Study into the development of a Sustainable Aviation Fuels Industry in the Northern Territory

Department of Industry, Tourism and Trade

Northern Territory Government

Summary Report

August 2024

EY
Building a better
working world

Acknowledgement of Country

We acknowledge the Traditional Custodians of the land on which we, the EY Darwin team live and work, the Larrakia people. As we arrive and leave for work each day, we look out over the Arafura Sea and are reminded of the incredible richness and vastness of this country, and the knowledge held by its custodians.

We pay our respects to those Traditional Custodians, past, present and emerging, who carry deep knowledge of this land, and as a team commit to being open to receive this knowledge and incorporate it in the work we do.

We also acknowledge the many other language groups and countries which make up the rich diverse cultures of our Territory. We pay our respects to all First Nations people of this great place.

Our team members come from all around the country, and we also pay our respects to custodians of these lands. Our commitment is that we will support our colleagues from other places to be open to receiving cultural and Indigenous perspectives, from the Territory and from the lands on which they live and work.

Release Notice

Ernst & Young (“EY”) was engaged on the instructions of the Department of Industry, Tourism and Trade (“DITT” or “Client”) to investigate the feasibility of establishing a Sustainable Aviation Fuel (SAF) industry in the Northern Territory (NT) in accordance with the engagement contract AGC21-0265-24-0043.

The report assesses the NT's potential role in the SAF value chain, considering market outlook, competitive production costs, and possible government interventions. It also analyses SAF technologies, inputs, and locational advantages, and acknowledges that these technologies are rapidly evolving, the impact of government incentives, and the aviation industry's decarbonisation efforts.

The study's findings, based on interviews, literature reviews, and analysis, are contextual and may need future updates, especially considering the aviation industry's recovery post-COVID.

The report focuses on aviation fuels, with an acknowledgment that SAF facilities could also produce other sustainable fuels, for example, for road transport and marine applications. These have not been considered in this study but could significantly affect market potential.

The results of EY’s work, including the assumptions and qualifications made in preparing the detailed report, are set out in EY’s detailed report dated 2 August 2024 ("Report"). The attached report is a summarised version (Summary Report). This Summary Report has been prepared on the specific instruction of DITT. The Summary Report should be read in its entirety including this notice, the applicable scope of the work and any limitations. A reference to the Summary Report includes any part of the Summary Report.

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Readers are advised that the outcomes provided are based on many detailed assumptions underpinning the scenarios, and the key assumptions are described in the Report. These assumptions were selected by the Client. The modelled scenarios represent three possible future options for the development and operation of the National Electricity Market, and it must be acknowledged that many alternative futures exist. Alternative futures beyond those presented have not been evaluated as part of this Report.

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Contents

Introduction

For the Northern Territory, global decarbonisation is an economic opportunity.

The aviation industry is an essential component of Australian infrastructure and global connectivity, enabling a range of services including passenger and cargo transport; emergency response and medical evacuation; and national defence. However, with 98,000 commercial flights scheduled per day, the industry accounts for 2% of global energy-related carbon dioxide (CO_2) emissions[1] and is one of the most challenging industries to decarbonise.

The industry has committed to achieving net zero emissions by 2050.[2] Low carbon fuel is central to reducing emissions and achieving the target.

Sustainable Aviation Fuel (SAF) is a biofuel used to power aircraft that is designed to be more environmentally friendly than conventional jet fuel. It is produced from sustainable resources and is developed to have a lower carbon footprint throughout its lifecycle, from production to combustion. SAF can be blended with conventional jet fuel and used in existing aircraft engines without modification, offering a potential reduction in greenhouse gas (GHG) emissions and helping the aviation industry move towards its sustainability goals.

SAF can be up to 99% carbon free depending on its production process which can involve biogenic or synthetic feedstocks.[3] Production costs vary widely based on the feedstock and technology used and are currently 3-5 times the cost of conventional jet fuel.[4]

This report investigates the SAF market and value chain to assess whether there is an opportunity for the Northern Territory (NT) to leverage its abundant natural resources and location to competitively participate in this growing industry.

The commercial viability of different SAF pathways is influenced by technological advancements and proximity to feedstocks.

This report considers the most mature or most prospective SAF production methods for the NT:

- Hydroprocessed Esters and Fatty Acids (HEFA)
- Fischer-Tropsch (FT)
- Alcohol-to-Jet (AtJ)
- Power-to-Liquid (PtL)

As new processes are approved for SAF use, there may be future opportunities for the NT in this sector. The NT has the potential to develop a SAF industry, but key considerations include local demand, export potential, feedstock availability, technological readiness, and environmental sustainability.

The availability of feedstock in the NT is currently limited. There is the potential for growth with diversification of the agricultural sector and circular economy focused infrastructure, increasing the availability of waste stock. Over time the NT’s renewable energy potential could support PtL SAF pathways including at the Middle Arm Sustainable Development Precinct (MASDP).

The NT's current demand for jet fuel is modest but expected to grow with increased defence aviation activity. The NT's strategic location near Southeast Asia’s growing markets and Singapore’s fuel trading hub is advantageous for SAF export as decarbonisation mandates and targets become more widespread in the region.

To produce SAF, the NT needs to apply careful consideration to production scale, local demand, export potential, feedstock availability, technological readiness, and environmental sustainability.

The NT Government can play a role in uncovering demand, attracting investment, and supporting feedstock aggregation or development.

Sustainability in Aviation

The aviation industry faces significant decarbonisation challenges. The global nature of services, long fleet replacement cycle and safety first's impact on innovation are all factors that make decarbonisation more difficult than other industries. This challenge is compounded by increasing demand for aviation services. If climate change mitigation in the aviation industry 'continues to lag behind other sectors, international aviation's share of global CO_2 emissions could rise to 22% by 2050'.[5]

