling, greater range, and a lighter chassis than battery EVs.⁷ These attributes make the technology a particularly attractive prospect for long-haul heavy freight transport in comparison to current EV technology, with the benefits of transporting greater payloads for longer distances and with shorter refuelling times. However, these comparative advantages are being challenged by advancements in EV technology, with improvements in battery capacity and the development of battery-swapping technology for heavy vehicles.⁸

The attributes of HFCVs may also be suitable for the provision of fleet vehicles to niche markets, such as bus, taxi, and security patrol fleets, where vehicles are required to be in constant operation.⁹ This application is being explored in Australia through state government investment in hydrogen bus pilot programs¹⁰ and car manufacturers trialling the introduction of light HFCVs through private leasing agreements.¹¹ Again, however, the viability of such programs will continue to be challenged into the future as electric bus prices fall.¹²

The Limitations of Hydrogen Fuel Cell Technology

The production and transportation of hydrogen for use in HFCVs is high and involves a multi-stage process requiring electrolysis, compression or liquefaction, storage, transportation, and the development of refuelling infrastructure.¹³ Each of these stages requires significant energy input as well as other associated costs, resulting in an average cost of hydrogen gas between \$7/kg and \$16/kg.¹⁴

Accordingly, HFCV may remain financially unviable for manufacturers, with the long-term feasibility of these vehicles reliant on a marked fall in the price of hydrogen.¹⁵ To match the affordability of driving an EV this figure would need to drop to \$2/kg or below.¹⁶

Although the increasing deployment of renewable energy generation is likely to cause a longer-term fall in the cost of energy input for the production of hydrogen, this fall would also cause a decrease in the cost of running an EV. Although the deployment of EVs require significant infrastructural investment, this investment is arguably lesser than the infrastructural investment involved with HFCV deployment (including supply, storage, maintenance, and refuelling infrastructure).¹⁷

This is evidenced by the current standing of hydrogen fuel infrastructure in California, one of the leading investment hubs for such infrastructure globally. Despite significant funding by California to subsidise the development of hydrogen refuelling stations since 2008, targets for the number of new stations have been reducing and existing stations have suffered closures due to endemic maintenance issues.¹⁸

In addition to the disparity in existing infrastructure, the uptake in EVs versus HFCVs by consumers is also vastly disparate. In Australia, only six HFCVs were acquired by consumers in 2023, all through leasing agreements.¹⁹ By comparison, more than 87,000 EVs were sold over the same period.²⁰ This variance in market share domestically is also reflective of the international market. Even California, a global leader in hydrogen refuelling infrastructure, saw consumers continue to favour EVs, with over 380,000 purchased in 2023, compared to only 3,143 HFCVs.²¹

Finally, for HFCVs to be truly ‘green’, the energy inputs required for hydrogen fuel must also be green. At present, a significant portion of hydrogen is produced from natural gas.²² This, in addition to the energy requirements of compression, storage, and transport, means that HFCVs will not be a green method of transport until all inputs are sourced renewably. While electric vehicles may also rely on a grid that is not sourced entirely from renewably generated electricity, the growth in renewable energy generation and distributed energy resources demonstrate that it is feasible for EVs to be entirely renewable energy generated.

What’s next for HFCVs?

Although the evidence demonstrates challenges for the mass adoption of HFCVs in the light passenger vehicle market, HFCVs may nonetheless have a role to play in niche subsectors of the green road vehicle market (such as with long-haul transport and vehicle fleets). This position was touted in the Australian Government’s [National Hydrogen Strategy 2024](#), which identified hydrogen as a solution to transitioning to the long haul transport sector.²³

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.

Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](#)

William Ryan
Senior Associate
[+61 2 8072 8271](#)

Michael Liu
Lawyer

¹‘Transport’, International Energy Agency (Web Page) <<https://www.iea.org/energy-system/transport>>.

²Ibid.

³ABC News, ‘Global Electric Vehicle Sales Surge in 2022, IEA Reports’ (2023) ABC News <<https://www.abc.net.au/news/science/2023-04-27/electricvehicle-ev-sales-increased-globally-2022-iea-outlook/102266800>>.

⁴Emilia Terzon, ‘Toyota is pushing hydrogen cars but will they ever be as cheap to run as EVs?’, ABC News (Web Page, 29 January 2024) <<https://www.abc.net.au/news/2024-01-29/toyota-hydrogen-cars-future-electricvehicles-uptake-challenges/103390084>>.

⁵BMW Group ‘Hydrogen Pioneers: BMW Group and Toyota Motor Corporation take collaboration to the next level to offer Fuel Cell Electric Vehicle (FCEV) options for passenger cars.’ (Press Release, 5 September 2024) <<https://www.press.bmwgroup.com/global/article/detail/T0444790EN/hydrogen-pioneers-bmw-group-and-toyota-motorcorporation-take-collaboration-to-the-next-level-to-offer-fuel-cell-electricvehicle-fcev-options-for-passenger-cars>>.

⁶Grattan Institute, Hydrogen: hype, hope, or hard work? (Report No 2013-13, December 2023) 15, 17, 19.

⁷New report to accelerate Australia’s hydrogen-powered transport future’, CSIRO (News Release, 21 August 2023) <<https://www.csiro.au/en/news/All/News/2023/August/New-report-to-accelerate-Australias-hydrogenpowered-transport-future>>.

⁸Hydrogen cars left at starting line as EV sales take off’, InDaily (Web Page, 18 March 2024) <<https://www.indaily.com.au/business/energy/2024/03/18/hydrogen-cars-left-at-starting-line-as-ev-sales-take-off>>.

⁹Terzon (n 4).

¹⁰Matt Baumgurtel, Adriaan van der Merwe and Megan Chau, ‘Hydrogen as a Transport Fuel’, Hamilton Locke (Web Page, 16 August 2022) <<https://hamiltonlocke.com.au/hydrogen-transport-fuel/>>.

¹¹Terzon (n 4).

¹²InDaily (n 8).

¹³John Poljak, ‘Why does \$4/kg hydrogen cost the customer \$30/kg?’, LinkedIn (Web Page, 17 March 2024) <<https://www.linkedin.com/pulse/why-does-4kg-hydrogen-cost-customer-30kg-john-poljak-rrwvc/>>.

¹⁴Terzon (n 4).

¹⁵Ibid.

¹⁶Ibid.

¹⁷Todd Woody, ‘Few Stations and \$200 to Fill Up: Life on California’s ‘Hydrogen Highway’’, Bloomberg (Web Page, 4 April 2024) <https://www.bloomberg.com/news/features/2024-04-04/california-s-hydrogen-fuelcell-cars-lose-traction-against-battery-models?cmid=BB040624_GREENDAILY&utm_medium=email&utm_source=newsletter&utm_term=240406&utm_campaign=greendaily>..

¹⁸Ibid.

¹⁹Terzon (n 4).

²⁰Ibid.

²¹Woody (n 17).

²²Ibid.

²³Department of Climate Change, Energy, the Environment and Water, National Hydrogen Strategy 2024 (Report, September 2024) 10.

Hydrogen Trains: Revolutionary or Overhyped?

Authors: Matt Baumgurtel, William Ryan and Sam Poulsen

Hydrogen trains (**HTs**) have emerged as a promising solution to decarbonising rail transport globally. Innovative technology and strong environmental credentials have attracted significant attention to HTs in Australia and abroad.

However, much of Australia’s rail network covers vast distances between remote and dispersedly spread population centres – begging the question: are HTs fit for these conditions?

In this article, we explore some of the basic science behind HTs, their operational advantages for Australia’s network, the challenges HTs face in scaling up operations in Australia, and what might come next for the nascent industry.

Hydrogen Trains: What are they?

Australia is on an ambitious path to reach net zero carbon emissions by 2050. Part of that journey will require decarbonising railway transport and replacing diesel locomotives with cleaner alternatives. HTs are fast becoming a promising solution to lift the environmental credentials of the industry. Using hydrogen as a fuel either within a combustion engine or to power a chemical reaction with oxygen in fuel cells, HTs can generate energy to power train motors.¹ Advantageously, HTs generate only water and heat as by-products and do not produce carbon emissions or air pollution.² Where feed hydrogen has been produced from clean energy sources such as wind and solar, HTs tend to have very low lifecycle emissions.³

Conversely, diesel engine trains (**DETs**) account for 60 per cent of the total direct and indirect emissions from the Australian national rail carbon footprint.⁴ Although rail is the least emissions-intensive mode of passenger transport (according to the International Energy Agency),⁵ DET emissions have, among other things, detrimental health consequences for Australians. The Australian Cancer Council has noted that 1.2 million Australians are exposed to diesel engine exhaust chemicals each year, and that people operating in transport are at higher risk of exposure.⁶ DET chemicals increase the risk of operators developing long-term health problems, negatively impacting public health costs. These health outcomes are avoided with HTs.

So, despite their environmental and health-related benefits, why have HTs not taken off? Below, we explore some key challenges to HT implementation across Australia’s rail network, and how those challenges might be addressed.

Challenges to Implementation

Use Cases: Where Hydrogen Trains Will Work, and Where They Won’t

In the race to de-carbonise rolling stock, one of the largest producers of HTs in Germany has claimed HTs will almost always lose to battery-electric trains (**BETs**) in procurement tenders in Europe.⁷ This is because railways in central Europe are usually close to stations with overhead charging lines that can charge BETs.⁸ This logic might also be applied to Australia’s urban railways which are typically close to charging stations in population centres around the country. HTs may not be appropriate on these railway networks, where BETs better suit existing charging infrastructure.

