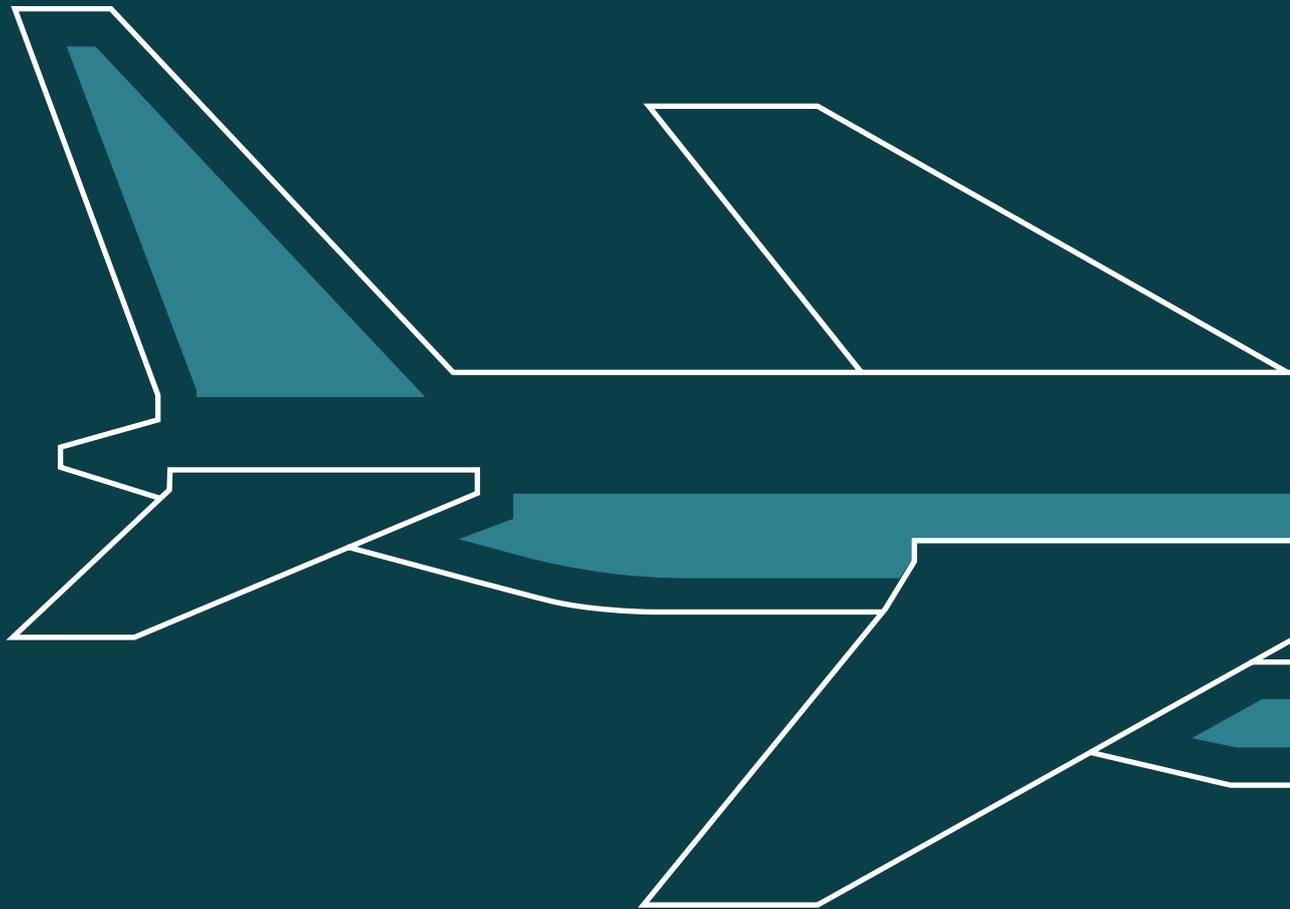

Sustainable aviation fuel Prospectus

March 2024

investregional.nsw.gov.au



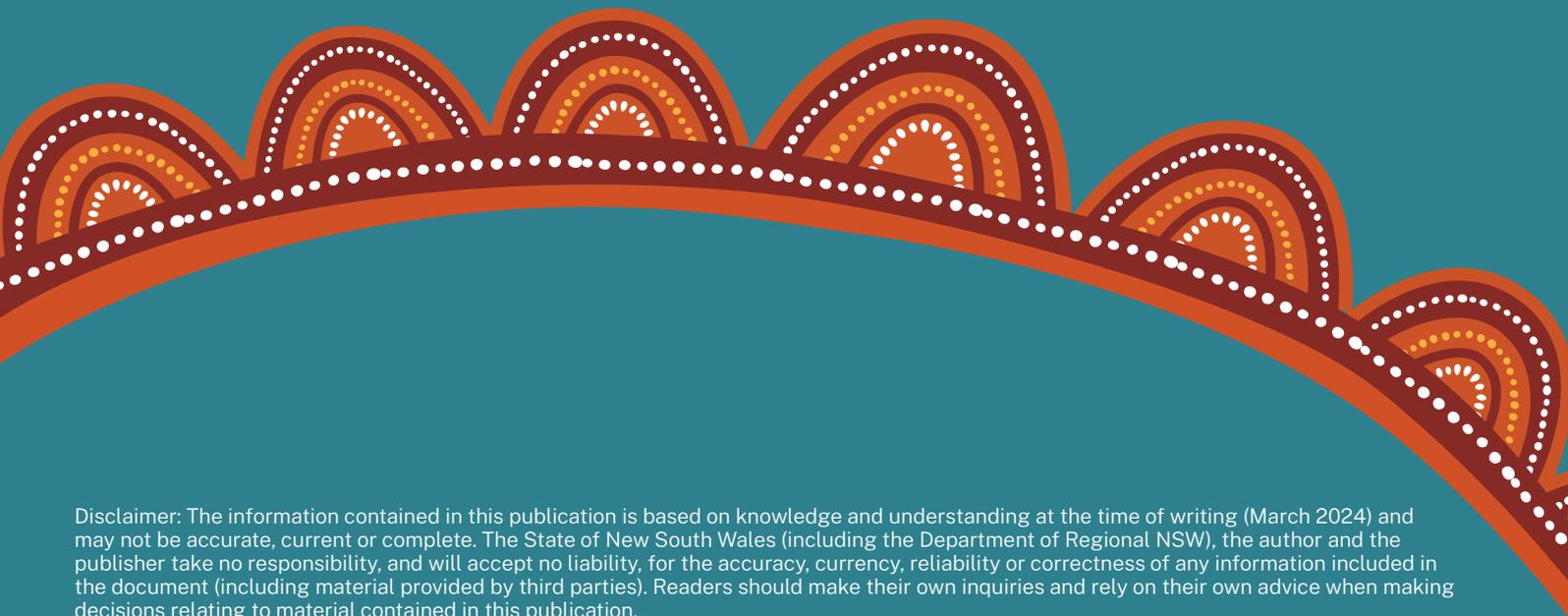


Acknowledgement of Country

The Department of Regional New South Wales acknowledges that it stands on Country which always was and always will be Aboriginal land. We acknowledge the Traditional Custodians of the land and waters, and we show our respect for Elders past, present and emerging.

We are committed to providing places in which Aboriginal people are included socially, culturally and economically through thoughtful and collaborative approaches to our work.

Artwork: 'On Country', Charmaine Mumbulla, 2022



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Executive summary

In an effort to decarbonise the aviation industry, countries around the world are setting significant sustainable aviation fuel (SAF) targets by 2050. NSW is perfectly positioned to meet this demand, for biogenic SAF, with a production potential of up to 5,200ML/year by 2050.

Modelling commissioned by the NSW Office of Regional Economic Development expects biogenic SAF to account for approximately 52% of all aviation fuel in Australia by 2050, with market value amounting to A\$11.9 billion in Australia and A\$4.8 billion in NSW.