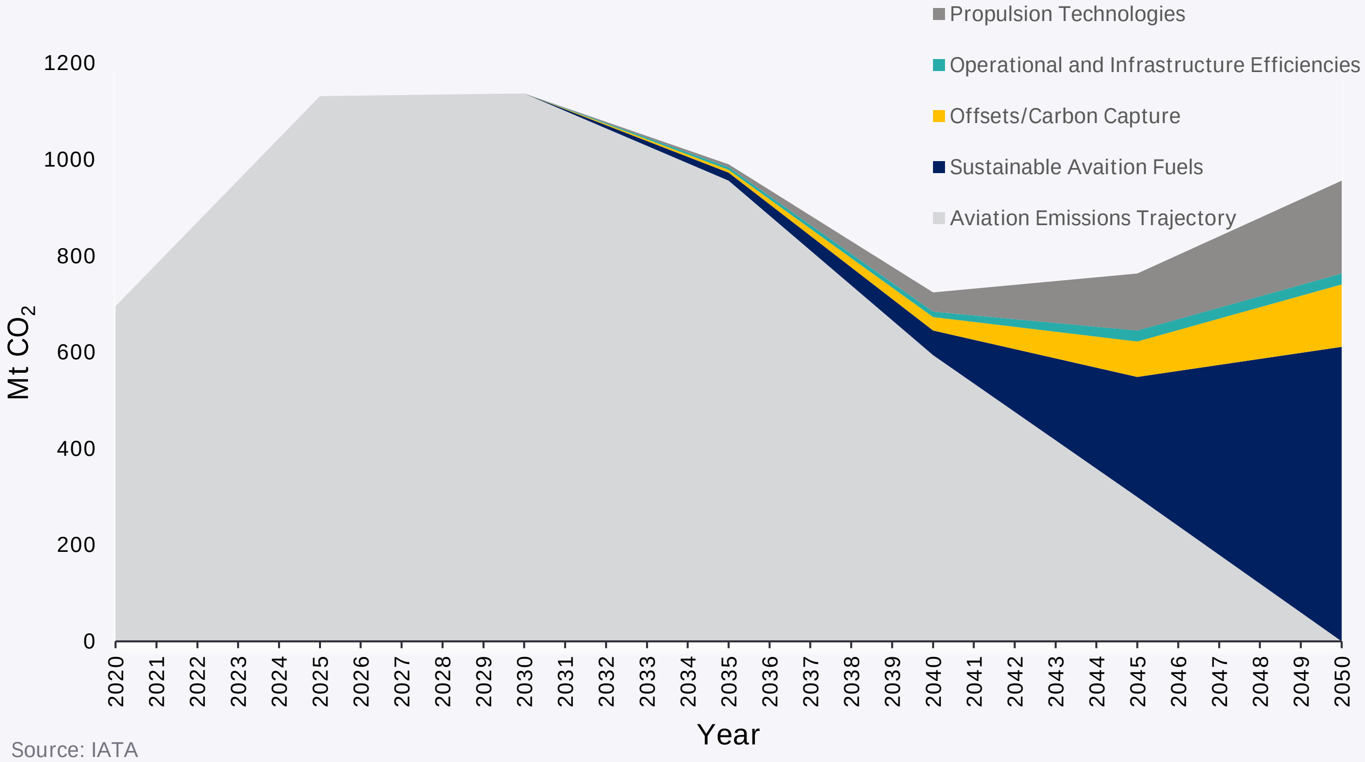
In Australia, domestic aviation emissions were 8 Mt in 2019 (pre-COVID) and are projected to rise to 10 Mt by 2035. Australia's emissions from domestic flights are the second highest in the world.[6]

Achieving net zero in the aviation sector will require the exhaustive use of all carbon mitigation measures available. Figure 1 shows the potential contribution of various mitigation measures to the net zero target and demonstrates the materiality of SAF.

The benefit of SAF is that it is considered a 'drop in fuel', requiring minimal addition infrastructure and already extensively blended for aviation across the globe.

> SAF is assumed to deliver the highest emissions savings in the energy transition of the aviation industry to reach net zero by 2050 and is a critical tool for these targets.[7]

Figure 1 – Carbon mitigation measures as a proportion of global emissions forecast



Source: IATA

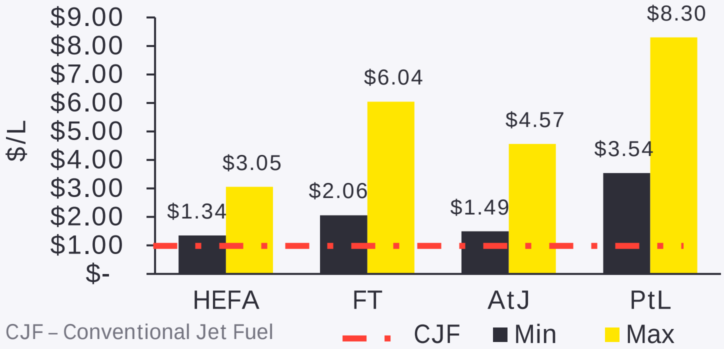
Market Overview

The global SAF market is rapidly evolving, reflecting technology advancements, international policy responses to climate change and industry driven emission targets.

SAF is a proven alternative to conventional jet fuel and already in widespread and growing use. Since 2021 over 100 SAF offtake agreements have been signed.[8] Current demand for SAF is primarily driven through government mandates and industry decarbonisation targets, however the level of uptake has varied across international jurisdictions. SAF production is being led by the European Union and the United States – reflecting the maturity of regulation and policy intervention in these regions.

SAF is considerably more costly to produce than the price at which conventional jet fuel can be procured. Figure 2 illustrates the cost comparison by production pathway to conventional jet fuel. Figure 3 charts global supply and demand for SAF out to 2050. From the 2040s, supply is expected to significantly increase yet; despite increasing production activity, demand is still expected to outstrip supply for decades.

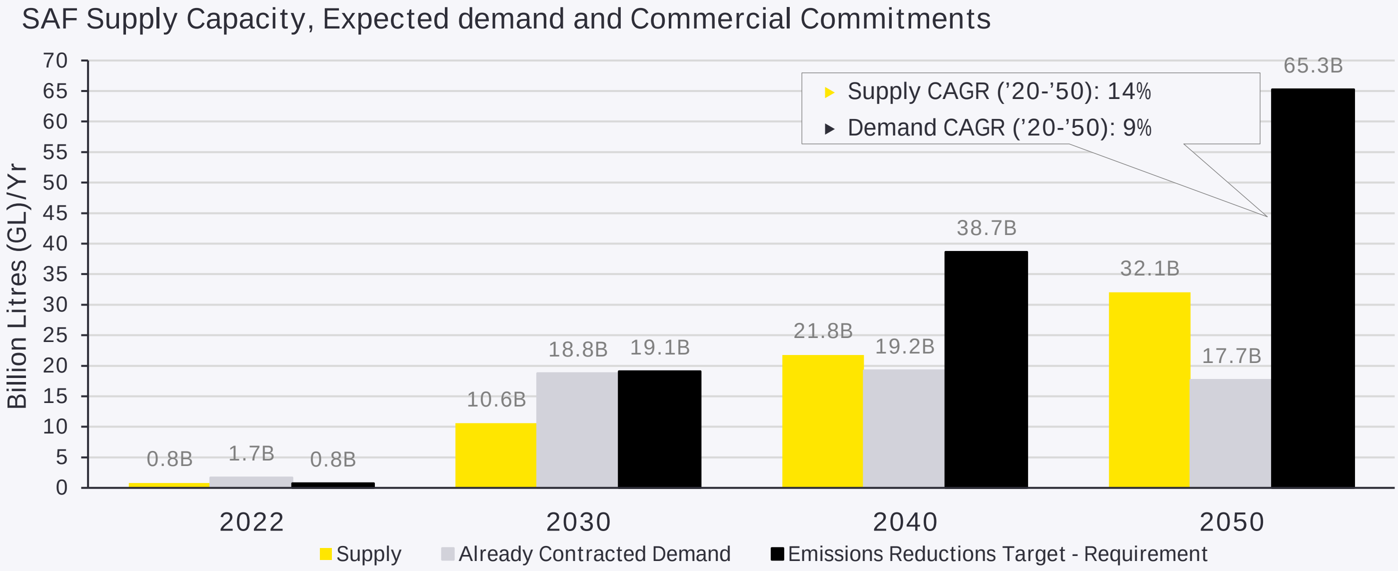
Figure 2 – SAF sales price by production method versus CJF sale price



CJF – Conventional Jet Fuel
Source: CSIRO, EY analysis, IATA

The supply of feedstocks for SAF is hindered by competition from existing markets, causing price and availability fluctuations. Producers may need to seek new raw materials or alternative technologies. The next section, SAF Technological Pathways, provides a summary of the most mature technological pathways for SAF production and its feedstock procurement.