However, HTs are typically capable of travelling much greater distances than BETs. HTs may therefore find success in the vast Australian rail networks that cover greater distances than urban centre networks and do not have charging infrastructure available. Further, using BETs on remote rail networks would not be economical given limitations on load capacity of existing batteries.⁹ Australia’s dispersed population centres and remote communities such as mining outposts require trains that can travel routes spanning hundreds, if not thousands, of kilometres. Promisingly, HTs look set to meet these demands. One HT model has, for example, been demonstrated to travel nearly 3,000km without refuelling.¹⁰ While this distance was likely due to optimised testing conditions, in 2022 another model was demonstrated to travel 1,175km without refuelling during the normal course of operation in Germany.¹¹

Infrastructure

However, HT technology is complex and requires the support of specialised infrastructure. With specialisation comes cost, and this is particularly apparent in remote regions where infrastructure costs are typically higher than in urban regions.¹² HT re-fuelling stations, for example, are more complex than typical DET stations due to technical requirements of hydrogen storage at high-pressure or in cryogenic tanks.¹³ This may mean that using HTs in certain applications such as remote mining, port or rail corridor locations are not immediately economical compared to DETs given the associated costs with setting up HT refuelling capabilities.¹⁴ Accordingly, proponents of HTs must also focus on reducing the costs associated with HT re-fuelling infrastructure.

Promisingly, the outlook on investment in the HT industry appears positive. The Australian Renewable Energy Agency announced on 21 December 2023 that it had shortlisted six applicants for its AUD \$2 billion Hydrogen Headstart Program (**Program**).

The Program will support large scale-renewable hydrogen production projects across multiple states in Australia,¹⁵ and is part of a broader \$127B pipeline of announced hydrogen industry investment in Australia.¹⁶ The Program puts Australia on a policy and strategic trajectory towards developing key infrastructure associated with HTs such as refuelling stations and will lay a solid foundation of investment to support this nascent industry. HT proponents may be able to capitalise on this investment to scale up HT use across Australia and into remote regions. In the 2024 Federal Budget, the Federal Government allocated a further \$8 billion in funding to support the production of renewable hydrogen through tax incentives and programs including the Program.

Safety

Hydrogen-related disasters, including the 1937 Hindenburg Blimp fire and the 2011 explosion at the Fukushima nuclear power plant have instilled public reluctance to accept hydrogen as a future fuel technology.¹⁷ This reluctance has fed into perceptions around the safety of HTs. In our previous [article](#), we noted that hydrogen properties call for specific safety requirements and infrastructure to ensure hydrogen can be transported, stored and delivered safely. Hydrogen safety issues usually fit into two categories, materials-related issues (e.g., components cannot withstand the high-pressure storage), and handling-related issues (e.g., human error).¹⁸ Addressing these issues suitably will be relevant to the successful uptake of hydrogen use in rail contexts. However, with appropriate industry standards and education these concerns are likely to fade as HT innovation continues. Key to this change will be HT proponents making use of large public schemes available such as the Program to invest in certification and safety measures.

What’s Next?

The Australian Federal Government released its National Rail Procurement and Manufacturing Strategy in November 2023 (**Strategy**). The Strategy forms part of a National Rail Manufacturing Plan (**Plan**) and outlines the Government’s commitment to “simplify procurement, harmonise standards across states and territories, increase innovation, and improve skills and capabilities in the rail manufacturing sector”.¹⁹ The Government’s Strategy, Plan and Program individually and collectively indicate a policy and strategic shift towards supporting the hydrogen and railway industries with the development of innovative and decarbonising technologies. Further, these policies may pave the way for future proponents of HTs to invest in and support this nascent industry.

While some concerns must be addressed before HTs become commonplace, HTs are on track to change the rail industry in Australia. HT environmental credentials and applications for long-haul routes position HTs as attractive to governments, investors and consumers alike.



The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](tel:+61459900080)



William Ryan
Senior Associate
[+61 2 8072 8271](tel:+61280728271)



Sam Poulsen
Graduate
[+612 8072 8271](tel:+61280728271)



¹What is a Hydrogen Train and How do They Work? (Webpage) <<https://www.twi-global.com/technical-knowledge/faqs/what-is-a-hydrogen-train>>.

²Daniel Ding, Xiao-Yu Wu, ‘Hydrogen Fuel Cell Electric Trains: Technologies, Current Status, and Future’ (2024) 17 Applications in Energy and Combustion Science, 2.

³Ibid.

⁴National Rail Carbon Footprint Study (June 2022)<<https://www.rissb.com.au/news/national-rail-carbon-footprint-study-available/>> 16.

⁵Oskaras Alšauskas, Rail (Webpage 11 July 2023) <<https://www.iea.org/energy-system/transport/rail>>.

⁶Diesel: What is Diesel Engine Exhaust (Webpage) <<https://www.cancer.org.au/cancer-information/causes-and-prevention/workplace-cancer/diesel>>.

⁷Rachel Parkes, ‘Hydrogen Will ‘Almost Always’ Lose Out to Battery-Electric in German Rail Transport: Train Manufacturer’, Hydrogen Insight (online, 22 August 2023) <<https://www.hydrogeninsight.com/transport/hydrogen-willalmost-always-lose-out-to-battery-electric-in-german-rail-transport-trainmanufacturer/2-1-1504868>>.

⁸Ibid.

⁹Ibid.

¹⁰Rachel Parkes ‘World record | Hydrogen Train Travels Nearly 3,000km Without Refuelling’ Hydrogen Insight (online 26 March 2024) <<https://www.hydrogeninsight.com/transport/world-record-hydrogen-train-travels-nearly-3-000km-withoutrefuelling/2-1-1617599>>.

¹¹Ibid.

¹²Ding (n 2) 1.

¹³Ding (n 2) 3.

¹⁴Ruth Knibbe et al., ‘Application and Limitations of Batteries and Hydrogen in Heavy Haul Rail Using Australian Case Studies’ (2022) 56 Journal of Energy Storage 4.

¹⁵Six Shortlisted for \$2 Billion Hydrogen Headstart Funding (Webpage) <<https://arena.gov.au/news/six-shortlisted-for-2-billion-hydrogen-headstart-funding/>>.

¹⁶Growing Australia’s Hydrogen Industry (Webpage) <<https://www.dcceew.gov.au/energy/hydrogen>>.

¹⁷Elham Abohamzeh et al., ‘Review of Hydrogen Safety During Storage, Transmission, and Applications Processes’ (2021) 72 Journal of Loss Prevention in the Process Industries 1.

¹⁸Ibid 1-2.

¹⁹National Rail Procurement and Manufacturing Strategy: A Part of the National Rail Manufacturing Plan (Webpage) <<https://www.industry.gov.au/publications/national-rail-procurement-and-manufacturing-strategy>>.

Global Approaches to Sustainable Fuels

– What can Australia Learn from Other Countries?

Authors: Matt Baumgurtel, William Ryan, and Michael Liu

With the rest of the world transitioning to sustainable fuels to meet their own net zero goals, Australian can learn some valuable lessons from Europe, the United States, China and beyond.

Adopting sustainable fuels, like green hydrogen (hydrogen made from renewable energy), biofuels, and synthetic fuels, is a key part of the new energy transition.

Although many countries have committed to reaching net zero emissions, their different economic, social, political, and environmental situations have led them to adopt various approaches to using sustainable fuels. However, there are key lessons that Australia can learn from these efforts.

European Union

The European Union presents a unique model as it sets collective climate targets for its member states.

The European Green Deal is the European Union's policy to become the first climate neutral continent by 2050. The European Union's [Renewable Energy Directive](#) has set a binding renewable energy target that 42.5% of all energy consumption by 2030 is generated by renewable energy sources. The European Union has also called for renewable energy generation to accommodate increased production of sustainable fuels.

The European Union's ambitious targets are driven by both climate concerns and the geopolitical drive to achieve energy security and affordable energy prices, This latter concern was heightened by the COVID-19 pandemic and the conflict between Russia and Ukraine (which affected the European Union's energy supply). On this point, a notable detail of the European Union's 2030 target includes becoming independent from Russian fossil fuels by increasing the use of sustainable fuels.¹

To achieve this, the European Union's hydrogen strategy – [‘A Hydrogen Strategy for a Climate-Neutral Europe’](#) calls for investments to decarbonise existing hydrogen production plants to produce green hydrogen and for the development of a union strategy for imported and domestic hydrogen based on the energy mix of each European Union member state. On biofuels, the European Union adopts a cautious approach despite being positive towards sustainable fuels generally. This is because policies that incentivise

biofuels such as woody biomass without constraints may lead to the deforestation and unwanted impacts on the manufacturing of wood-based products.²

While the European Union has set collective climate targets and issued guidance on sustainable fuels, domestic strategy has also been set by particular member states. For example, [Germany's](#) National Hydrogen Strategy aims to meet 20 TWh of annual national energy consumption requirements with hydrogen by 2030. Further, [Sweden](#) has policies incentivising ethanol and biodiesel with the aim for a fossil-free transport sector by 2030.

United States

The approach to sustainable fuels in the United States' net zero emissions strategy for 2025 is comprised of both state-level and federal-level policies.

