Securing our Fuel Future: Resilience Through Low Carbon Liquid Fuels

This report was written by

Deloitte.

Foreword

Report Context

Australia's growing reliance on overseas fuel imports in an increasingly complex geopolitical environment present an opportunity for a domestic LCLF market to enhance energy independence while supporting decarbonisation.

Several transport subsectors have already identified LCLF as the only practical near-term enabler of decarbonisation, and some LCLF production projects have emerged in response to this perceived demand. But to date, the market has not achieved activation and capital is not flowing.

This report examines the future of fuel refining in Australia and the role of low carbon liquid fuels.

Important Notice

Contents

Executive Summary

Ongoing dependence on imported liquid fuels will represent an increasing resiliency risk to the Australian economy as it decarbonises

Australia consumes **56.5 billion litres** of liquid fuels each year, predominantly diesel and petrol used for road transport, freight, and mining applications.

Australia increasingly relies on fuel imports. Domestic fuel **refining capacity has declined by 70%** over the last two decades, with **fuel imports now costing $50bn each year.** Asia supplies around 90% of liquid fuel imports, with just three countries responsible for the majority of both diesel and jet fuel supplies.

Australia faces increasing fuel security challenges through to 2050. The long-term viability of domestic refineries remains uncertain, with our two remaining facilities providing approximately 14 BL of supply. Without strategic intervention, sectors dependent on liquid fuels risk complete import reliance, exposing them to global market volatility.[2]

Even if electrification trends are maintained, we will still need almost 30BL of liquid fuel in 2050, which is likely to be supplied by imports.

As the economy electrifies, fewer sectors remain exposed to fuel imports. **By 2050, aviation, mining and long-haul freight could account for 80% of liquid fuel demand;** almost double their share of today's fuel mix.

Essential parts of the economy will depend on these liquid fuel dependent sectors for the foreseeable future. There are **up to 375k workers in highly aviation and road freight dependent industries – almost 2.7% of the workforce.**

The emerging economics of low carbon liquid fuels (LCLF) offers a pathway for new Australian fuel production capacity

LCLFs are low emission alternatives to conventional fossil-derived fuels. LCLFs are made from biogenic feedstocks (e.g. sugarcane and tallow) and non-biomass resources (e.g. captured carbon dioxide and hydrogen) through different conversion pathways, depending on the feedstock used. Sustainable Aviation Fuel (SAF) and renewable diesel are examples of LCLFs.

The steady decline of the Australia's refining industry highlights four dimensions essential to competitiveness: (i) feedstock availability and suitability, (ii) scale and cost efficiencies, (iii) domestic demand dynamics, and (iv) policy support.

Like traditional refining, **feedstock costs can account for up to 77% of low carbon liquid fuel production costs.** Scale economies will continue to dominate, both refining and in feedstock value chains. Competitiveness will be driven by the carbon intensity of feedstocks in different markets.

Australia's significant feedstock base and sophisticated agricultural value chains can translate into compelling competitive advantages in LCLF refining. **Australia already exports ~$6bn in feedstocks and produces ~175 ML of first-generation biofuels (ethanol and biodiesel) each year, with capacity for up to ~546 ML of annual production.**

Australia has the components to produce LCLFs at a lower opportunity cost to our current fuel suppliers. Key advantages include: (i) significant and scalable biomass supplies, (ii) bankable feedstock supply chains, (iii) low carbon farming practices, (iv) established agricultural R&D programs to enhance yields and lower carbon intensity, and (v) significant renewable energy potential.

Rising demand for LCLF's is a tailwind for a new wave of advanced domestic refining capacity.

CSIRO estimate that Australia has feedstock potential to supply 8,100 ML of LCLF by 2030 and up to 12,800 ML by 2050.

We can secure our future by accelerating deployment of low carbon liquid fuels to build resilient supply chains with reduced exposure to international forces

CSIRO's LCLF production estimates for Australia would be; enough to displace 19% of expected imports required in 2040, and up to 47% by 2050. Although realising this potential hinges on invest ments in production capacity and feedstock infrastructure.

Australia's current project pipeline represents **almost 2 billion litres of LCLF production potential.** This is the equivalent to all the fuel we imported from Japan in 2024.