Figure 3 – Global SAF supply and demand



CAGR – Compound Annual Growth Rate
Source: S&P Global, World Economic Forum, EY analysis

Major jet fuel users in the NT include domestic airlines such as Virgin Australia, Jetstar and Qantas; international airlines such as Singapore Airlines; and the Australian and visiting defence forces.

Fuel consumption is subject to many factors. Assuming an Airbus A320 (typical Jetstar aircraft) uses 2,500kg or roughly 3,000L an hour,[9] a 25ML SAF plant could provide the fuel for over 8,000 hours of flying time – 2,000 flights from Darwin to Sydney per year, or just over 5 per day. On this basis, there could be adequate domestic demand to absorb SAF if produced at small scale locally. However, many factors must be considered, not least of which is the price differential between SAF and conventional jet fuel and that SAF is expected to be blended, not a sole fuel source for at least the next couple of decades.

Nonetheless, Australia currently imports 90% of liquid fuels, including aviation fuels. Domestic demand for jet fuel is expected to increase by 75% by 2050,[10] presenting a potential opportunity to develop a sovereign fuel production capability.

Market Overview

The SAF industry is subject to wide-ranging government interventions that target both supply and demand. The global nature of the aviation sector can see government policy interventions affect the commerciality of projects, making some locations significantly more challenging or more compelling for investment. This shifting investment environment presents risk and opportunity as the viability and competitiveness of projects targeting the SAF value chain can be influenced by the factors outlined below, adapted from the CSIRO report, *Sustainable Aviation Fuel Roadmap* (2023).

SAF Demand

Blending mandate	A regulatory requirement mandating a minimum percentage of SAF blended with conventional jet fuel, progressively increasing over time.
Emission intensity mandate	A regulatory requirement that sets a maximum limit on the GHG emissions per unit of energy produced by aviation fuels – encouraging the adoption of SAF.
Voluntary SAF purchase	Business decision to adoption of SAF – likely driven by airlines' sustainability goals, customer preferences, or industry initiatives.
Domestic carbon pricing or cap-and-trade	Economic policies assigning a cost to carbon emissions (price) or limiting emissions with tradable allowances (cap-and-trade), creating a financial incentive for cleaner fuels.

SAF Supply

Tax incentive or exemption	Fiscal instruments such as tax credits, excise tax reductions, or depreciation benefits to make SAF production and use more economically attractive.
Innovation fund	Dedicated finances to accelerate research, development, and deployment of SAF technologies, overcoming commercialisation hurdles.
Capital funding	Critical financial resources to develop and build the infrastructure and technology needed for widespread production, distribution, and use of SAF.
Contract-for-difference	Guarantees a fixed price for SAF, reducing risk for producers and encouraging investment.
Direct subsidies	Direct financial assistance (grants or rebates) provided by governments or other entities to stakeholders in the SAF supply chain, aimed at accelerating SAF adoption by lowering its cost of production, distribution, or purchase.
Fossil fuel levy	Charges on fossil fuels can fund SAF initiatives like blending mandates or innovation funds, accelerating the transition to a low-carbon aviation sector.

Hydroprocessed Esters and Fatty Acids (HEFA)

Technology Pathway

This established technology utilises sustainable feedstocks like UCO, animal fats and bio-seed oils. HEFA offers a mature and commercially viable solution with established production facilities around the world. Airlines like KLM and United Airlines have already incorporated HEFA into their fuel blends. Its scalability is limited by feedstock availability.

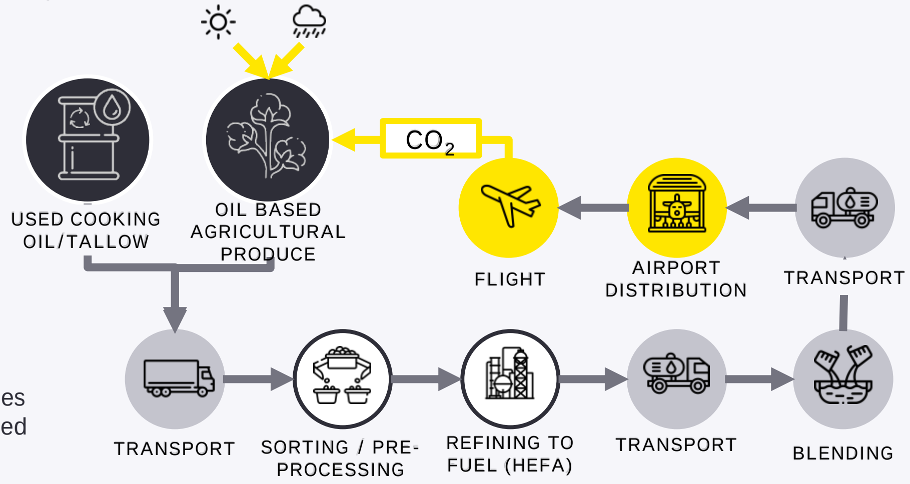
1 Feedstock Preparation: Feedstocks undergo pre-treatment to remove impurities or water.

2 Hydrodeoxygenation: The feedstock contains oxygen. This step uses H_2 to remove it, creating hydrocarbons.

3 Cracking: The resulting hydrocarbon chains might be too long. This stage breaks these smaller molecules with the desired length for jet fuel.

4 Distillation & Purification: This separates the various hydrocarbon molecules based on their boiling points. Other products include Bio-diesel, E-LNG and Naphtha.

Figure 4 – HEFA value chain



Source: EY Analysis, IATA

Feedstock Procurement

Used Cooking Oil (UCO)

UCO is a power dense feedstock and globally traded commodity. Australia contributes a small share of the UCO global market, producing around 100,000 tonnes per year, or 0.76%.[11] The NT's Shoal Bay recycling facility collects approximately 8 tonnes of UCO per annum – an insufficient volume to support a small HEFA based plant.