Federal policies such as the [Renewable Fuels Standards Rule](#) sets out detailed targets of renewable fuel volume targets, as set out below:

Volume Targets (billion RINs)^a

	2023	2024	2025
Cellulosic biofuel	0.84	1.09	1.38
Biomass-based diesel ^b	2.82	3.04	3.35
Advanced biofuel	5.94	6.54	7.33
Renewable fuel	20.94	21.54	22.33
Supplemental standard	0.25	n/a	n/a

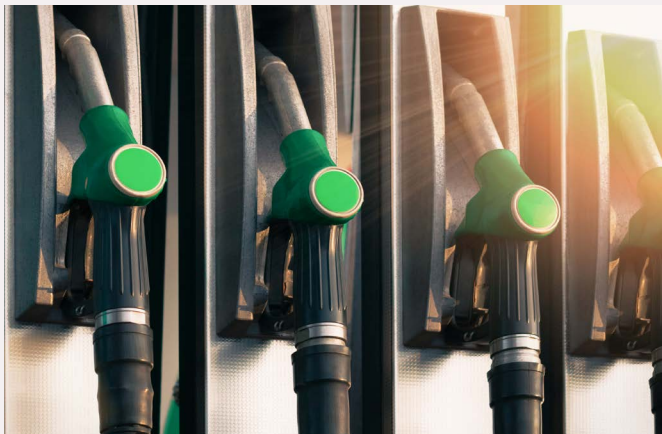
^a One RIN is equivalent to one ethanol-equivalent gallon of renewable fuel.

^b BBD is given in billion gallons.

Source

More specifically, the United States has also set specific targets in relation to the decarbonisation of its transportation sector (the country's largest emissions source) as a part of the White House's 2021 publication titled ‘Long-Term Strategy of the United States’ (**Long Term Strategy Publication**). Within the publication, the [White House](#) has established a goal that 3 billion gallons of sustainable aviation fuel will be produced by 2030.

The United States will also incentivise carbon capture and green hydrogen produced from renewable energy, nuclear energy, and waste to energy facilities, as well as investing in infrastructure such as biorefineries and transportation infrastructure.³ Although the White House did not provide details of such incentives in its Long Term Strategy Publication, there are various government incentives in respect of



sustainable fuels available in the US, including [tax credits](#) for green hydrogen producers, and [financial assistance](#) to landowners and operators who supply feedstock for biofuel production facilities.

At the state level, different policy frameworks apply. For example, California's Low Carbon Fuel Standard (**LCFS**) is a framework that awards [environmental credits](#) for the use of sustainable fuels and mandates the carbon intensity of transportation fuels in California must decline [each year](#). To comply, fuel sellers must reduce emissions within their own supply chains or procure credits under the LCFS framework. The Kleinman Center of Energy Policy estimates that since 2013, USD \$22.1 billion worth of LCFS credits have been issued to biofuel producers.⁴ While the LCFS has been effective, it has also been criticised for prioritising biofuels over electrification, causing environmental harms such as deforestation, competing with food production, and increasing retail fuel prices.⁵

China

China has become a global leader in the sustainable fuels sector despite producing the [most greenhouse gas emissions](#). To achieve [carbon neutrality](#) by 2060, China has prioritised the development of [renewable energy sources](#) driven by the dual goals of reducing air pollution and addressing climate change.

China is the world's largest producer of hydrogen and the China Hydrogen Alliance anticipates hydrogen to comprise approximately 10% of China's energy supply by 2050. Although hydrogen production in China has traditionally relied on fossil fuels as feedstock, China plans to shift this reliance to renewable sources of feedstock. Specifically, by 2025 – China aims to reduce one million to two million tons of carbon emissions annually by developing the capacity to produce 100,000 to 200,000 tons of [renewable hydrogen](#) annually. It also intends to have a fleet of 50,000 hydrogen fueled vehicles.⁶

Takeaways for Australia

As Australia progresses towards its goal of [net zero by 2050](#), it should consider the sustainable fuel strategies and policies adopted by other countries. This will promote comparative lessons and open up opportunities for collaboration.

Australia has traditionally been an energy exporter of coal and natural gas. Given Australia's [renewable energy advantages](#) (including comparatively high solar radiation per square meter), it is well positioned to foster the production and export of green hydrogen. This was recognised in the Australian government's 2024 National Hydrogen Strategy. Notably, Australia has established partnerships with countries that prioritise hydrogen as a part of their energy transition strategy such as [Germany to supply hydrogen](#). Given China is the largest hydrogen producer, hydrogen policies in China may be valuable in informing Australia's hydrogen production strategy.

Besides hydrogen, biofuels also form an important part of Australia's sustainable fuels strategy. The Australian Renewable Energy Agency (**ARENA**) [anticipates significant growth](#) in the biofuels industry, particularly in the aviation industry. ARENA has published Australia's Bioenergy Roadmap which sets out various incentives and regulatory frameworks which promote the use of biofuels derived from agricultural waste, dedicated energy crops, and municipal solid waste. Awareness of the European Union's cautious approach and California's bold approach towards biofuels provides valuable guidance on issues to be aware of as the biofuel industry in Australia matures.

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](#)





William Ryan
Senior Associate
[+61 2 8072 8271](#)





Michael Liu
Lawyer



¹European Parliament and Council, 'Directive (EU) 2023/2413 of the European Parliament and of the Council of 12 December 2023' (Web Page, EUR-Lex). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413>.
²European Parliament and Council, 'Directive (EU) 2023/2413 of the European Parliament and of the Council of 12 December 2023' (Web Page, EUR-Lex). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413>.
³Ibid.
⁴Ibid.
⁵Ibid.
⁶Ibid.

[Return to contents page](#) 32

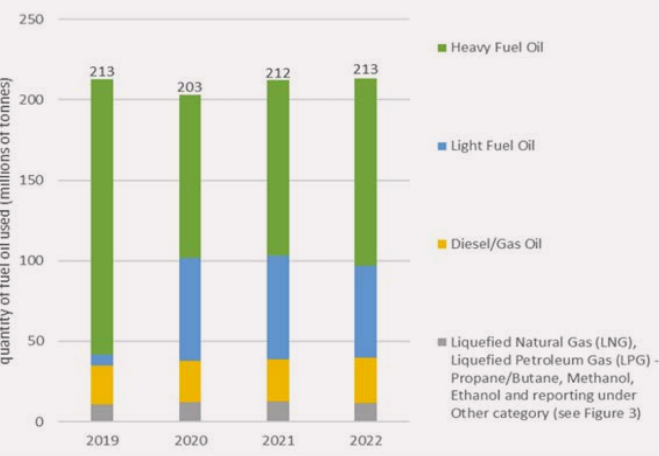
The Future of Alternative Marine Fuels for Sustainable Shipping

Authors: Matt Baumgurtel, Adriaan van der Merwe, Megan Chau and Eamonn Carpenter

The maritime industry is on a journey to decarbonise. Currently accounting for approximately 3 per cent of the world's total CO2 emissions, the shipping sector is facing mounting societal and regulatory pressure to transition to more sustainable practices.¹

In this article, we explore the types of traditional and alternative marine fuels, give an overview of the changing attitudes towards alternative fuels and highlight the changes in the regulatory landscape.

Currently, the most common marine fuels are Heavy Fuel Oil (**HFO**), Light Fuel Oil and Diesel / Gas Oil (together, **Traditional Marine Fuels**) (see below).²



These Traditional Marine Fuels emit around 1 gigatonne of greenhouse gas (**GHG**) emissions per year, including sulphur oxides (**SOx**) and nitrogen oxides (**NOx**), which account for approximately 2.5 per cent of global GHG emissions annually.³

The International Maritime Organization (**IMO**) has set a goal of achieving net-zero emissions by approximately 2050, with a short-term goal of having zero, or near-zero, GHG emission technologies, fuels, or energy sources making up at least 5 per cent of the fuel mix.⁴ Accordingly, there are a number of alternative marine fuels which are being pursued as low-GHG alternatives (**Alternative Marine Fuels**).

Types of Alternative Marine Fuels

Ammonia

Ammonia is a mix of nitrogen and hydrogen, which does not emit any CO2 during combustion. Ammonia has half the energy density of Traditional Marine Fuels (though higher than hydrogen) and is highly toxic, flammable, and corrosive, which necessitates specialised storage and handling.⁵ However, green-ammonia production should scale with the continued uptake of renewable energy and additional benefits from the existing infrastructure resulting from its use in agriculture.