Announced projects highlight the intent of Australian market participants to compete with fuel imports with new domestic refining capacity. There are very few operational LCLF plants across our trading partners, with much of this supply needed to meet recently announced mandates.

LCLF production would create new revenue streams for Australia's agricultural producers and waste generators. Substantial capital requirements would attract investment to regional and rural areas with feedstock supply potential. Most significantly, developing LCLF production capacity creates long-term regional employment extending well beyond plant construction and operations. This would align with Australia's existing industrial capabilities while creating new high-value technical positions that would be anchored in regional a reas

Industry players and policymakers have already taken important steps to bring new refining capacity forward. **But we need to take the next step and convert our pipeline into realised investment and operating refineries.** Only then can we derisk our future fuel needs.

Section 1: Reliance on imported liquid fuels

Ongoing dependence on imported liquid fuels will represent an increasing resiliency risk to the Australian economy as it decarbonises

Key takeaways

- **Australia consumes 56.5 BL of liquid fuels each year and only 30% of demand is for passenger vehicles**
- **Five refineries representing 31,660 ML of production capacity have closed in the past 12 years**
- **Australia imports almost 80% of liquid fuels, and just 3 countries account for ~65% of the country's fuel imports**
- **By 2050, 80% of the liquid fuel demand could be concentrated in sectors that are both hard to electrify and critical to Australia's economic function.**

Fuel Dependence: Where are liquid fuels used across the economy?

Australia consumes 56.5 billion litres of liquid fuels each year, mostly diesel and petrol used for road transport, freight, and in mining

Australia uses 56.5 billion litres of liquid fuel each year, more than half of all energy used in the country.[1] These liquid fuels generated about 150 Mt of carbon emissions in 2022-23, making up around 32% of Australia's total emissions.[2]

Diesel is Australia's most-used liquid fuel, with over 32 billion litres used in 2023.[1] Other liquid fuels consumed include petrol, aviation turbine fuel, aviation gasoline, and fuel oil.

Who uses liquid fuels?

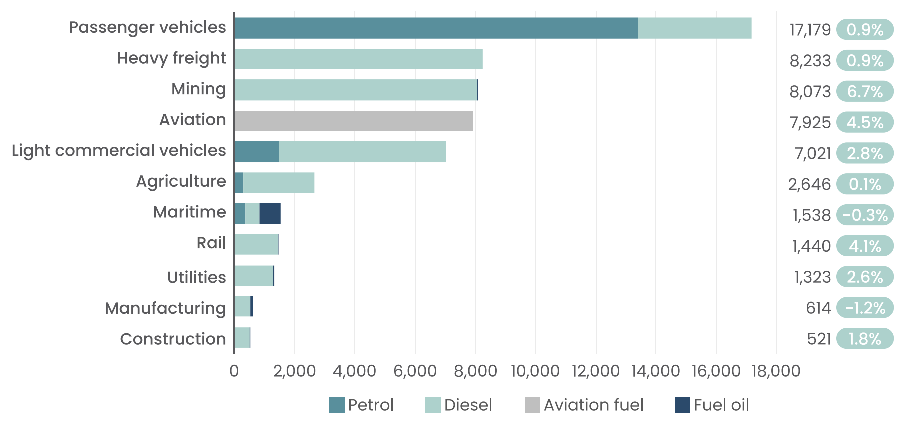
Cars and passenger vehicles use the most liquid fuel – about 30% of the total. These vehicles can be readily replaced by electric alternatives, while other **uses of liquid fuels that do not have low-emissions alternatives available today face bigger challenges in transitioning.** This includes liquid fuel used by freight operations (20%), mining (14%), and aviation (14%) which collectively generate around 85% of liquid fuel-related carbon emissions (see Figure 1).

Why some sectors can't change easily

Freight, mining, and aviation will continue to rely on liquid fuels out into the future. Aviation and shipping are harder to electrify because it is not practical to replace fuel with heavy batteries that can weigh many times more than the plane or ship itself. Similarly, batteries are impractical for long-distance road freight applications. Mining is power intensive and will rely heavily on liquid fuels to power off-road/off-grid applications in remote locations with limited or no access to 24/7 grid electricity.

Australia's liquid fuel consumption has continued to grow, especially in the hard-to-abate sectors.