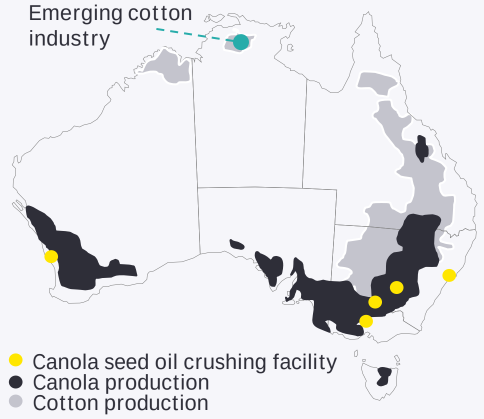
Tallow

Tallow, a rendered form of animal fat, diverts waste from landfills and reduces reliance on virgin vegetable oils. Additionally, its high energy density translates to more fuel per unit of feedstock, improving efficiency in the conversion process. With limited tallow production in the NT, domestic and international imports would be required.

Bio-seed crops

The NT has a growing cotton industry and the potential to grow other crops such as canola. As depicted in the map, oilseed cultivation is a well-established industry across Australia with existing technologies and supply chains, making it easier to scale up production.

Figure 5 – Oil crop growing areas in Australia



Source: CSIRO, Sustainable Aviation Fuel Roadmap

Feasibility in the Northern Territory

HEFA presents a mature and commercially ready option, yet its scalability within the NT is constrained by feedstock limitations. An increase in feedstock supply could be achieved through domestic and international imports of UCO and tallow, or by accelerating the cultivation of bio-seed crops in the region.

Fischer-Tropsch (FT)

Technology Pathway

The FT process for producing SAF is a well-established technology with a proven track record in creating synthetic fuels. Pilot plants have successfully demonstrated its capability for SAF production, however commercial deployment is still under development, requiring further optimisation for cost reduction and efficiency for long-term viability.

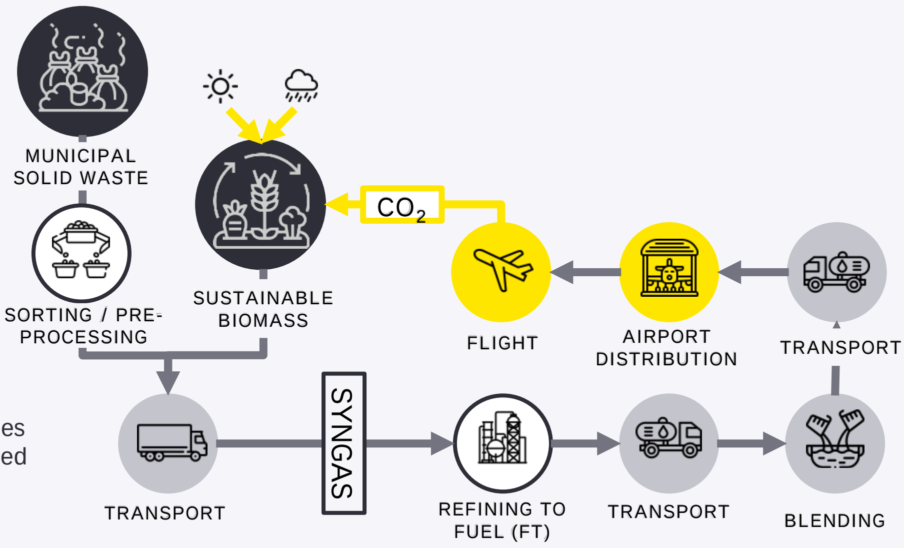
1 Feedstock Preparation: Municipal Solid Waste (MSW) is sorted to ensure only suitable feedstocks are presented.

2 Hydrodeoxygenation: Feedstock is converted into a synthetic gas called syngas. This syngas is a mixture of H_2 and carbon monoxide.

3 Cracking: The syngas is then fed into a reactor with a catalyst. Under high pressure and temperature, the catalyst promotes the conversion of syngas into a liquid hydrocarbon mix.

4 Distillation & Purification: This separates the various hydrocarbon molecules based on their boiling points. Other products include Bio-diesel, E-LNG and Naphtha.

Figure 6 – FT value chain



Source: EY Analysis, IATA

Feedstock Procurement

FT technology enables the conversion of diverse feedstocks, such as biomass, natural gas, forestry residues, and MSW, into synthetic hydrocarbons including jet fuel.

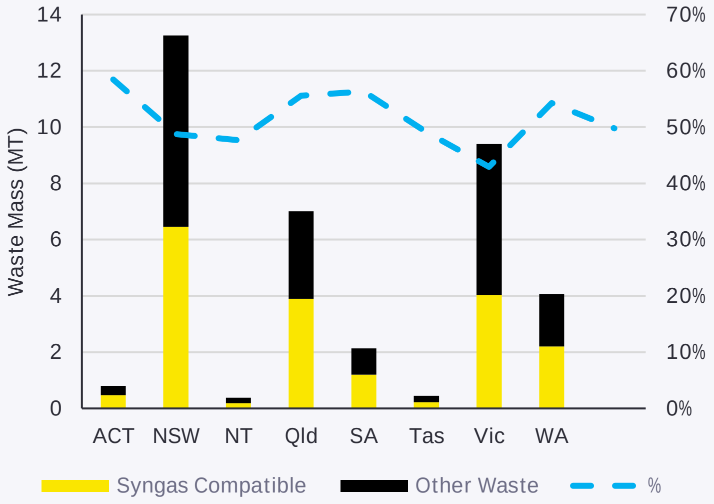
Municipal Solid Waste (MSW)

The everyday rubbish generated by households and businesses - food residue, plastics, paper, textiles, wood waste and rubber - offers a potential source of feedstock for SAF production in Australia. Existing waste collection and processing infrastructure provides a well-established supply chain for MSW. As depicted in Figure 7, the NT's mass of MSW is low.

Agricultural and Forestry Residues

Agricultural and forestry practices generate significant leftover biomass materials called residues. These include leftover stalks, leaves, and husks from crops, or wood chips, bark, and branches from trees. However, efficient collection and aggregation infrastructure is lacking, and commercially difficult to implement.

Figure 7 – Australian MSW by state



Source: DCCEEW, National Waste Report 2022

Feasibility in the Northern Territory

The required feedstock to develop FT is not currently available or of very limited scale in the NT. The low energy density of renewable FT feedstocks necessitates an efficient and cost-effective feedstock aggregation network to achieve competitive production costs. For the NT, the long-distance aggregation of residues and waste feedstocks presents commercial challenges.

Alcohol-to-Jet (AtJ)

Technology Pathway

The AtJ technology pathway is still under development but holds promise due to its ability to utilise various feedstocks, including non-food biomass and waste resources. Large-scale production facilities are just starting to emerge and pilot projects have shown promising results. AtJ offers some potential advantages. The readily available alcohol feedstock can streamline the process compared to other methods.