Liquefied Natural Gas

Liquefied Natural Gas (**LNG**) is natural gas cooled to a liquid state, making it more compact for storage and transport. As a marine fuel, LNG offers significant environmental advantages, including lower emissions of SOx and NOx, compared to traditional HFO.⁶ However, LNG is still a fossil fuel and sits between the potential future fuels like ammonia, hydrogen or methanol, and Traditional Marine Fuels. As a result, it is seen as a bridging fuel that can help achieve emission reduction targets while the use of Alternative Marine Fuels are being scaled up.⁷

Biofuels

Biofuels, which are derived from organic materials such as plant oils, animal fats and recycled cooking oils, present an alternative to fossil fuels for the maritime sector. Biofuels can significantly reduce greenhouse gas emissions, with some biofuels offering up to an 80 per cent reduction in GHG emissions compared to conventional fuels.⁸ However, the sustainability of biofuels depends on the ability to preserve their source. For example, using crops for fuel can compete with priority for food production and lead to deforestation. Additionally, the maritime sector is in direct competition with the uptake of sustainable aviation fuel (**SAF**).⁹ SAF is produced from the same cooking oils and animal fat waste used to create marine biofuels. Although SAF has higher production costs than marine biofuels, the aviation industry's margins are better suited to absorbing or passing on the costs, meaning the aviation industry is likely to absorb a majority of supply moving forward.¹⁰

Hydrogen

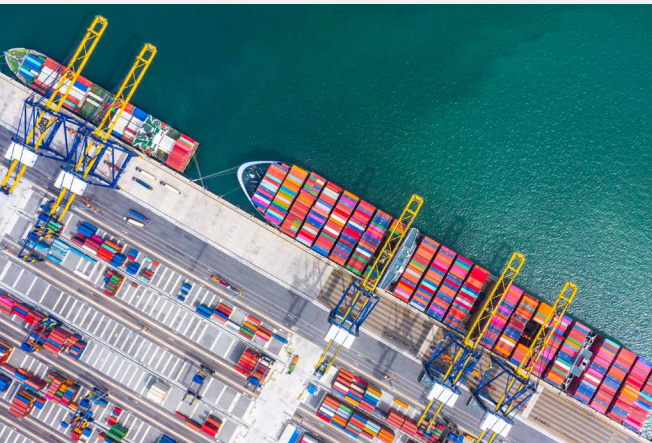
Hydrogen is a 'zero-emission fuel', making it a highly attractive option for the maritime industry's decarbonisation. Hydrogen combustion produces very little NOx, no SOx and no carbon dioxide (**CO2**) emissions. However, it is one of the least energy dense fuel sources by volume (raising operating expense concerns) despite having high energy content by weight.¹¹ Hydrogen storage and handling also pose significant challenges, requiring advanced storage solutions such as cryogenic tanks, and the conversion of hydrogen via compression, liquefaction, or chemical compounding.¹² There is no one size fits all solution to storage, as no single storage method is capable of housing high density energy without expending large amounts of energy to safely store that energy.¹³ As a result shipowners are facing high capital expenditure costs associated with transitioning to hydrogen including costs associated with fitting and maintaining the required storage and engines for hydrogen use, as well as production, conversion and training-related costs.

Methanol

Methanol, a liquid at ambient temperatures, offers a practical alternative marine fuel due to its ease of storage and handling. It can be produced from various feedstocks, including natural gas, biomass, and even CO2. Methanol combustion results in lower emissions of SOx, NOx, and particulate matter compared to Traditional Marine Fuels. However, methanol has a lower energy density than HFO, necessitating larger storage volumes on ships. Additionally, methanol production is extremely limited.¹⁴

Changing attitudes – Decarbonisation efforts

In 2023, the Global Centre for Maritime Decarbonisation and Boston Consulting Group conducted an industry survey with 128 shipowners and operators who collectively owned or operated over 14,000 merchant vessels.¹⁵ While 73 per cent viewed getting to net-zero operations as a strategic priority, the lack of commercial incentives and low economic viability of these fuels have been identified as one of the leading challenges for adoption.¹⁶ Specifically, Alternative Marine Fuels require investment from shipowners to build, or retrofit, their vessels to use such fuels,¹⁷ attract a premium over conventional fuels, require higher-skilled labour to operate and have a lower energy density.¹⁸



Regulations supporting the transition

The IMO's goal of achieving net-zero emissions by approximately 2050 are supported by the following climate policies:

- 1. US Inflation Reduction Act** – the US Inflation Reduction Act incentivises developers and investors to produce Alternative Maritime Fuels through providing tax credits for the production of clean hydrogen, and additional credits for carbon sequestration.¹⁹
- 2. EU Emissions Trading System** – the EU Emissions Trading System acts as a cap-and-trade program which now applies to the maritime and aviation industries. It requires companies to purchase allowances (a right to emit a certain amount of GHGs) if their vessels travel within the EU.²⁰ This program, over time, will increase the price of these allowances which incentives vessel owners to transition to Alternative Marine Fuels.²¹
- 3. FuelEU Maritime Regulation** – the FuelEU Maritime regulation (entering into force in 2025) sets GHG emissions intensity requirements on the energy used by ships over 5000 gross tonnage trading in the EU, targeting a 2 per cent decrease in GHG by 2025, and an 80 per cent decrease by 2050.²² Notably, this target does not just cover CO2 emissions, but undertakes a full lifecycle assessment of the fuels used onboard, from well-to-wake.²³
- 4. FuelEU pooling mechanisms** – the FuelEU pooling mechanism under the Fuel EU Maritime Regulation allows for vessel in compliance with the set annual GHG targets to share any extra allowance or surplus GHG emission with other vessels. In this sense, overachieving vessels are able to monetise on compliance – or fleet owners may take a broader view of their fleet's compliance in line with the policy. However, there is not currently a government run marketplace for the surplus.²⁴

What does the future hold?

The shipping sector is being driven by both penalties and incentives to adopt Alternative Marine Fuels. This combination of regulatory pressure, and growing understanding and investment into the production and storage of biofuels, methanol and hydrogen derivative products will continue to propel the shipping sector to transition away from Traditional Marine fuels. The challenges facing shipowners are notable and the apprehension is warranted. However, as the transition continues shipowners will need to determine (perhaps irrespective of the commercial viability) when, not if, they will adopt more widespread use of Alternative Marine Fuels.

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, construction, including the buying and selling of development and operating projects. For more information, please contact Hamilton Locke New Energy Partner Matt Baumgurtel.

For more information, please contact:



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](tel:+61459900080)





Adriaan van der Merwe
Special Counsel
[+61 40 312 0410](tel:+61403120410)





Megan Chau
Lawyer
[+61 2 8072 8271](tel:+61280728271)





Eamonn Carpenter
Lawyer
[+61 2 8072 8271](tel:+61280728271)



¹ World Economic Forum, 'Reducing barriers to maritime fuel projects is key to decarbonizing shipping' (18 April 2024) <<https://www.weforum.org/agenda/2024/04/why-reducing-barriers-for-maritime-fuel-projects-is-key-to-progressing-on-decarbonization/>>.

² Future Fuels and Technology Project, International Maritime Organization, 'Report on annual carbon intensity and efficiency of the existing fleet' (2022) <<https://futurefuels.imo.org/home/latest-information/fuelconsumption-dcs/>>.

³ Maersk Mc-Kinney Moller Center, 'Maritime Decarbonization Strategy 2022' (8 December 2022) <https://www.zerocarbonshipping.com/publications/maritime-decarbonization-strategy/>; Methanol Institute, 'Measuring Maritime Emissions: Policy Recommendations Regarding GHG Accounting of the Maritime Industry' (August 2021) <https://www.methanol.org/wp-content/uploads/2021/11/Methanol-Institute-Measuring-Maritime-Emissions-Policy-Paper-August-2021.pdf>

⁴ International Maritime Organization, RESOLUTION MEPC.377(80) (7 July 2023) <https://wwwcdn.imo.org/localresources/en/MediaCentre/PressBriefings/Documents/Clean%20version%20of%20Annex%201.pdf>.

⁵ Global Maritime Forum, 'Ammonia as a shipping fuel' (14 March 2022) <https://globalmaritimeforum.org/insight/ammonia-as-a-shipping-fuel/>.

⁶ The International Council on Clean Transportation, 'The Climate Implications of using LNG as a Marine Fuel' (28 January 2020) <https://theicct.org/publication/the-climate-implications-of-using-lng-as-a-marine-fuel/>.

⁷ Wärtsilä, 'LNG as fuel for ships: expert answers to 17 important questions' (19 June 2024) <https://www.wartsila.com/insights/article/lng-fuel-forthought-in-our-deep-dive-q-a>.

⁸ Hui Xu et al, 'Life Cycle Greenhouse Gas Emissions of Biodiesel and Renewable Diesel Production in the United States' (2022) <https://pubs.acs.org/doi/10.1021/acs.est.2c00289>.

⁹ World Economic Forum, 'Climate goals: airlines are pinning their hopes on sustainable aviation fuel' (11 December 2023) <https://www.weforum.org/agenda/2023/12/airlines-sustainable-aviation-fuel-carbon-targets/>.

¹⁰ Lynn Loo et al, 'Voyaging toward a greener future: Insights from the CCMD-BCG Global Maritime Decarbonization survey' (September 2023)<https://www.bcg.com/publications/2023/voyaging-toward-a-greenermaritime-future>.

¹¹Shipping Australia, 'Hydrogen fuel, clean, plentiful and not ready (2021) <https://www.shippingaustralia.com.au/wp-content/uploads/2021/08/Shipping-Australia-Winter-2021-Future-Fuels-Hydrogen-not-read.pdf>.

¹²Laurens Van Hoecke et al, 'Challenges in the use of hydrogen for maritime applications' (2021) 14 Energy & Environmental Science <https://pubs.rsc.org/en/content/articlehtml/2021/ee/d0ee01545h>; 'Hydrogen fuel, clean, plentiful and not ready' (n 11).

¹³ 'Challenges in the use of hydrogen for maritime applications' (n 12).

¹⁴'Maritime Decarbonization Strategy' (n 3).

¹⁵'Voyaging toward a greener future' (n 10).

¹⁶Ibid.

¹⁷Though, consider, Maersk Mc-Kinney Moller Centre, 'Preparing Container Vessels for Conversion to Green Fuels' (28 September 2022) <https://www.zerocarbonshipping.com/publications/preparing-container-vessels-forconversion-to-green-fuels-2/>.

¹⁸Ibid.

¹⁹U.S. Energy Information Administration, 'Issues in Focus: Inflation Reduction Act Cases in the AEO2023' (16 March 2023) <https://www.eia.gov/outlooks/aeo/IIF_IRA/>.