Figure 1: Australia's liquid fuel use by sector and pre-covid 15-year growth rate[3,4]



Source: 1. Australian Government (**2024**). 2. Deloitte analysis. 3. Deloitte analysis based on DCCEEW (2023), Australian Energy Statistics, Table F. 4. Growth Rate of Road sub-sectors is instead 2012-2018

Rising Tide: Australia increasingly relies on fuel imports

Australia's domestic fuel refining capacity and capability has declined by 70% over the last two decades, with fuel imports now costing $50bn each year

Growing fuel imports

Five refineries representing 31,660 ML of liquid fuel production capacity have closed in the past 12 years.[3] In the past, Australia has had up to eight operational refineries that met most of domestic fuel demand but have closed over time or converted into coastal terminals for importing and storing fuel. These closures began around the world in 2005-2006, attributed to tight profit margins of mature refining markets and an expansion of more efficient refining capacity in Asia and the Middle East led to excess global supply. [4]

Current refining landscape

Australia now has two refineries left, and varying levels of government support are provided to keep them competitive. Ampol's Lytton refinery (Qld) and Viva Energy's Geelong refinery (Vic) collectively retain 13,770 ML/year of onshore refining capacity. These aging facilities face viability challenges during periods of low global oil prices that can compress their profit margins unsustainably. In response, the Australian Government's Fuel Security Services Payment scheme provides financial support when margins deteriorate below viable level - $37m has been drawn down since the scheme began in 2021.[5]

Relying more on imported fuel

Australia's reliance on imported fuels has reached approximately 80% of total consumption. Refined petroleum is Australia's largest import by value at more than A$50.7 billion in 2023. This is equivalent to ~9% of the total value of Australia's top 25 imports in goods and services and 12% of all imported goods.[2] As seen in Figure 2, imports of total refined petroleum products have consistently increased from 2010 to 2024 as refineries closed over time. The 2024 import mix was dominated by diesel (~60%) and aviation turbine fuel (~15%).[6] Figure 3 shows that fuel imports have continued to grow consistently and now accounts for ~10% of all imports by value.

Figure 2: Australia's share of refined petroleum products as supplied by domestic production and imports, 2010 – 2024[1]

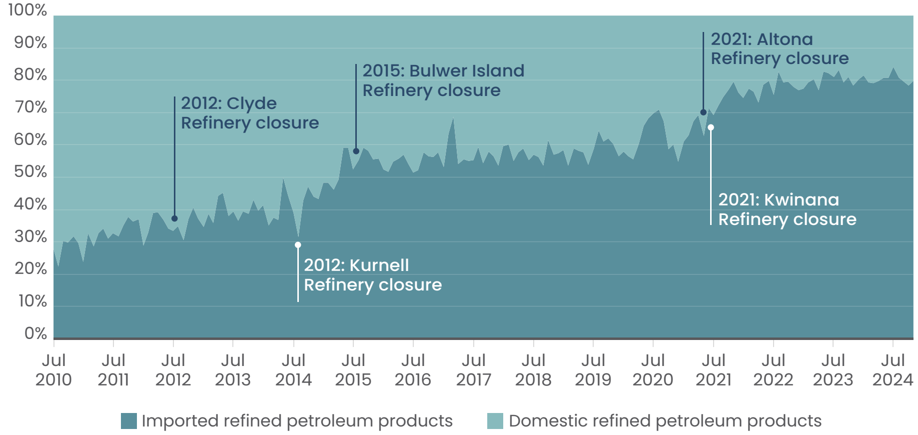
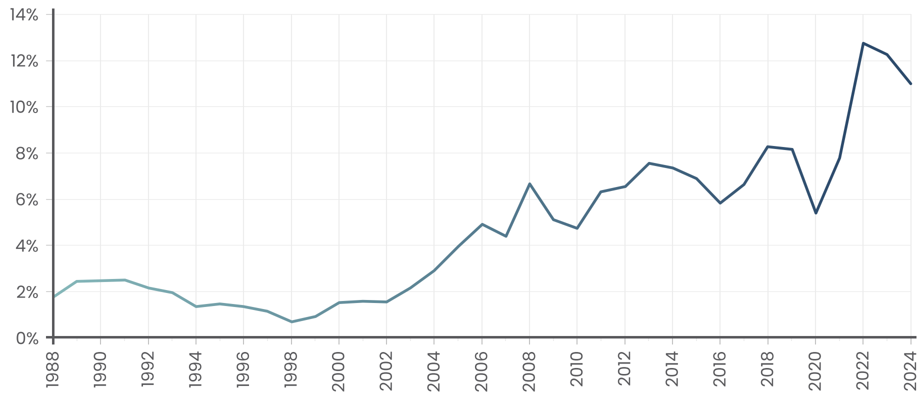