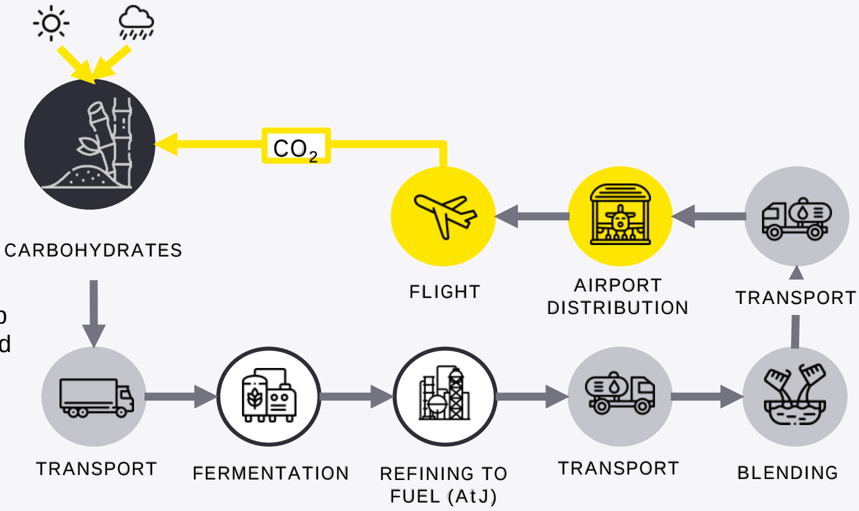
1 Alcohol Production: The journey starts with the creation of alcohol, typically ethanol. This can be done by farming, harvesting fermenting sugary crops and carbohydrates.

2 Dehydration and Oligomerisation: This stage removes oxygen in the alcohol and links the alcohol molecules together into short hydrocarbon chains.

3 Hydrocarbon Processing: The short hydrocarbon chains from the previous step must be lengthened. The chains are refined into molecules with the desired size and branching for jet fuel performance.

4 Distillation & Purification: This separates the various hydrocarbon molecules based on their boiling points. Other products include Bio-diesel, E-LNG and Naphtha.

Figure 8 – AtJ value chain



Source: EY Analysis, IATA

Feedstock Procurement

Carbohydrates

The primary feedstock investigated for the AtJ technology pathway is the fermentation of Australian carbohydrate crops into ethanol. Figure 9 outlines areas of main carbohydrate crops, sugarcane, sugar and sorghum.

SAF feedstocks must not compete with crops that can also be used as food or animal feed (first-generation raw materials). It must be crops generally used for further processing or by-products of first-generation materials (second-generation raw materials).

Sorghum, sugarcane and bagasse (by-product of the sugarcane industry) are key potential feedstocks for SAF production in Australia, being second generation material.

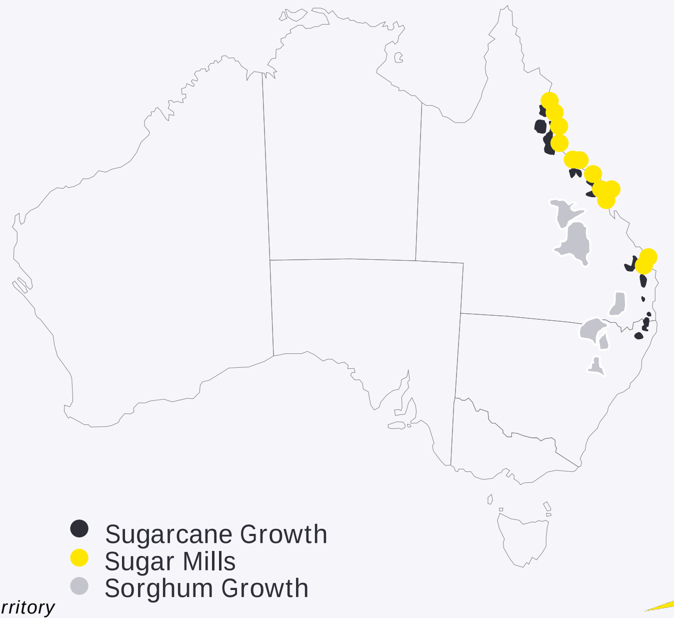
Feasibility in the Northern Territory

The required carbohydrates to develop AtJ are not currently available in the NT. AtJ may become a more plausible option if significant agricultural precincts progress or alternate agricultural projects with the required feedstock are proposed.

Residues and Municipal Solid Waste (MSW)

AtJ is an alternative technology pathway for residues and MSW. Syngas generated from gasifying MSW and woody residues can be processed into ethanol for onward processing into SAF through AtJ.

Figure 9 – Sugar and sorghum growing areas in Australia



Source: CSIRO, Sustainable Aviation Fuel Roadmap

Power-to-Liquid (PtL)

Technology Pathway

PtL, an early-stage technology for sustainable fuels, leverages renewable electricity to create renewable Hydrogen (H_2). This H_2 combines with captured CO_2, offering a limitless feedstock approach for producing synthetic liquid fuels. While PtL offers a promising pathway, large-scale production necessitates progress in efficiency and drastic reduction in cost over the coming decades.

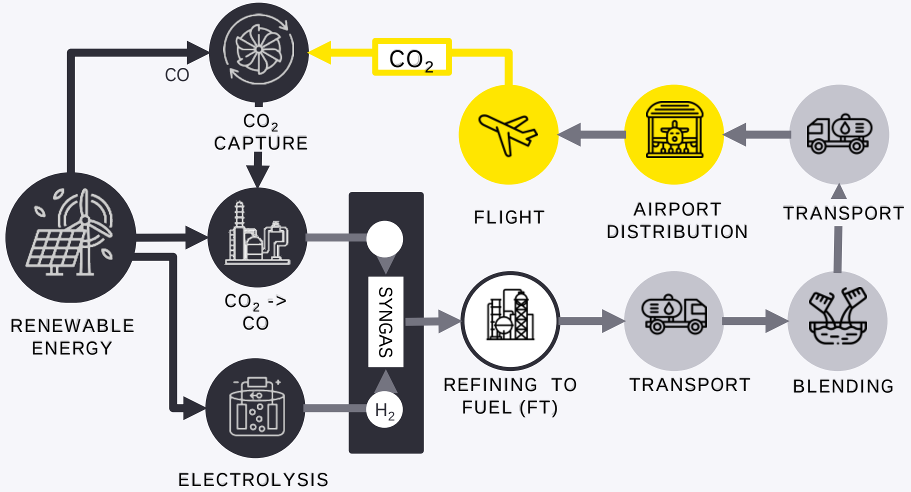
1 Feedstock Preparation: Renewable H_2 and CO_2 are captured from water and the environment by renewable energy.

2 Syngas Production: Feedstock is converted into a synthetic gas called syngas. This syngas is a mixture of hydrogen and carbon monoxide.