The total SAF demand in NSW is estimated to be between 4,000 and 4,300ML/year by 2050.*

NSW's competitive advantage lies in:



Large volumes of feedstock availability in strategic regional areas, namely Riverina-Murray, New England North West and the Central West



Metropolitan municipal solid waste (MSW) and commercial & industrial waste (C&I) can potentially be combined with regional feedstocks to service Sydney Airport, the Western Sydney Airport and/or export markets through Port of Newcastle and Port Kembla



Strong existing and future transport infrastructure enabling supply chain development



Highly qualified workforce with transferrable skills for the SAF supply chain in existing and future workforce



World-leading NSW industry-led innovation networks and universities.

Regional breakdown of all feedstocks



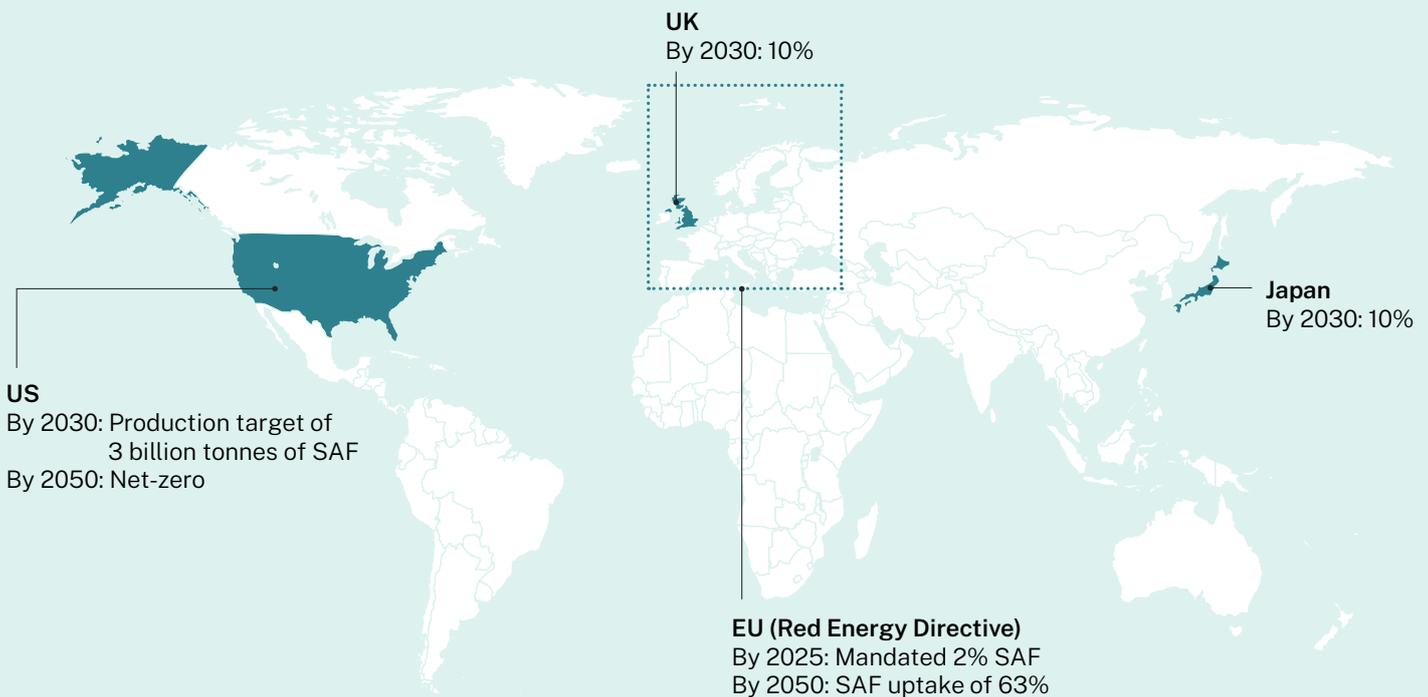
* Note: Competition for feedstocks, across multiple fuel types, will be a factor in determining the volume of SAF produced.

Demand

Global demand for SAF through to 2050

Forecasted global aviation energy demand to 2050 shows rapid adoption of SAF with major regions and industries having already set targets to 2030 and 2050.