²⁰Maersk Mc-Kinney Moller Center, 'Transatlantic Testing Ground; Assessing impacts of EU and US policies on accelerated deployment of alternative maritime fuels' (January 2024) <<https://www.zerocarbonshipping.com/publications/assessing-impacts-of-eu-and-us-policies-on-accelerateddeployment-of-alternative-maritime-fuels/>>.

²¹Ibid.

²²Directorate-General for Mobility and Transport, European Union https://transport.ec.europa.eu/transport-modes/maritime/decarbonisingmaritime-transport-fueleu-maritime_en

²³Ibid.

²⁴Maersk Mc-Kinney Moller Center, 'FuelEU Explainer: Pooling and the Business Case for Green Shipping' (24 April 2024) <https://www.zerocarbonshipping.com/news/explainer-pooling-and-the-business-casefor-green-shipping/>



Fuelling the Future: Australia’s Path to Net Zero Transportation

Authors: Matt Baumgurtel and David O'Carroll



The transport sector is a significant contributor to the nation’s emissions at 21 per cent,¹ accounting for 3.8 tonnes of CO2 per capita (excluding aviation).² Against this backdrop, CO2 emissions from the transport sector must fall by more than 3 per cent per year until 2030 to ensure that Australia is on track to meet its Net Zero target.³

In this article, we explore the best fuel for each mode of transport, drawing on consumer and investor sources of anxiety: cost, range, and infrastructure challenges.

Cars and Light Commercial Vehicles (LCVs)

Electric Batteries in Cars

In 2023 it was reported that cars and LCVs are responsible for 60 per cent of emissions in the Australian transport sector and 10 per cent of emissions overall.⁴ Consumer concerns regarding range and cost have stimulated efforts at both federal and state government levels to encourage the uptake of electric vehicles (**EVs**) by offering AUD\$3000 rebates,⁵ as well as an AUD\$171 million investment in EV charging facilities over four years as part of the NSW Electric Vehicle Strategy,⁶ and an AUD\$500 million commitment as part of the National Electric Vehicle Strategy.⁷

The 2024-25 Federal Budget (the **Budget**) committed to provide AUD\$154.5 million over six years commencing on 1 January 2025, plus AUD\$12.6 million annually thereafter, to implement a [New Vehicle Efficiency Standard \(NVES\)](#), compliant with the New Vehicle Efficiency Standard Act 2024. The NVES is aimed at enhancing fuel-efficient vehicle options to lower transport emissions.

The Budget funding includes AUD\$84.5 million over five years to establish a regulatory body for administering the NVES, which includes gathering comparable data with international counterparts. The Budget also allocates AUD\$60 million over four years for electric vehicle charging infrastructure.⁸

The uptake of EVs is well-positioned to foster investor confidence in the production and supply of charging facilities to be rolled out at a national level.

Driving Green or Grey?

Despite the rapid charging speed of hydrogen vehicles, Toyota’s Carbon Policy Manager, Andrew Willis, admits hydrogen “infrastructure is limited” and is therefore “holding up wider adoption”.⁹ With a keen emphasis on achieving

Net Zero targets, the amount of electricity required for hydrolysis presents inefficiencies in hydrogen production. Moreover, a staggering 96 per cent of the hydrogen production is categorised as grey hydrogen.¹⁰ Despite the cost advantage of grey hydrogen at approximately AUD\$1-2 per kg, compared to green hydrogen at approximately AUD\$5-7 per kg, grey hydrogen relies on fossil fuel sources, thus undermining Net Zero targets.

The Budget aims to achieve this through the introduction of the Hydrogen Production Tax Incentive (**HPTI**). The HPTI promises refundable tax credits of AUD\$2 per kg of renewable hydrogen produced at qualifying facilities from 1 July 2027 to 30 June 2040. These credits will be available for up to ten years for projects that secure final investment decisions by 2030.

Further information is available in our recent article [Hydrogen on the Horizon: Unpacking Australia’s New Hydrogen Production Tax Incentive](#).

Overall, strong Federal infrastructure support resulting in increased investor and consumer confidence positions EVs as a more pragmatic option compared to hydrogen cars and LCVs.

Heavy Duty Trucks

The International Council of Clean Transportation claimed that a switch to battery-electric trucks could save up to 63 per cent greenhouse gas emissions over the vehicle’s lifecycle, with a further 84 per cent reduction when solely using renewable energy.¹¹ The use of battery electric trucks has sparked government interest. In 2023, the Australian Renewable Energy Agency (**ARENA**) granted AUD\$20 million to Team Global Express for the purchase of 36 medium and 24 light battery electric trucks, and AUD\$20.5 million to support financing battery electric trucks purchased through the Clean Energy Finance Corporation and Taurus Motor Finance agreement.¹²

More recently, the Budget has allocated an investment of AUD\$115 million in a battery electric bus depot under the Zero Emission Bus Transition Strategy that will introduce 1,200 new electric buses by 2028.¹³

Why Don’t We Make the Switch?

While EV batteries provide a compelling solution to reducing emissions, the size and weight of the battery used in trucks is problematic to handle, ship, and poses significant fire risks. Specialist training and co-ordination across the supply chain on an inter-state basis must be achieved to make this a feasible option.

The Budget allocated AUD\$523.2 million through the Battery Breakthrough Initiative. This will be administered by ARENA to advance battery manufacturing capabilities in Australia through targeted production incentives. An additional AUD\$20.3 million will support the Building Future Battery Capabilities to scale up and improve standards within value chains to enhance battery manufacturing for the transport sector, including heavy vehicles.¹⁴

Expressions of Interest can be registered [here](#).

Despite Federal and State commitments to invest in EV charging infrastructure, ‘range anxiety’ from truck drivers and owners remains. The lack of charging points in remote areas across long journeys makes the switch to EV batteries a less favourable option. If consumer and investor confidence is restored, the Electric Vehicle Council predict that 100 per cent of the national fleet will be electric by 2040 meaning that ample energy generation for EVs would be required to avoid severe grid impacts.¹⁵

Power Without the Bulk

Although hydrogen is unlikely to be a good fit for cars and LCVs, the combination of its rapid fuelling time and similar range to fossil fuel offers a superior solution for trucks when compared to EVs. Additionally, the AUD\$80 million investment in hydrogen refuelling networks on key freight routes could promote a similar “turnkey” service to that seen in South Korea.¹⁶ This approach bridges gaps in the supply chain by manufacturers also guaranteeing a network of green hydrogen refuelling stations across standardised routes, as well as promoting job opportunities and investment in remote areas.

Based on this, hydrogen is poised to emerge as the preferred solution over EV batteries in trucks, due to the lack of weight restrictions and perceived consumer range anxiety.

Trains

Much like trucks, trains are likely to encounter challenges related to the size and weight of batteries, as well as experiencing lengthy charging times and causing subsequent grid impacts. However, the fixed rail routes and existing infrastructure could be more easily tapped into to make recharging EV batteries a problem of the past. Germany rolled out a hydrogen fuelled trainline in 2018 and has experienced great success that was quickly offset by the excessive manufacturing and running costs. Going forward, Germany will be replacing the remaining diesel trains with electric battery trains, not hydrogen.¹⁷

Recent industry consultations on the Australian Railway Association’s forthcoming [rollingstock decarbonisation](#) critical path have identified that energy supply will be a critical factor in determining the commercial viability of these new technologies.¹⁸ Ultimately, despite the success of hydrogen trains, the lower cost and competitive efficiencies of electrical battery powered trains are likely to attract better consumer and investor confidence.

Shipping

Shipping accounts for around 3 per cent of global CO2 emissions but continues to face challenges in transitioning to alternative fuels such as hydrogen, ammonia, or other biofuels.¹⁹ The Danish shipping giant, Maersk has begun to make the move to greener fuels, but an industry wide transition would require a regulatory overhaul and a harmonised approach from shipping developers and manufacturers.

Electric batteries are an unlikely contender for the shipping sector due to the lengthy re-charging times. However, Australia is well-equipped to supply and transport ammonia and hydrogen, particularly since the AUD\$30 million partnership between Singapore and Australia to create a ‘green shipping corridor’ by 2050.²⁰

Ammonia has also been hailed as a potential long-term near net zero shipping fuel with fewer barriers to market entry. Although much of our existing exposure to ammonia has not been as a shipping fuel, the International Code of the Construction and Equipment of Ships Carrying Liquefied gases in Bulk codifies the requirements of ammonia as shipping fuel.²¹ As well as toxicity to humans and wildlife, the low density of ammonia,²² compared to hydrogen, would require it to be stored at higher volumes, reducing the capacity to carry cargo resulting in reduced profit margins. Like hydrogen, the availability of green ammonia is limited, and whilst regular ammonia does not produce CO2, it does produce N2O,²³ a more potent alternative.

The large-scale uptake of green hydrogen will need to be backed by large investments to facilitate the specialist storage containers which are at temperatures of around –253°C. The key challenge is large scale production and shipping manufacturers who are likely to turn to additional fuel sources, such as biofuel, until hydrogen can be produced and stored at a sufficient scale to meet demand. The

Australian landscape lends itself well to the mass production of biofuels and many ship engines would not require substantial refits to utilise them.²⁴

To meet the demands for shipping fuel, multiple sources of low-carbon variants, such as biofuel, will be pursued alongside hydrogen until supply is at a sufficient scale to meet demand.

Aviation

A Smooth Take Off...

Much like shipping, the shift to hydrogen fuelled aircraft would require strong financial outlays, such as government incentives and public and private investment in the supply and storage of hydrogen.