3 Fischer-Tropsch Synthesis: The syngas is then fed into a reactor with a catalyst. Under high pressure and temperature, the catalyst promotes the conversion of syngas into a liquid hydrocarbon mix.

4 Distillation & Purification: This separates the various hydrocarbon molecules based on their boiling points. Other products include Bio-diesel, E-LNG and Naphtha.

Figure 10 – PtL value chain



Source: EY Analysis, IATA

Feedstock Procurement

Hydrogen

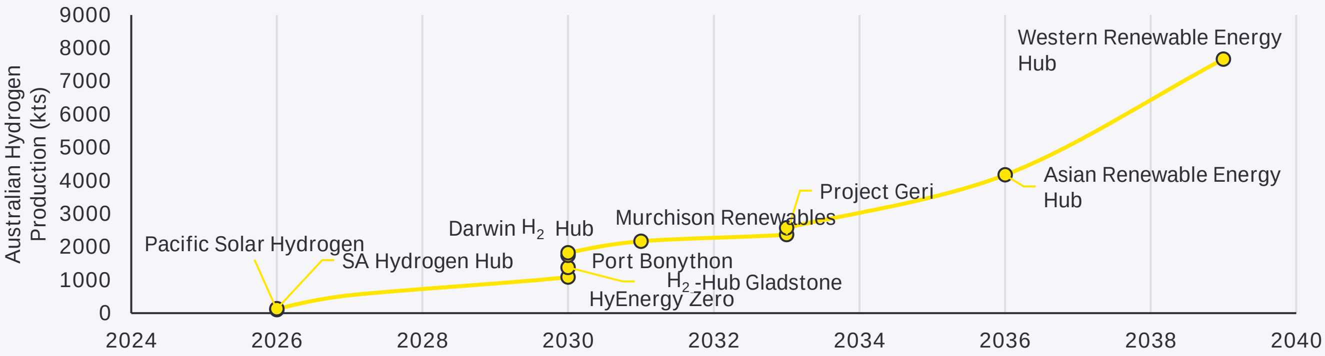
Australia is undergoing a significant transformation in its energy sector, transitioning to renewable energy sources. As illustrated in Figure 11, Australia has 111GW of energy projects planned,[12] but domestic renewable H_2 production is minimal. Grid infrastructure development is a generational challenge, and focus has sharpened on localised grid firming techniques to alleviate the load on energy market infrastructure. These developments position Australia to become a significant renewable H_2 producer and exporter over time.

Carbon Dioxide

To create sustainable PtL SAF, responsible CO_2 sourcing is key. Initially, using CO_2 from ammonia and ethanol production is cost-effective. Subsequently, biogenic CO_2 from biomass and Direct Air Capture (DAC) can be integrated. Focusing on current CO_2 emissions before DAC deployment accelerates technological advancement while minimizing upfront costs. H_2 production for PtL uses clean water, but its consumption is minimal relative to other energy sectors.

Figure 11 – H_2 project pipeline

Source: EY data



Feasibility in the Northern Territory

PtL has the potential for excellent scalability in the long term, allowing for significant production increases as demand grows. Low cost and available renewable electricity, an established renewable H_2 industry and sustainable CO_2 sources within the NT are preconditions required for long-term sustainability.

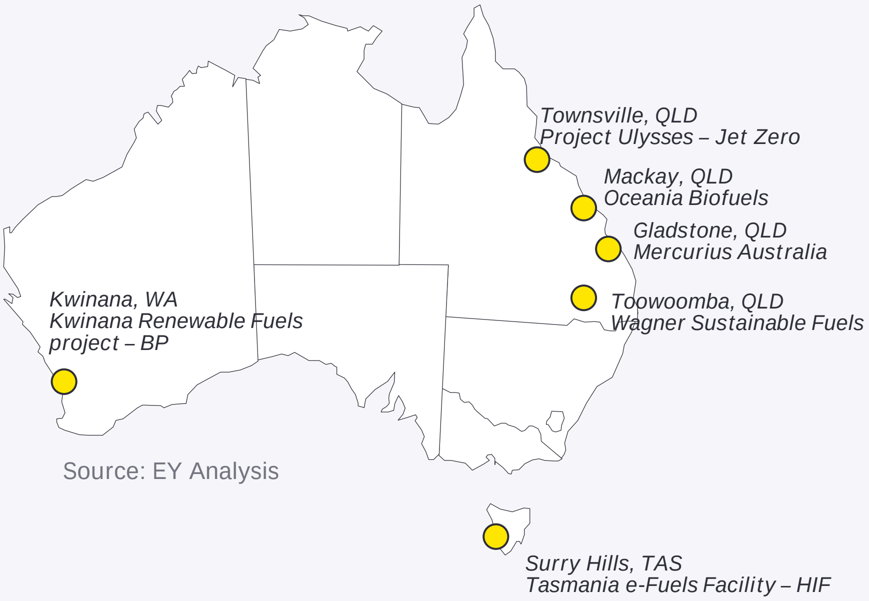
Australian Policy Landscape

Federal Government

In 2023, the Australian Government announced the establishment of the Australian Jet Zero Council to provide advice to the Australian Government on decarbonising the industry, comprised of senior stakeholders from across the aviation industry and its supply chains.[13] The Jet Zero Council has committed to an eight-point work plan which includes advising on the development of a SAF industry and ecosystem in Australia.

Australia has not, as yet, introduced mandates to drive the uptake of SAF, however the 2024 federal budget allocated $18.5 million over four years to develop a certification scheme for sustainable aviation fuels and a further allocation of $1.5 million to assess the costs and benefits of moving to mandates.[14]

Figure 12 – National SAF and biofuel specific projects



Source: EY Analysis

State Governments

Queensland

Focused effort since 2016 has positioned QLD as a key hub for pilot projects and sites for SAF biorefineries. Recent efforts include working with industry to investigate using existing refinery infrastructure to produce SAF, supporting Jet Zero's feasibility study, signing a Memorandum of Understanding with Qantas to collaborate on SAF industry development and working with Airbus on a helicopter trial of SAF.

Western Australia

WA's 2020 Climate Policy prioritises low-carbon transport, aiming for wider adoption of clean fuels (potentially including SAF) alongside renewable energy and H_2 development.

Victoria

VIC's circular economy policy promotes waste reduction and supports projects like converting waste to SAF through a dedicated $10 million fund. This aligns with their H_2 development plan which focuses on clean energy alternatives for the state.

South Australia

SA's Hydrogen Jobs Plan outlines their plans for a renewable driven economy. In 2024 the government signed a MOU with Zero Petroleum who are investigating producing synthetic fuels in South Australia.

New South Wales

NSW has produced an investment prospectus for investors looking to invest in SAF, and outline the government strategy and supports available, as well as the relative advantages of different regions in the state.