Global SAF targets



Industry body targets¹

Industry body	SAF target
International Air Transport Association	Fly Net Zero Program, by 2050: Net zero, 449 billion litres of SAF per year
International Civil Aviation Organization	Long-term global aspirational goal (LTAG), by 2050: Net-zero emissions
Clear Skies for Tomorrow Coalition	Coalition of 60 companies committed to accelerate the supply and use of SAF by 2030 to reach: 10% of global jet aviation fuel supply

To achieve net zero in the aviation sector by 2050, the industry will need to rapidly adopt SAF production pathways such as: biogenic sustainable aviation fuel (SAF) from Hydroprocessed Esters and Fatty Acid (HEFA), Alcohol to Jet (AtJ) and Gasification Fischer-Tropsch (GFT) pathways, as they reach technical and commercial maturity. Biogenic SAF can act as a drop-in fuel, directly substituting fossil jet fuel which allows biogenic SAF to be used for large commercial flights.

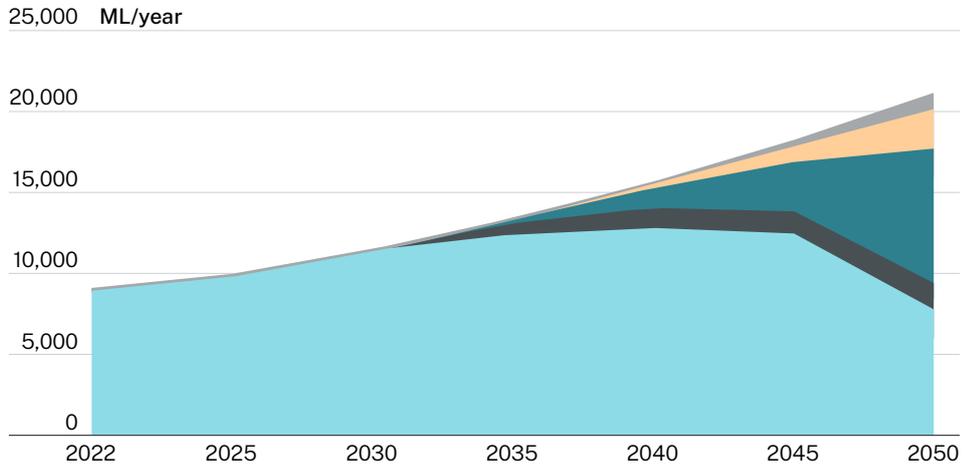
¹ Mission Possible Partnership, 2023, <https://missionpossiblepartnership.org/wp-content/uploads/2023/01/Making-Net-Zero-Aviation-possible.pdf>

Australian demand for SAF through to 2050

Biogenic SAF is estimated to constitute between 22% to 52% of total aviation fuel demand in Australia by the year 2050.

- Fossil jet fuel
- HEFA
- AtJ and GFT
- Power to liquid
- Hydrogen

Australian demand – medium scenario



Total Australian demand for aviation fuel and biogenic SAF in 2050

2050	Low	Medium	Prudent
Total demand aviation fuel in Australia (ML/year)	21,146	21,146	17,622
Production of biogenic SAF in Australia (ML/year)	5,838	9,807	10,491

Key takeaways from the forecast



By 2050, biogenic SAF in Australia is expected to have a market share of approximately:

- low scenario **22%**
- medium scenario **38%**
- prudent scenario **52%**



Lower production costs leads to greater biogenic production, specifically through Gasification Fischer Tropsche (GFT) and Alcohol to Jet (AtJ). The medium and low scenario has a ramp up for GFT and AtJ in 2045 while the prudent scenario achieves its ramp-up by 2040.

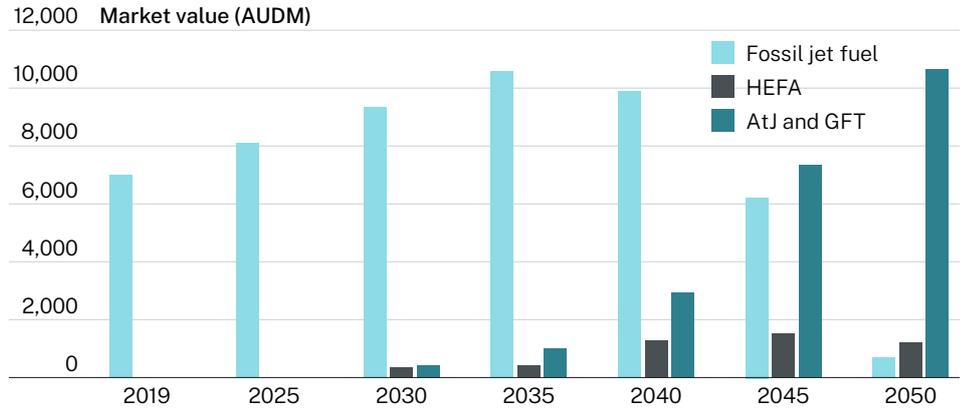
Note:
GFT refers to Gasification Fischer-Tropsch, AtJ refers to Alcohol-to-Jet and HEFA refers to Hydroprocessed Esters and Fatty Acids. HEFA, GFT and AtJ are all pathways for production of biogenic-based SAF.

By 2050, the market value of biogenic SAF could amount to A\$11.9 billion in Australia and A\$4.8 billion in NSW based on projected demand volumes (see page 3).

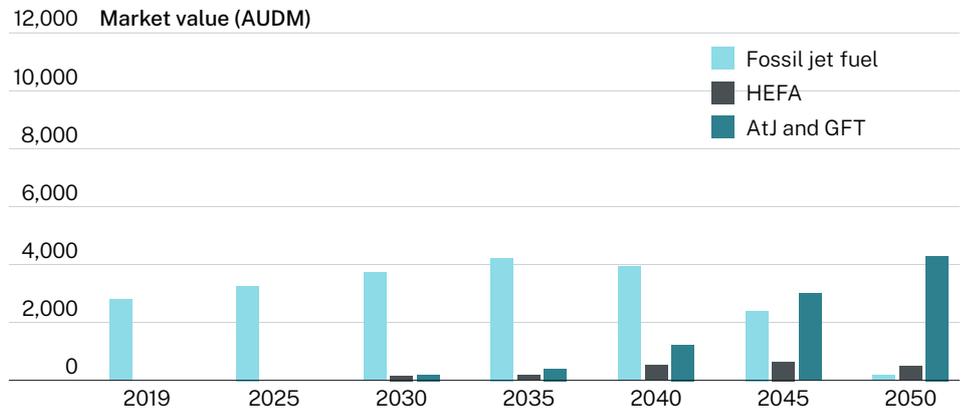
This presents a significant commercial opportunity for project developers and investors.