To enable a complete overhaul, many aviation giants have committed to the development of hydrogen-compatible fleets. Airbus has announced that they could be taking flight as early as 2035²⁵ and Boeing around 2050.²⁶ The development of hydrogen aircraft has sparked global interest and significant investment from the likes of Japan with an impressive 4 trillion JPY (AUD\$39.2 billion) public-private investment partnership.²⁷ Increased market entrants will promote competitive pricing and accelerate technological developments, such as the production and storage of hydrogen.

One Size Won’t Fit All

As part of the Federal Government’s Jet Zero Council, Qantas suggested in their recent report that government Sustainable Aviation Fuel (SAF) mandates should be implemented to reach production targets of 5 per cent by 2030 and 28 per cent by 2040, as well as providing a AUD\$1.5 million grant to de-risk investment opportunities.²⁸ Head of Sustainability, Andrew Parker, believes that this strategy will strengthen Australia’s fuel independence and create economic security.²⁹ Additionally, long term contracts with fuel providers could play a vital role in meeting targets, such as the Delta and Neste partnership who have committed to replacing 10 per cent of traditional jet fuel by 2030.³⁰

The Budget includes several initiatives to advance the domestic low carbon liquid fuels industry, including SAF. AUD\$18.5 million is allocated over four years to develop a fuel certification scheme. An additional AUD\$1.5 million over two years will fund an analysis of the costs and benefits of demand-side measures for sustainable fuels.³¹

At this stage, no single feedstock would produce a sufficient volume of fuel to enable a direct transition to SAF and whilst both hydrogen and biofuel production are being slowed by infrastructure challenges, commercial and cross-border partnerships are likely to increase investor appeal and enable large scale production.

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](tel:+61459900080)





David O'Carroll
Senior Associate
[+61 421 497 311](tel:+61421497311)





¹⁸Towards net zero for transport and infrastructure', Australian Government, Department of Infrastructure, Transport, Regional Development, Communication and the Arts (Web Page, 2024) <<https://www.infrastructure.gov.au/infrastructure-transport-vehicles/towards-net-zero-transport-andinfrastructure>>.

²⁵Shifting Gear: The Path to Cleaner Transport', Climate Council (Web Page, 19 May 2023) 13 <https://www.climatecouncil.org.au/wp-content/uploads/2023/05/CC_MVSA0354-CC-Report-Road-to-Personal-Transport_V5-FA-Screen-Single.pdf>.

³Ibid.

⁴The National Electric Vehicle Strategy', Australian Government (Web Page, 19 April 2023) <<https://www.dcceew.gov.au/energy/transport/national-electricvehicle-strategy>>.

⁵Ibid.

⁶NSW Electric Vehicle Strategy', NSW Climate and Energy Action (Web Page) <<https://www.energy.nsw.gov.au/nsw-plans-and-progress/governmentstrategies-and-frameworks/electric-vehicle-strategy>>.

⁷National Electric Vehicle Strategy', Department of Climate Change, Energy, the Environment and Water (Report, 2023) <<https://www.dcceew.gov.au/sites/default/files/documents/national-electric-vehicle-strategy.pdf>>.

⁸2024-25 Federal Budget Wrap', Roads Australia (Web Page, 15 May 2024) <<https://roads.org.au/2024-25-federal-budget-wrap/>>.

⁹Emilia Terzon, 'Toyota is pushing hydrogen cars but will they ever be as cheap to run as EVs?', ABC News (online, 29 Jan 2024) <<https://www.abc.net.au/news/2024-01-29/toyota-hydrogen-cars-future-electric-vehicles-uptakechallenges/103390084#:~:text=%22The%20refuelling%20infrastructure%20is%20limited,the%20growth%20in%20the%20volumes%22>>.

¹⁰Hydrogen as a fuel: the pros and cons', Pirelli (Web Page) <<https://www.pirelli.com/global/en-ww/road/cars/hydrogen-as-a-fuel-the-pros-and-cons-53908/>>.

¹¹Battery electric trucks emit 63% less GHG emissions than diesel', The International Council on Clean Transportation (Web Page) <<https://theicct.org/battery-electric-trucks-emit-63-less-ghg-emissions-than-diesel/>>.

¹²Depot of the future delivers Australia's largest electric vehicle logistics fleet', Australian Renewable Energy Agency (Web Page) <<https://arena.gov.au/news/depot-of-the-future-delivers-australias-largest-electric-vehicle-logisticsfleet/>>.

¹³Transport for NSW, Zero Emission Bus Transition Strategy: Executive Summary (Report, 2023) 3.

¹⁴The Hon Ed Husic MP, 'New batter strategy to make more batteries here' (Media Release, Ministers for the Department of Industry, Science and Resources, 23 May 2024).

¹⁵Electric trucks: Keeping shelves stocked in a net zero world', Electric Vehicle Council (Web Page) 13 <https://electricvehiclecouncil.com.au/wp-content/uploads/2022/01/ATA-EVC-Electric-trucks_Keeping-shelves-stocked-in-a-netzero-world-2.pdf>.

¹⁶Driving the Nation Fund' Department of Climate Change, Energy, the Environment and Water (Web Page) <<https://www.dcceew.gov.au/energy/transport/driving-the-nation#:~:text=The%20Australian%20Government%20doubled%20the,key%20highway%20routes%20across%20Australia>>.

¹⁷Hydrogen as a fuel: the pros and cons', Pirelli (Web Page) <<https://www.pirelli.com/global/en-ww/road/cars/hydrogen-as-a-fuel-the-pros-and-cons-53908/>>.

¹⁸Federal Government invests \$22.7 billion for Future Made in Australia with a focus on renewable energies', Australian Railway Association (Web Page, 23 May 2024) <<https://ara.net.au/news/federal-government-invests-22-7-billionfor-future-made-in-australia-with-a-focus-on-renewable-energies/>>

¹⁹Climate impact of shipping', Transport & Environment (Web Page) <<https://www.transportenvironment.org/topics/ships/climate-impactshipping#:~:text=What%20is%20the%20impact%20of,emissions%20%E2%80%933%20the%20same%20as%20flying.>>>.

²⁰'Singapore-Australia Green Economy', Department of Foreign Affairs and Trade (Web Page) <<https://www.dfat.gov.au/geo/singapore/singaporeaustralia-green-economy-agreement>>.

²¹Potential of Ammonia as Fuel in Shipping [updated]', European Maritime Safety Agency (Web Page) <<https://www.emsa.europa.eu/newsroom/latestnews/item/4833-potential-of-ammonia-as-fuel-in-shipping.html>>.

²²An Overview of Ammonia as Fuel for Ships' Bureau Veritas, Marine & Offshore (Web Page) <<https://marine-offshore.bureauveritas.com/shippingdecarbonization/future-fuels/ammonia#:~:text=There%20are%20several%20advantages%20to,is%20widely%20and%20freely%20available.>>>.

²³Ibid.

²⁴Time for International Action on CO emissions from Shipping', European Union, Climate (Web Page) <https://climate.ec.europa.eu/system/files/2016-11/marine_transport_en.pdf>.

²⁵Hydrogen, AN important decarbonisation pathway', Airbus (Web Page) <<https://www.airbus.com/en/innovation/low-carbon-aviation/hydrogen>>.

²⁶Marisa Garcia, 'Japan Plans \$26 Billion New Hydrogen-Powered Passenger Jet Program', Forbes (online, 28 March 2024) <<https://www.forbes.com/sites/marisagarcia/2024/03/28/japan-plans-26-billion-new-hydrogen-poweredpassenger-jet-program/?sh=717f029064e8>>.

²⁷Ibid.

²⁸Developing a SAF industry to decarbonise Australian aviation', Qantas (Web Page) 4 <<https://www.qantas.com/content/dam/qantas/pdfs/qantasgroup/icf-report-australia-saf-policy-analysis-nov23.pdf>>.

²⁹Ibid.

³⁰How Delta and Neste are working toward making flying more sustainable', Neste (Web Page) <<https://www.neste.com/products-and-innovation/sustainable-aviation/case-stories/how-delta-and-neste-areworking-towardmaking-flying-more-sustainable>>.

³¹The Hon Catherine King MP, 'Have your say on a future made in Australia: unlocking Australia's low carbon liquid fuel opportunity' (Media Release, 13 June 2024).

Decarbonising Aviation: The Flight Plan to a Low Carbon Future

Authors: Matt Baumgurtel, William Ryan, Conor Bates and Sam Poulsen

The aviation industry has connected Australians to the world since the early 20th century. In many ways, however, the environment has footed the bill for the industry's progress – although signs of change are taking off. We explore recent industry trends, challenges and opportunities available to the aviation industry to meet decarbonisation targets, plus delve into the new technologies revolutionising aviation.

Recent industry announcements

Despite the national trend towards emissions reduction, Australia's aviation emissions continue to increase.¹ Although aviation is considered a 'hard-to-abate' emissions sector, the Australian Government is committed to assisting the industry reach net zero. For example, the Australian Jet Zero Council (**Council**) was announced in June 2023. The Council brings together a cross-section of aviation industry stakeholders to:²

1. lead efforts to achieve net zero aviation;
2. advise the Government on sustainable aviation matters including adopting sustainable aviation fuel (**SAF**), measures to reduce emissions and ways of securing our supply chains; and
3. support industry decarbonisation efforts.