Tasmania

TAS's March 2023 Bioenergy Vision explores generating renewable energy from organic waste and residues. It investigates the potential for existing facilities to be converted for biofuel production, potentially displacing natural gas and transport fuels.

Australian Capital Territory

The ACT's Waste Management Strategy, which recognises the potential for bioenergy and incudes an action item to 'Expand bioenergy generation and investigate new energy-from-waste technologies to generate energy'.

Findings

Through analysis of the four dominant SAF pathways and the NT’s competitive positioning, the investigation found:

1

HEFA and PtL pathways show potential for the NT.

A comparison of the NT’s attributes against the various potential SAF technology pathways reveals HEFA (at a small scale due to limited feedstocks) and PtL (at large scale due to high CAPEX requirements) as the strongest opportunities. Current feedstock analysis indicates insufficient resources for AtJ and FT pathways to support a plant. However, the feasibility of each option is dynamic, influenced by technology, markets, investor appetite and policy settings which can shift the viability of a SAF pathway over time.

2

Feedstocks are the primary cost driver for any SAF across the life-cycle of a SAF plant.

Competitively priced inputs are fundamental to the long-term commercial potential of a SAF plant. Careful thought should be given to the availability, sustainability, and regulatory status of potential feedstocks in the long-term before pursuing industry implementation.

3

Aggregating and exporting HEFA feedstock is an opportunity as prices are expected to stay strong.

UCO, tallow and oil seeds have a strong market value and should be aggregated and put to productive use. These HEFA feedstocks could be exported interstate or internationally for biofuel use. These energy dense feedstocks are expected to enjoy strong demand and increasing scarcity, protecting prices overtime.

4

A small-scale HEFA plant could be pursued, subject to securing feedstocks and shoring up local offtake.

HEFA is an established technology that is viable for the NT to produce SAF in the near to medium term to service local demand. The path to commercialisation would require a comprehensive analysis considering factors like cost-effectiveness, environmental impact, opportunity cost, and long-term feedstock availability.

5

PtL's potential depends on emerging renewable and H_2 projects. Its commercial success requires export markets and infrastructure development for economic scalability.

With the right investments, policy support, and industry collaboration, the NT could overcome the current challenges of high capital expenditure and technological immaturity to establish a competitive and sustainable PtL SAF industry. The PtL industry offers a scale opportunity to supply both domestic and export markets. To assess this potential, a detailed examination of forthcoming large-scale utility projects, R&D and commercialisation costs, and demand from key SAF hubs is necessary.

Potential Opportunity

HEFA (Small Scale – Domestic)

Size of Opportunity

> 75,000 tpa*

Plant size

25ML

Price

$1.45/L

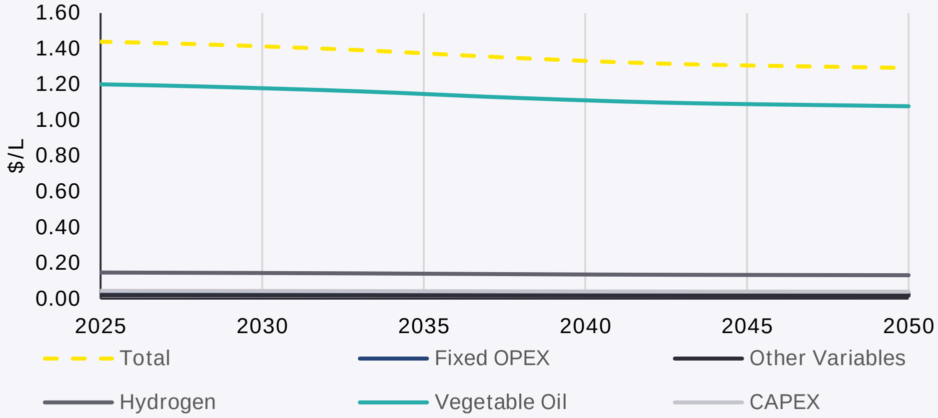
Feedstock cost

83% of LCOP

> Feedstock requirements would be from a combination of potential HEFA feedstocks sources.

CSIRO expects the cost of production for HEFA based SAF to be $1.45/L in 2025 and $1.29/L in 2050. Bio-based feedstocks are the key cost driver, representing 83.40% of the levelised cost of production (LCOP).

Figure 13 – HEFA levelised costs of production ($/L)

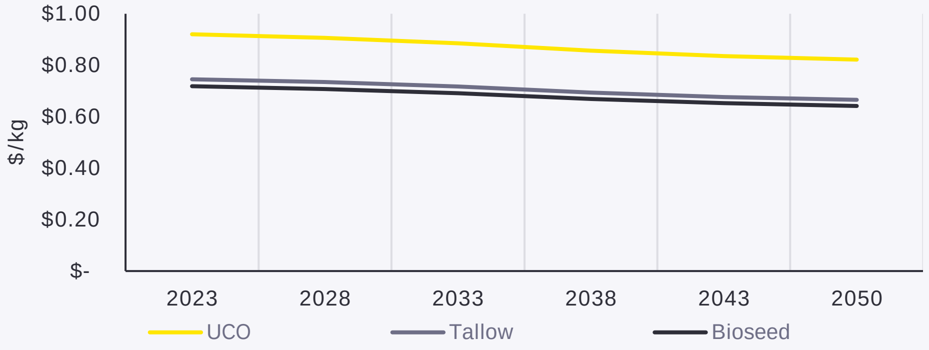


Source: CSIRO, *Sustainable Aviation Fuel Roadmap*

To ensure SAF produced is competitive, feedstocks should be procured at reasonable rates. Generating 1kg of HEFA based SAF requires 1.64kg of UCO,[15] 2.02kg of tallow[16] and 2.10kg of vegetable oils.[17]

On this basis, the feedstock requirements of a 20,000t (approx. 25ML) per annum SAF plant are 32,786t of UCO, 40,485t of tallow and 42,000t of vegetable oils, which should be procured at approximately the following unit costs:

Figure 14 – Price of feedstocks required to achieve the CSIRO jet fuel price



Source: EY analysis, based on CSIRO's *Sustainable Aviation Fuel Roadmap*.

Capital costs for HEFA are proportionately less than for the other technologies,[18] which make a small-scale plant focused on the domestic market a possibility. There is some risk for a producer in this market, secure feedstock supplies, domestic mandates and offtake agreements may provide some certainty.