Investors and project developers can currently access the ARENA SAF Initiative Fund to advance pilot projects, supply chain solutions and feasibility studies.

Australian market value of biogenic SAF – prudent scenario



NSW market value of biogenic SAF – prudent scenario



Snapshot of SAF in Australia

2

In response to global net zero commitments, SAF is being viewed as one of the key opportunities for decarbonising the aviation sector:

Qantas



Qantas has set their target to reach net zero by 2050. In 2023, Qantas announced an A\$400 million climate fund for sustainable projects and technologies, which includes its A\$290 million partnership established in 2022 between Qantas and Airbus to establish a SAF industry in Australia.²

Virgin Australia



Virgin Australia has clocked more than one million kilometres using SAF.³ In 2021, the company announced commitments to net zero by 2050 and SAF is stated to be a key vector in attaining such targets.⁴

BP



In 2023, BP announced plans to convert their Kwinana refinery in Western Australia to generate 50,000 barrels per day of SAF and renewable diesel by 2030, with first production to commence in 2026.⁵

Ampol



Ampol plans to explore the production of advanced biofuels at their Lytton refinery in Brisbane with ENEOS Group. The companies are exploring investment with the QLD State Government as part of the Queensland Biofutures 10-year Roadmap.⁶

Australian Jet Zero Council



The Australian Government announced the establishment of the Australian Jet Zero Council in June 2023.

The council brings together a cross-section of senior stakeholders from across the aviation sector and its supply chains to lead efforts to deliver net zero aviation in Australia. The council will also coordinate across the sector to provide advice to Government on issues related to the aviation industry's transition to net zero emissions.⁷

Sustainable Aviation Fuel Funding Initiative



Australia's Bioenergy Roadmap identified aviation as a hard-to-abate industry where market opportunities could be unlocked from Australia's bioenergy sector. In November 2021, the Federal Government allocated \$30 million of funding to the Australian Renewable Energy Agency (ARENA) to support the development of an advanced biofuels sector.⁸

² Qantas, 2023, <https://www.qantas.com/au/en/qantas-group/acting-responsibly/our-planet/climate-fund.html>

³ Virgin Australia, 2019, <https://newsroom.virginaustralia.com/release/virgin-australia%E2%80%99s-sustainable-aviation-fuel-flies-one-million-kilometres>

⁴ Virgin Australia, 2021, <https://www.virgin.com/about-virgin/latest/virgin-australia-commits-to-net-zero-by-2050>

⁵ BP, 2023, https://www.bp.com/en_au/australia/home/media/press-releases/biorefinery-plans-new-milestone.html

⁶ Ampol, 2023, <https://www.ampol.com.au/about-ampol/news-and-media/eneos-partnership>

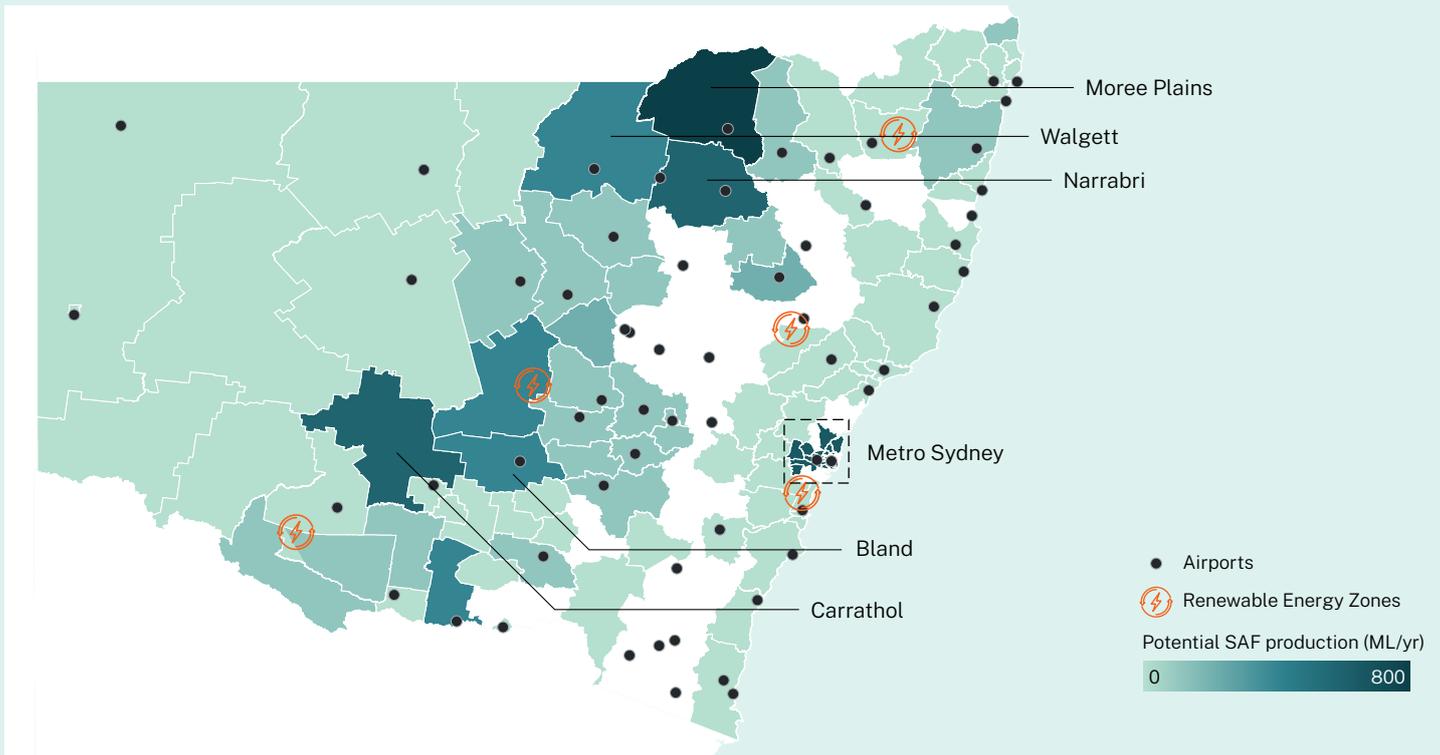
⁷ Australian Jet Zero Council, <https://www.infrastructure.gov.au/infrastructure-transport-vehicles/aviation/australian-jet-zero-council>

⁸ <https://arena.gov.au/assets/2023/06/sustainable-aviation-fuel-funding-initiative-announcement.pdf>

Statement of opportunities

NSW SAF development opportunities

The LGA snapshot below of feedstock density in NSW provides a closer view of the potential sites for SAF production.