Relatedly, in September 2023, the Government released its Aviation Green Paper (**Green Paper**). The Green Paper outlines the Government's policy direction for the aviation sector up to 2050, including its focus on sustainability.³

These commitments demonstrate the increased governmental focus on decarbonising the Australian aviation industry, including supporting the Government's wider legislated targets of Australia reaching net zero by 2050.

The Government's Aviation White Paper (**White Paper**) is expected to be released in late 2024. The White Paper will complement the Green Paper and set the long-term policies to guide the next generation of growth and innovation in the aviation sector.⁴ The first listed priority of the White Paper is to maximise the aviation sector's contribution to achieving net zero carbon emissions, including through SAF and emerging technologies.⁵ Additionally, the Government has announced the Emerging Aviation Technology Partnerships Program, which will fund and support development of innovative aviation technologies including low and zero emissions propulsion systems.⁶

New technologies transforming the industry

The majority of industry emissions stem from operating planes. Airlines must reduce these emissions to facilitate the industry's net-zero transition.⁷

A number of solutions have been put forward to reduce emissions, as follows.

Hydrogen powered aircraft

The advantages of hydrogen as a transport fuel is [well documented](#). Hydrogen technologies are attractive to airlines because they have the major benefit of producing only water and heat as the byproduct of energy production and so are emissions and air-pollutant free.

However, hydrogen-powered aviation depends on complex technology and associated infrastructure (as discussed in our [previous article](#)). As an example, hydrogen-powered aviation infrastructure involves establishing bespoke refuelling stations as well as deploying parking stands which can accommodate different sized aircraft.

Further, upgrading airports globally with uniform hydrogen-supporting infrastructure is a key barrier preventing hydrogen powered aircraft from becoming commonplace on long-haul routes. Unpredictability in routes, emergency landings, and changes to schedules (among other things) mean that airlines require ubiquitous infrastructure to operate and service their fleets.

By contrast, it is more probable that hydrogen planes will be deployed for short-haul applications within Australia. The domestic aviation industry has already demonstrated an interest. For example, Australian airline Regional Express recently partnered with Dovetail Electric Aviation to trial aircraft fitted with hydrogen-electric engine technology.⁸ Further, Stralis Aero, a Queensland-based organisation, is developing retrofitted hydrogen fuel cell engines on smaller planes.⁹

Government support has been encouraging. Recent initiatives including the Hydrogen Headstart Program may assist the Australian aviation industry to develop the supporting infrastructure required to get the hydrogen planes off the ground.¹⁰

Electric powered aircraft

Electric powered aircraft are propelled by a battery system that replaces fuel-powered piston and turbine engines.¹¹ Similar to hydrogen-powered planes, this technology is likely to be more relevant to domestic flights than long-haul flights. Trialling battery electric planes in commuter, regional and short-range environments will be fundamental in developing more energy efficient, climate-friendly and cost-effective larger aircraft. This sentiment is supported by recent announcements in the Green Paper which indicate electric aircraft will be limited to routes less than 500km due to battery energy density limitations. However, not to diminish the importance of these aircraft, Dovetail Electric Aviation has received AUD \$3 million in funding from the Australian Government to convert turbine-powered planes into electric-powered aircraft.¹² This investment and others like it suggest the Government is supportive of bringing electric planes to market for short-range flights.

Sustainable aviation fuel

SAF is likely the key to unlocking the aviation industry's net zero ambitions. SAF (which describes non-petroleum feedstock) can:

1. reduce CO2 emissions by up to 80 per cent;
2. be produced from a variety of waste products;¹³
3. integrate easily with existing aircraft engines;
4. provide superior range to other technologies; and
5. be easily scaled.¹⁴

These advantages make SAF a strong contender to dominate a net zero aviation industry.¹⁵

Government support for SAF

In support of SAF uptake, in 2023, the Commonwealth Scientific and Industrial Research Organisation (**CSIRO**) released the Sustainable Aviation Fuel Roadmap (**Roadmap**). The CSIRO suggests that Australia is in a prime position to develop a domestic SAF industry, identifies opportunities to produce and scale production, and highlights the challenges this nascent industry will face.¹⁶ These findings are important, given that SAF currently accounts for just 0.2 per cent of global jet fuel use.¹⁷ However, the proportion of SAF in global jet fuel supply is expected to increase rapidly. Already, the contribution of SAF is triple that produced in 2022, and it is expected to triple once again in 2024 to 1.875 billion litres.¹⁸

To read more on the opportunity to invest in the Australian SAF industry, see our [expert insights series with John Sheehy and Rodrigo Arias of Pottinger](#).



Industry support of SAF

Promisingly, the industry has started to invest in the infrastructure required to support SAF in Australia. Boeing and Wagner have commenced the design and construction of Australia’s first steady supply of SAF in Queensland,¹⁹ and LanzaJet and Jet Zero have committed to a novel licence and engineering agreement to convert bioethanol into SAF.²⁰ Further, domestic carriers including Qantas and Virgin Australia have committed to utilising more SAF in their operations. Specifically, Qantas is targeting 10 per cent of its fleet to be powered by SAF by 2030.²¹

These commitments are important given the ‘green premium’ that SAF currently demands, being two to four times the cost of standard jet fuel.²² Since fuel represents 30-40 per cent of an airline’s cost base, the green premium will heavily impact airlines’ bottom lines.²³ However, economies of scale and appropriate government support are likely to reduce this cost over time. This trajectory, coupled with SAF’s ability to integrate with existing technology, is likely to make SAF the favourite of airlines and manufacturers.

The road ahead for sustainable aviation

The path to decarbonising Australia’s aviation industry is challenging but promising. Government initiatives, such as the Australian Jet Zero Council and the Aviation Green Paper, reflect a strong commitment to achieving net-zero aviation by 2050. Emerging technologies, including hydrogen and electric-powered aircraft, offer innovative solutions, particularly for short-haul flights. However, the infrastructure and technological limitations of these alternatives mean their full potential is still up in the air.

SAF stands out as the most viable near-term solution, capable of significantly reducing emissions while integrating with existing aircraft and infrastructure. Although SAF currently comes with a ‘green premium,’ increasing investments and scaling production should lower costs, making it an essential tool in reducing the aviation industry’s carbon footprint. As the industry navigates these new opportunities and challenges, ongoing government support, coupled with advancements in technology, will be crucial to realising a sustainable future for aviation.

For more information, please contact:



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](tel:+61459900080)





William Ryan
Senior Associate
[+61 2 8072 8271](tel:+61280728271)





Conor Bates
(Consultant, admitted in Ireland,
not admitted in Australia)





Sam Poulsen
Graduate
[+61 8072 8271](tel:+6180728271)



¹Aviation Green Paper: Towards 2050 (September 2023) 75.

²Australian Jet Zero council (Web Page) <<https://www.infrastructure.gov.au/infrastructure-transport-vehicles/aviation/australian-jet-zero-council>>.

³Aviation Green Paper (n 1).

⁴Aviation White Paper <<https://www.infrastructure.gov.au/infrastructuretransport-vehicles/aviation/aviation-white-paper>>.

⁵Ibid.

⁶Aviation Green Paper (n 1) 89.

⁷Other changes which are not discussed in this article include the adoption of more advanced plane materials such as carbon fibre, on-ground operational and maintenance improvements, and carbon offsetting (Ibid 76).

⁸Ibid 89.

⁹Ibid.

¹⁰Hydrogen Headstart Program (Web Page) <<https://www.dcceew.gov.au/energy/hydrogen/hydrogen-headstart-program#>>.

¹¹Aviation Green Paper (n 1) 87.

¹²Ibid 89.

¹³Net Zero 2050: Sustainable Aviation Fuels (Web Page) <<https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet—alternativefuels>> 1.

¹⁴Aviation Green Paper (n 1) 81.

¹⁵Ibid.

¹⁶Sustainable Aviation Fuel Opportunities for Australia (Web Page) <<https://www.csiro.au/en/research/technology-space/energy/sustainable-aviationfuel>>.

¹⁷Net Zero 2050: Sustainable Aviation Fuels (n 12) 2.

¹⁸SAF Volumes Growing but Still Missing Opportunities’ (Press Release, 69, IATA, 6 December 2023).

¹⁹Boeing, Wagner Advance Australia’s Sustainable Aviation Fuel Industry’ (News Release, Boeing, 19 April 2024).

²⁰Jessica Fisher ‘LanzaJet & Jet Zero Australia Sign Agreement to Advance Australia’s First Ethanol to SAF Plant’ The Fly Report (online, 13 February) <<https://news.flyjets.com/article/lanzajet-and-jet-zero-australia-signagreement-to-advance-australias-first-ethanol-to-saf-plant>>.

²¹Valuing Our Planet (Web Page) <<https://www.qantas.com/au/en/qantasgroup/sustainability/our-planet.html>>.

²²Sustainable Aviation Fuel Roadmap (Report, 2023) <<https://www.csiro.au/en/research/technology-space/energy/sustainable-aviation-fuel>> 17.

²³Ibid.



New Energy Expert Insights Retrofitting BESS on Solar PV Projects with Joanna Leigh – Quintas Australia

Authors: Matt Baumgurtel, Megan Chau and Christine An

In this edition of New Energy Expert Insights, we sat down with Joanna Leigh, Country Manager of Quintas Australia, to discuss Retrofitting BESS on solar PV projects.



Joanna Leigh is the Country Manager of Quintas Energy Australia, with a focus on Asset Management, 24/7 control room activities spanning operations, bidding, and trading, as well as development, construction management, and advisory services.