**Tonnes per annum*

Based on stakeholder consultation with QANTAS and Darwin International Airport

Potential Opportunity

PtL (Large Scale – Export)

Size of Opportunity

Global export

Plant size

300ML

Price

$4.10/L

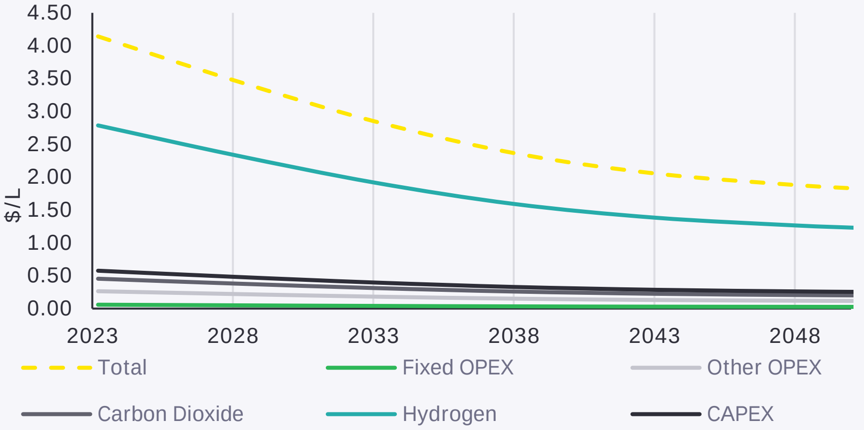
Feedstock cost

67% of LCOP

Large-scale export opportunities provide the NT with a unique prospect to galvanise its renewable endowment.

CSIRO expects the cost of production for PtL based SAF to be $4.10/L in 2025 and $1.80/L in 2050. The cost of H_2, and subsequently the cost of renewable energy, are key cost drivers, representing 67% of the LCOP, as shown in Figure 15.

Figure 15 – PtL levelised costs of production ($/L)



Source: CSIRO, *Sustainable Aviation Fuel Roadmap*

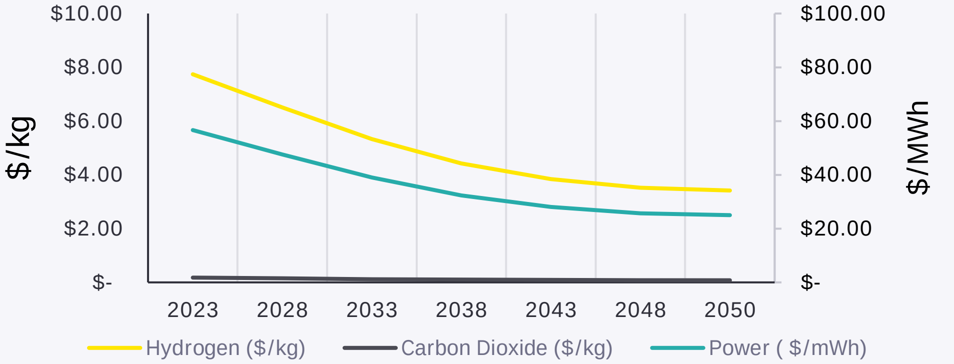
The remaining 33% of the LCOP includes plant establishment capital expenditure (CAPEX) (13.92%), CO_2 (10.97%), fixed operational expenditure (OPEX) (1.43%) and other OPEX (6.39%).

The early stage of the PtL process provides plenty of opportunity to find technical improvements and process efficiencies. Driven by the growth of the renewable H_2 sector and the global uptake of renewable power generation, the cost of PtL based fuel production is expected to more than halve between 2025 and 2050.[19]

To ensure SAF produced is competitive, feedstock commodities should be procured at reasonable rates. The feedstock requirements for 1kg of PtL derived SAF, based on the latest energy-mass balance in literature is approximately 0.45kg of renewable H_2,[20] 3.20kg of sustainably sourced CO_2,[20] and 61.50kWh of renewable energy.[20]

On this basis, the feedstock requirements to feed a 300ML per annum SAF plant are 108kt of renewable H_2, 768kt of sustainably sourced CO_2 and 14,760GWh of renewable energy, which should be procured at approximately the following unit costs:

Figure 16 – Price of feedstocks required to achieve the CSIRO jet fuel price



Source: EY analysis, based on CSIRO's *Sustainable Aviation Fuel Roadmap*

Next Steps

At 100% blend a flight to Sydney needs ~12,500 litres of SAF

A small scale HEFA plant could produce 25M litres of SAF per year or 5.50 flights to Sydney per day using 100% SAF

The SAF market is rapidly growing, driven by the aviation industry's aim for net-zero emissions by 2050, with demand expected to exceed supply for years. The NT, with its location near Southeast Asia, has potential for SAF export despite its current modest demand for jet fuel and limited feedstock like UCO and tallow. Any SAF industry proposal needs to be considered carefully with proper assessment and analysis.

The NT’s natural resource wealth, land availability, and strategic location offer potential for developing a SAF industry, with HEFA and PtL identified as the most promising pathways for near-term and long-term implementation, respectively. AtJ and FT pathways currently lack the feedstocks at scale locally to support a SAF plant.

HEFA technology presents an immediate opportunity for SAF production in the NT that subject to sourcing of feedstocks, domestically and possibly internationally could be further explored. A small-scale HEFA plant could cater to local demand from commercial aviation and defence, subject to securing feedstocks and offtake agreements. Alternatively aggregating and exporting HEFA feedstocks is another point in which the NT can enter the SAF value chain.

PtL technology, while not yet commercialised, could provide scalability and an export opportunity in the long term. The NT's development of renewable energy and green hydrogen infrastructure and products will be critical for PtL's sustainability.

The NT has specific advantages that may support it becoming a player in the global SAF market through the development of PtL technology.

- Abundant renewable energy resources: The NT has potential for renewable energy, which can be harnessed to meet the high energy demands of PtL SAF production.
- Availability of feedstocks: The region has access to the necessary feedstocks for PtL, such as renewable H_2 and CO_2, with the potential for sustainable sourcing and scalability.
- Strategic location for export markets: The NT’s proximity to markets, particularly Singapore’s trading hub, positions it advantageously as a future hub for SAF export.
- Existing infrastructure and industry: The NT’s mature LNG/energy sector provides a foundation for the development of PtL technology, including potential sources of CO_2 and expertise in energy production.
- Supportive government: Darwin H2 Hub, AA Powerlink, and Tiwi H2, have received support from the NT Government, indicating a supportive policy environment for renewable energy and renewable H_2 initiatives.
- Opportunity for leadership: With PtL technology still in its nascent stage globally, the NT has the potential to position itself as a notable player in this field by leveraging its natural resources, existing infrastructure, and strategic initiatives.

The economic viability of SAF production in the NT will be influenced by global cost trends, policy developments, and the competitive landscape. The NT's solar irradiance and proposed infrastructure projects, such as the Middle Arm Sustainable Development Precinct, could support large-scale renewable energy production, essential for PtL SAF pathways.

A key limitation of this study is the focus on sustainable aviation fuels. A SAF production plant is likely to also produce other sustainable fuels which could service other uses such as marine, significantly expanding the size of addressable market. Any investment would be expected to reflect and maintain optionality of products.

The NT Government can play a role in facilitating outcomes by working to identify and consolidate demand while establishing policy settings that will accumulate feedstock.

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