Pilot project opportunities
 The local council area's of Carrathol, Bland, Moree Plains, Walgett and Narrabri are excellent potential domestic demonstration SAF production locations.

Potential feedstock aggregation opportunity
 Project proponents or investors could aggregate feedstocks in northern NSW (e.g. New England-North West) or southern NSW (e.g. Riverina-Murray) to either export or import feedstocks to/from other states to build a SAF production facility.

MSW and C&I in Metropolitan Sydney
 Metropolitan Sydney has significant MSW and C&I waste which can be aggregated with additional waste on the periphery of Sydney in locations such as Hunter Valley, Central Coast, Wollongong and Lithgow.

Proximity to regional airports
 Moree Plains and Narrabri are within a ~500km radius of the Coffs Harbour and Ballina Airports. Land located in the Central West region is within an approximately ~250 km radius to Wagga Wagga, Canberra and Dubbo airports.

Leveraging existing refinery infrastructure
 Project proponents or investors can provide feedstock from locations such as Moree Plains to the refinery in Lytton QLD, which is a brownfield refinery (~500km distance).

Proximity to Renewable Energy Zones (REZs)
 Proximity to REZs allows for clean fuel producers, including SAF and green hydrogen, to take advantage of zero-marginal cost electricity as an input into production.

→ **NSW, Australia's largest state by Gross State Product, has a large proportion of Australia's total demand for aviation fuel.**



Sydney has the largest amount of airport traffic in Australia, with the majority of NSW aviation fuel consumption at 3,600 ML/yr attributed to the Sydney airport. This is forecasted to double in the next 20 years.⁹ By 2026, NSW will also be home to Western Sydney Airport – expected to handle 10 million passengers annually.¹⁰

→ **NSW's strategic ports are also key domestic and international trade gateways which could play a vital role in the future SAF value-chain for NSW, enabling SAF/feedstock export.**



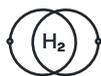
This includes Port Eden, Port Botany, Port Kembla and the Port of Newcastle.

→ **NSW's rail and road network connectivity can facilitate the transportation of feedstock and SAF.**



NSW has approximately 6,700 km of operational rail connectivity.¹¹ The State is committed to developing important freight rail linkages, such as Inland Rail which will be approximately 1,700 km in length and include over 1,000 km of major upgrades and enhancements and 600 km of new track via regional Victoria, NSW and Queensland.¹²

→ **Hydrogen Hubs are also located in Newcastle and Port Kembla, feeding state, national and international demand over the long term.**



Hydrogen Hubs are regions where producers and users of green hydrogen across industrial, transport and energy markets are co-located. In March 2023, NSW Government awarded A\$64.3 million of funding from the Hydrogen Hub initiative to the first 2 hub projects in Illawarra and Moree Plains.



⁹ NSW Department of Infrastructure, Transport, Regional Development and Communications, n.d., <https://www.westernsydneyairport.gov.au/sites/default/files/documents/2020-factsheet-wsa-overview.pdf>

¹⁰ Infrastructure Pipeline, n.d., <https://infrastructurepipeline.org/project/western-sydney-airport>

¹¹ Transport NSW, n.d., <https://gov.uat.cds.transport.nsw.gov.au/operations/logistics-network/nsw-rail-network>

¹² NSW Department of Planning, <https://www.planning.nsw.gov.au/assess-and-regulate/state-significant-projects/inland-rail>

Competitive advantages

NSW's competitive advantage for biogenic SAF production

Feedstock availability, airlines' demand, existing infrastructure and enabling government initiatives positions NSW as a key Australian state for biogenic SAF production.

Feedstock availability

NSW has significant biogenic SAF production potential with the feedstock total estimated at 21Mt/yr. Key areas for further production analysis include Riverina-Murray, New England-North West and Central-West.



Workforce

Existing workforce capabilities in regional NSW aligns closely with the skillsets required for SAF production. This includes employees skilled in professional, scientific and technical services, construction, mining, and electricity, gas, water and waste services.



R&D capability

NSW has emerged as a leading hub for R&D largely due to the contributions of state of the art universities such as UNSW and the University of Newcastle. For example, UNSW and the University of Newcastle are currently collaborating on a project aimed at the production of low-cost SAF from renewable hydrogen and carbon dioxide.¹³

SAF demand

Sydney has the greatest airport traffic in Australia with the majority of NSW aviation fuel consumption at 3,600 ML/yr attributed to the Sydney airport. This is forecasted to double in the next 20 years.¹⁴ By 2026, NSW will also be home to Western Sydney Airport - expected to handle 10 million passengers annually.¹⁵ NSW is also strategically positioned to produce SAF through mobilisation of aviation, rail, road and maritime infrastructure to enable a future SAF value-chain.

¹³ CSIRO, 2022, <https://research.csiro.au/hyresearch/innovations-in-sustainable-aviation-fuels-saf-production-and-deployment-at-scale/>.