Quintas Energy Australia, part of the global Quintas Group, manages over 8GW of assets across the country. The team delivers specialised asset management, technical advisory, financial, analytics, and development services for solar PV and Battery Energy Storage System (BESS) installations. With offerings like 24/7 control room services, technical assessments, and comprehensive revenue reporting, Quintas Energy Australia works closely with contractors, developers and investors to optimise asset performance and maximise returns for stakeholders.

What does retrofitting BESS on solar PV projects practically involve?

Retrofitting an existing solar photovoltaic (PV) project to include a battery energy storage system (BESS) is a complicated process, which generally involves the following steps:

1. Initial Assessment

While some solar PV projects are designed to be “BESS-ready,” it is crucial to undertake a red flag due diligence to identify potential barriers. This due diligence will, for example, identify if amendments are required to land tenure agreements or authorisations to enable the envisaged retrofitting. It will also comment on the technical and financial feasibility, which is often impacted by whether an AC or DC connection is pursued.

2. Grid Connection Considerations

The optimal size of the BESS will be determined considering grid connection limitations. For instance, a solar PV project

with a 100 AC generation capacity may only allow for 20 to 25 MW of load capacity for a BESS. This discrepancy necessitates careful consideration of how the battery will be operated, impacting the project’s overall efficiency and profitability.

3. Compliance and Testing

AEMO undertakes Dynamic Model Acceptance Testing to assess whether the BESS integration complies with current grid performance standards. This process can be lengthy and costly, depending on how old the existing PV plant is and what generating performance standards it was approved on.

4. Upgrading Equipment

Existing inverters, including firmware and the power plant controller, may need to be modified or replaced to maximise the project performance after BESS integration. Depending on the PV design, hybrid controllers may also have to be installed to enable DC connections.



Why are market participants pursuing this retrofitting? What are the benefits and why is it required?

Many solar projects in the National Electricity Market (NEM) are not generating the anticipated returns due to prevalent economic curtailment, especially during shoulder seasons, which can last several months. BESS offers a solution by storing excess energy generated during peak sunlight hours for discharge when needed, helping optimise output and improve financial performance. Regions like Queensland and South Australia have been particularly affected, prompting operators to consider retrofitting with BESS.

Why is Quintas different to its competitors in the retrofitting process? What makes your approach more comprehensive than competitors?

Quintas leverages its extensive relationships with Original Equipment Manufacturers and its operational expertise on successful BESS integration. Unlike many standalone PV systems, adding BESS requires a robust 24/7 control room, which we provide, ensuring continuous support from development through construction to operational management. While some investors attempt the integration themselves, they often lack detailed knowledge of their site and the nuances of PV operations, which often leads to mistakes.

Furthermore, Quintas excels in analysing previous projects, understanding the intricacies of existing installations, and identifying potential challenges. This holistic support model ensures that our clients are well-equipped to manage their systems effectively, setting us apart in the retrofitting landscape.

Should there be any government intervention/support in this space?

The Australian Government should reduce the requirements for upgrading the grid and provide incentives for adding BESS to established solar PV projects. The integration leverages existing infrastructure, which is more cost-effective and quicker than adding new generators or substations.

Moreover, effective government regulation should be implemented to prevent the overdevelopment of projects in this free market and to efficiently allocate resources where they are truly needed. In doing so, this ensures better outcomes and more strategic use of capital.

What are the barriers/challenges to successful BESS retrofitting?

Investors prefer fully wrapped solutions that minimise their risk exposure and are reluctant to take on additional responsibilities associated with BESS integration. However, the nature of BESS requires a more hands-on approach, shifting a greater share of risk to the investors.

Also, as margins continue to tighten in the energy market, many investors attempt to add BESS without hiring an expert to assess and analyse the technical feasibility. Unfortunately, this can lead to costly mistakes, as some companies that attempted to manage risks independently have struggled or failed. Underestimating the challenges of BESS integration can lead to significant operational and financial pitfalls, highlighting the need for a more informed and cautious approach.

What is happening in other jurisdictions with regard to BESS integration?

One key difference between Australia and other regions like Europe and the U.S. is the base load energy. Both Europe and the U.S. maintain a substantial amount of nuclear energy, which provides a stable base load that cannot be easily turned off. This contrasts with Australia's grid, which is less stable and more reliant on variable renewable sources. Consequently, the integration of batteries is uniquely suited to Australia's needs.

[AEMO's 2024 Integrated System Plan](#) forecasts that by 2050, more than half of homes in the NEM are likely to have distributed energy resources (**DER**), such as rooftop solar, with the capacity of 86 GW. While tapping into this DER market would be crucial in the future in Australia, the challenges associated with DER, such as unstable grid operation, should be managed first.

Ultimately, there's a pressing need for all energy participants to engage with the grid. As more individuals choose to go off-grid (often only accessible to wealthier households), the burden of maintaining the grid falls increasingly on those who remain connected. This creates a vicious cycle where the costs of grid maintenance rise, further straining the system and jeopardising its sustainability.

What else can / should be done to promote BESS integration?

Investors do not need extensive background knowledge before approaching Quintas, as a preliminary red flag due diligence can be completed quickly to evaluate feasibility. Prioritising this due diligence within the processes of network service providers and AEMO could significantly expedite the integration process. With optimal timing, projects could go from zero to fully commissioned in just over a year, representing the fastest way of enhancing energy storage capacity using the least resources.

Moreover, leveraging existing infrastructure through BESS can provide substantial benefits without the environmental impacts associated with constructing new facilities. This approach not only maximises the efficiency of current assets but also minimises land use, as adding batteries typically requires only minimal modifications to existing solar sites.

The Hamilton Locke team advises across the energy project life cycle – from project development, grid connection, financing, and construction, including the buying and selling of development and operating projects. For more information, please contact Matt Baumgurtel.



Matt Baumgurtel
Partner, New Energy Lead
[+61 459 900 080](#)



Megan Chau
Lawyer
[+61 2 8072 8271](#)



Christine An
Lawyer
[+61 8 6311 9160](#)



Inaugural NEAN Pub Social!

NEAN is a network for New Energy industry professionals from graduate to senior associate level, aimed at building connections and sharing industry knowledge among members. NEAN seeks to foster and grow relationships between industry stakeholders at the earlier stages of their careers.

Recent Events



On 15 October, the New Energy Associates Network came together for our first-ever pub social at the Edinburgh Castle, and it could not have been better! The relaxed setting made for great conversations, laughs, and a true sense of community.

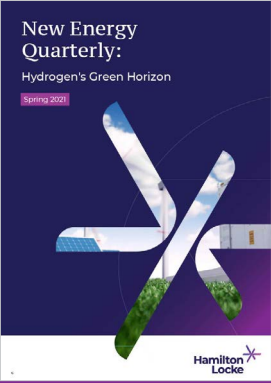
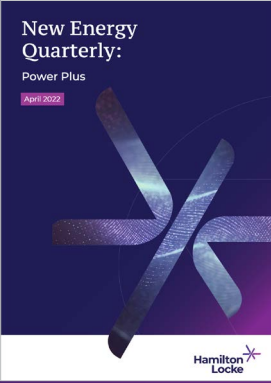
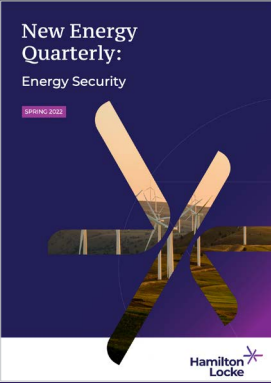
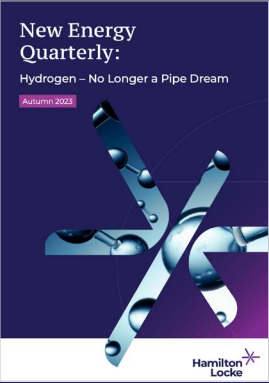
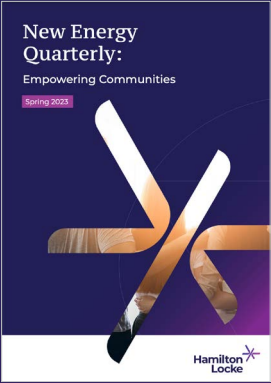
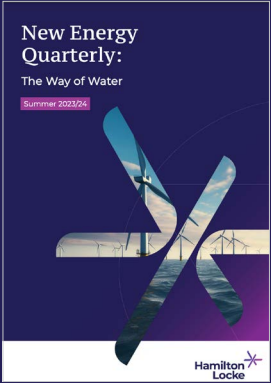
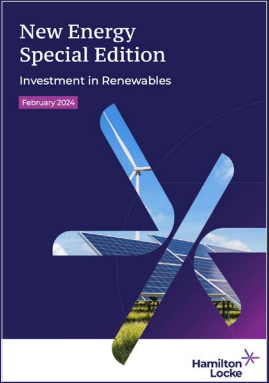
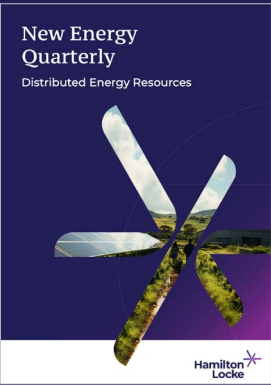
Thank you to everyone who joined. It was great to connect, share insights, and strengthen relationships with such an inspiring group of peers in the New Energy sector.

We're looking forward to the next one already and hope to see you all at the upcoming NEAN fireside chat! Details to come shortly.

Want to be added to the mailing list for the next NEAN event?

Please reach out to [David O'Carroll](#).

New Energy Quarterlies



Expert Insights