¹⁴ NSW Department of Infrastructure, Transport, Regional Development and Communications, n.d., <https://www.westernsydneyairport.gov.au/sites/default/files/documents/2020-factsheet-wsa-overview.pdf>

¹⁵ Infrastructure Pipeline, n.d., <https://infrastructurepipeline.org/project/western-sydney-airport>

NSW's most abundant regions for SAF feedstocks

Region	Most abundant feedstock types	Total tonnage (ton/yr)
Riverina-Murray	Cropping 3,247,688 MSW 128,625 C&I waste 154,195 Forestry 218,447 Livestock 94,218 Wood processing 254,730	7,000,000
Sydney region ¹⁶	C&I waste 1,663,750 MSW 1,466,783 C&D waste 692,625	3,823,158
Central West	Cropping 2,162,740 MSW 332,844 C&I waste 58,368 Forestry 104,939 Wood processing 110,759	2,769,650
New England-North West	Cropping 2,077,259 MSW 58,932 Forestry 121,544 Livestock 114,813	2,372,548
Richmond - Tweed	Cropping 368,399 Forestry 70,444 Livestock 74,018	580,000
Coffs Harbour - Grafton	Cropping 179,785 Forestry 246,391 Wood processing 91,901	545,000
Mid North Coast	MSW 217,977 C&I waste 137,756 Forestry 221,595 Livestock 95,663	804,000
Hunter Valley excluding Newcastle	Livestock 117,314 MSW 420,757 C&I waste 207,843	850,000
Illawarra	MSW 164,212	270,000
Capital Region	Cropping 436,784 MSW 309,894 C&I waste 175,997 Forestry 495,924 Livestock 93,537 Wood processing 53,528	1,500,000
Total		22,000,000

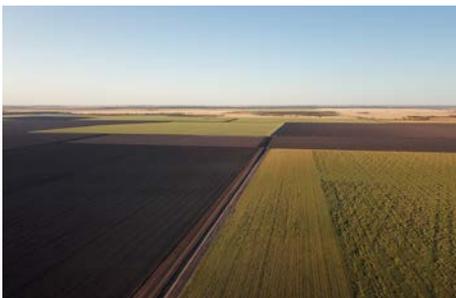
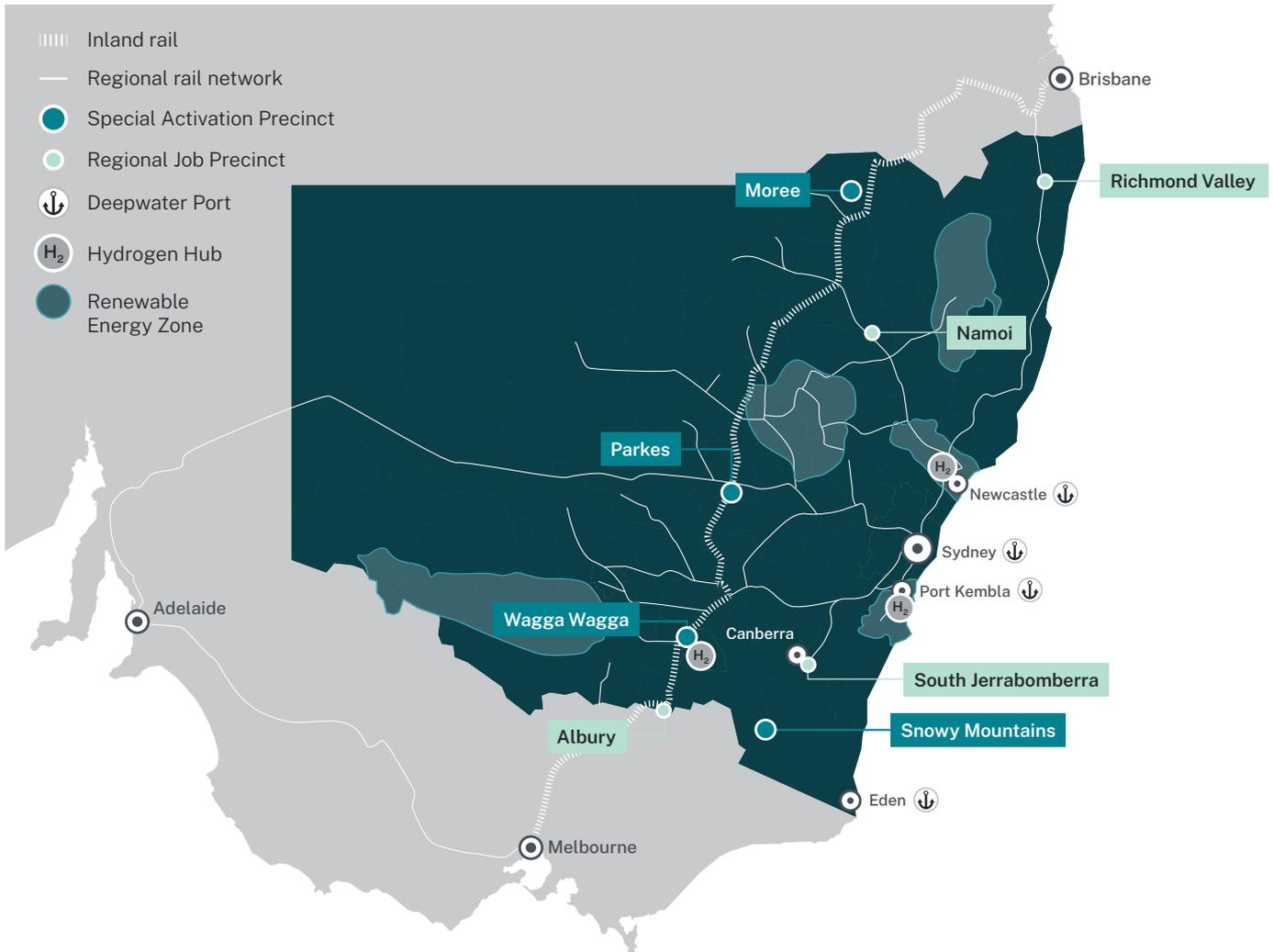
Note:

C&I: Commercial and industrial, MSW: Municipal solid waste, C&D: Construction and demolition

¹⁶ Inclusive of all Sydney regions except Blue Mountains

NSW enabling infrastructure to meet SAF demand

Existing and future ports and railway infrastructure positions NSW as an ideal location for producing SAF.



Agricultural land in Moree



Freight train passing through the Riverina Intermodal Freight and Logistics Hub, Wagga Wagga



Aerial of Narrabri

Regional NSW's complementary workforce

There is significant crossover between the required skillsets and the existing workforce capability in potential SAF production hotspots in regional NSW.

Regional NSW's workforce capabilities are well-suited to the skills required for SAF production. Industries considered to have transferrable skills include:



Professional, scientific and technical services



Electricity, gas, water and waste



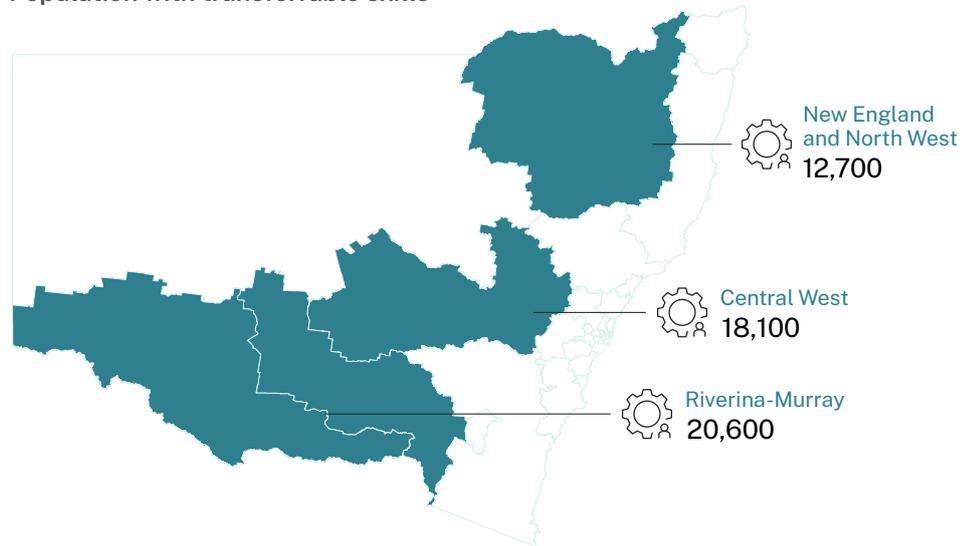
Construction



Mining

The map highlights the number of people in NSW's SAF production hotspots with skills transferrable to the SAF industry.

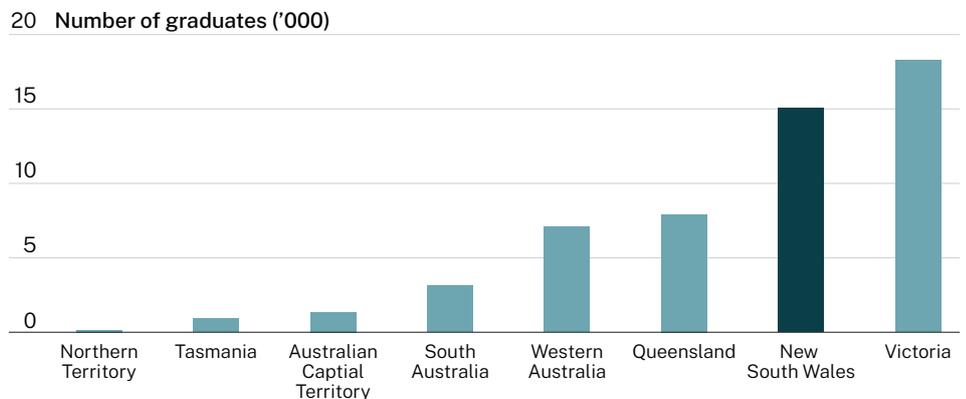
Population with transferrable skills



Note: workforce capability includes current full-time and part-time employees in industries with transferrable skills. Source: <https://labourmarketinsights.gov.au/>

In addition to current workforce capabilities, NSW has the greatest number of science and engineering graduates among the states with highest feedstock potential (Queensland, Western Australia, and NSW). This will continue to support NSW's competitive advantage in this space.

Science and Engineering Graduates Australia (2020)



Source: <https://www.education.gov.au/higher-education-statistics/resources/award-course-completions-pivot-table>

NSW Research & Development (R&D) capability

Contributions from industry-led innovation networks, universities, and CSIRO have established NSW as a leading SAF R&D hub.

Trailblazer for recycling and clean energy



UNSW and the University of Newcastle, along with industry partners and CSIRO, are running the TRaCE Program for 4 years from 2023 to accelerate the commercialisation of clean energy solutions and systems. Federal Government funding of A\$50 million has been matched by A\$50 million cash and \$A47 million in-kind from UNSW and the University of Newcastle. Areas of focus include sustainable fuels.¹⁷

University of Sydney



Sydney University's Net Zero Initiative focuses on R&D to optimise fuel efficiencies, aircraft design, adoption of hydrogen fuel cells and the development of battery and hybrid engines to create an emissions-free aviation sector.¹⁸

CSIRO

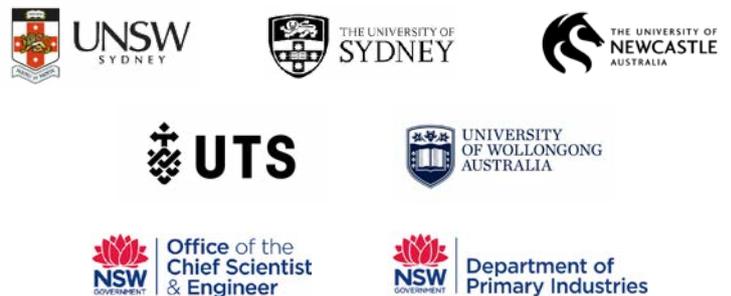


CSIRO Futures and the Toward Net Zero Mission are collaborating with Boeing to develop a roadmap for cost-effective production of SAF. The SAF roadmap will be available in the second half of 2023.¹⁹

NSW Powerfuel and Hydrogen Network (PFH2)



The NSW Powerfuel and Hydrogen Network (PFH2) is an industry-led innovation network under the NSW Decarbonisation Innovation Hub. PFH2 aims to work with stakeholders to accelerate the industrial translation of mature and emerging P2X technologies and build expertise to address the challenges faced by clean fuels and chemicals across value chains.²⁰



¹⁷ UNSW, n.d., <https://www.smart.unsw.edu.au/research-programs/trailblazer-recycling-and-clean-energy#:~:text=Hosted%20by%20UNSW%20and%20in,clean%20energy%20solutions%20and%20systems>

¹⁸ University of Sydney, n.d., <https://net-zero.sydney.edu.au/our-research/>

¹⁹ CSIRO, 2023, <https://research.csiro.au/tnz/sustainable-aviation-fuel-roadmap/>

²⁰ NSW Chief Scientist & Engineer, n.d., <https://www.chiefscientist.nsw.gov.au/rdnsw/future-industries-reports/nsw-power-to-x-industry-pre-feasibility-study>

Complementary NSW Government policies

5

The NSW policy landscape is well suited to supporting SAF production

NSW's Net Zero Industry and Innovation Program (NZIIP)²¹ positions NSW as a leading destination for SAF projects



Relevance to SAF industry

The NZIIP offers the following funding relevant to the SAF industry:

- funding available for the development of supply chains and low carbon fuels, de-risking future project development
- support for research and commercialisation trials to stimulate private investment, and increase market certainty and research.



Objectives

- Support hard-to-abate industries accelerate their transition to net zero
- Develop and grow low emissions industries



Investment

Through the NZIIP, the NSW Government will invest A\$360 million until 2030 to deliver NZIIP initiatives:²²

- A\$305 million is allocated to abatement projects for high emitting manufacturing and mining facilities
- A\$55 million is allocated to deliver clean manufacturing precincts in the Hunter and Illawarra regions
- for every NSW Government dollar invested, the State aims to attract A\$2 to A\$6 of private investment.



Focus areas

- High emitting industries, such as mining and manufacturing
- New low carbon industry foundations, such as renewable energy and low carbon fuels
- Clean technology innovations, such as research institutes and commercial trials
- Sustainable aviation fuel.

²¹ NSW Climate and Energy Action, n.d., <https://www.energy.nsw.gov.au/business-and-industry/ways-get-started/net-zero-industry-and-innovation>

²² NSW Chief Scientist & Engineer, n.d., <https://www.chiefscientist.nsw.gov.au/rdnew/future-industries-reports/nsw-power-to-x-industry-pre-feasibility-study>

NSW's Waste and Sustainable Materials Strategy²³ provides a strong foundation for the production of SAF feedstock



Relevance to SAF industry

Key mandates from the NSW Waste and Sustainable Materials Strategy include:

- the separation of food and garden organics for all NSW households by 2030
- the separation of food waste for targeted businesses and other entities that generate the highest volumes of food waste, including large supermarkets and hospitality businesses by 2025.

This will increase the availability of organics for SAF feedstock.



Objectives

- Meeting future infrastructure and service needs for waste management
- Reducing carbon emissions through better waste and materials management
- Protect the environment and human health from waste pollution



Investment

The Strategy's actions are backed by A\$356 million to help deliver priority programs and policy reforms, such as the mandating of organics separation.



Targets

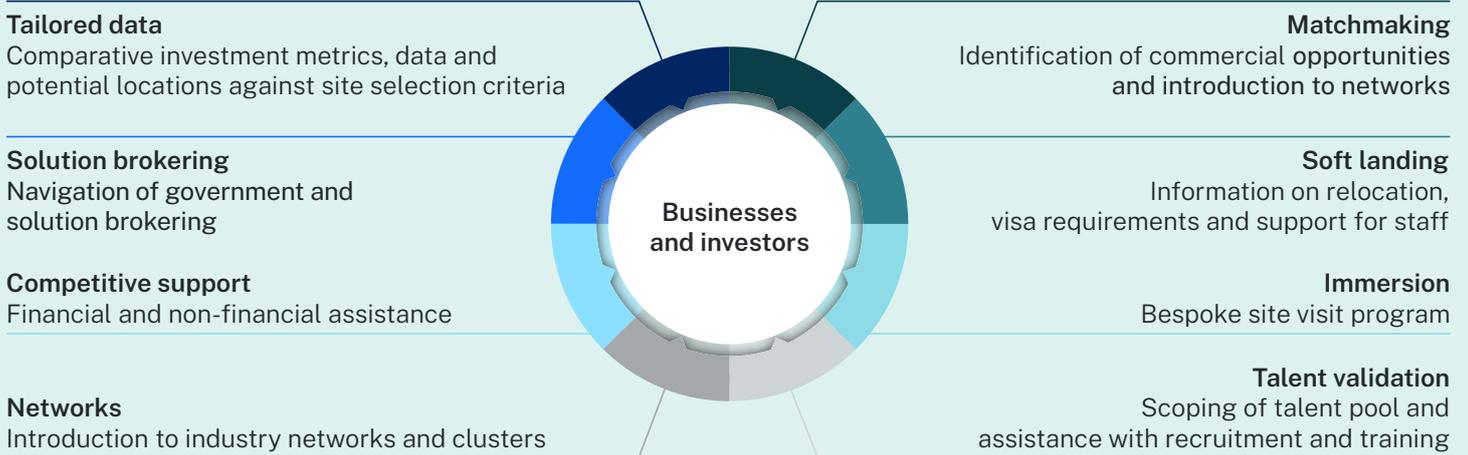
- Reduce total waste generated by 10% per person by 2030
- Have an 80% average recovery rate from all waste streams by 2030
- Significantly increase the use of recycled content by governments and industry
- Phase out problematic and unnecessary plastics by 2025
- Halve the amount of organic waste sent to landfill by 2030

²³ NSW Department of Planning, Industry and Environment, 2021, https://www.dpie.nsw.gov.au/_data/assets/pdf_file/0006/385683/NSW-Waste-and-Sustainable-Materials-Strategy-2041.pdf

Glossary

Term	Definition
ADF	Australian Defence Force
ASTM	American Society of Testing and Materials
AtJ	Alcohol to jet
C&I	Commercial and Industrial
CASA	Civil Aviation Safety Authority
CHJ	Catalytic hydrothermolysis
CRI	Commercial readiness index
FT	Fischer-Tropsch
GFT	Gasification Fischer-Tropsch
GHG	Greenhouse gas
HC-HEFA	Hydro-processed hydrocarbons, esters and fatty acids
HEFA	Hydroprocessed Esters and Fatty Acids
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
INS	Invasive Native Species
LCFS	Low Carbon Fuel Standard
MCA	Multi-criteria analysis
MSW	Municipal solid waste
NZIIP	Net Zero Industry and Innovation Program
PRU	Prudent
REZ	Renewable Energy Zone
SA4	Statistical Area Level 4
SAF	Sustainable aviation fuel. Biogenic SAF refers to SAF produced from biomass sources, through processes such as HEFA, AtJ and GFT.
SAP	Special Activation Precinct
SIP	Synthetic Iso-Paraffin
TRL	Technology Readiness Level

Dedicated team to further your business





→ For more information about sustainable aviation fuel opportunities within regional NSW please contact the team info@investregional.nsw.gov.au

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