Figure 3: Australian fuel imports as a share of all imports by value[2]



Source: 1. DCCEEW (**2024**). Analysis includes automotive gasoline, aviation turbine fuel, diesel oil and fuel oil. 2. ABS International Trade in Goods (**2024**). 3. Parliament of Australia (**2020**). 4. APH Economics Committee (**2013**). 5. DCCEEW (**2025**). 6. Australian Petroleum Statistics (**2024**).

Crude Awakening: Asian refineries are a key dependency for Australian fuel users

Australia relies on Asia for around 90% of liquid fuel imports, with 60% of imported product derived from Middle Eastern crude

Profiling Australia's fuel suppliers

Australia's liquid fuel supply chain is reliant on Asian refineries with over 90% of refined petroleum products sourced from regional suppliers (Figure 4). While overall regional dependency has remained stable, the supplier landscape has evolved significantly, with China, South Korea, and Singapore emerging as dominant suppliers.

Supply concentration risk is particularly acute in diesel and jet fuel markets. The diesel import market shows high concentration, with South Korea (35%), Malaysia (17%) and Singapore (13%) controlling 65% of supply. Jet fuel demonstrates similar vulnerability, with China (30%),South Korean (29%) and Singapore (18%) accounting for 77% of imports (Figure 5).

Meanwhile, Australian fuel imports from other regions have decreased or are limited. Japan's contribution has contracted since 2019 to 7% of diesel imports, while India maintains a modest 11% share of diesel and 4% jet fuel imports. Less than 1% of total diesel imports are sourced from the United States.

Geographic concentration presents multiple strategic vulnerabilities:

- **Supply chain disruption risk:** Australia's heavy reliance on Asian refineries leaves essential national infrastructure exposed to regional disruptions. A single major incident in Southeast Asia or North Asia could impact Australia's fuel availability and affect all sectors.
- **Economic security risk:** Australia's economy is particularly vulnerable to fuel supply disruptions. With diesel powering the mining sector and national freight network, and jet fuel essential to tourism and domestic connectivity, supply interruptions could trigger widespread economic impacts.
- **Defence capability implications:** Australia's defence capabilities may face heightened risk from the concentration of fuel imports. With 30% of jet fuel from China and 35% of diesel from South Korea, any regional tensions could directly impact Australian Defence Force readiness and operational capacity, which required 227.3 ML jet fuel, 66.2 ML marine diesel, and 18.4 ML automotive diesel in 2020/21.[2]

Figure 4: Top 8 importing countries for refined petroleum 2010 – 2024[1]

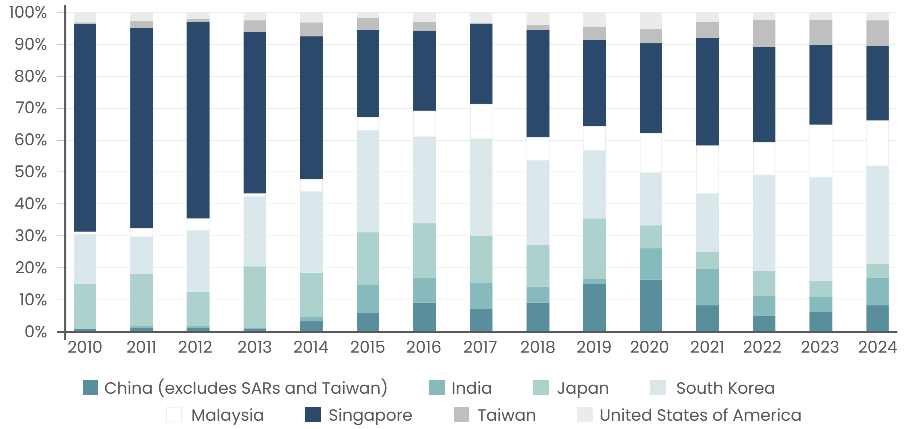
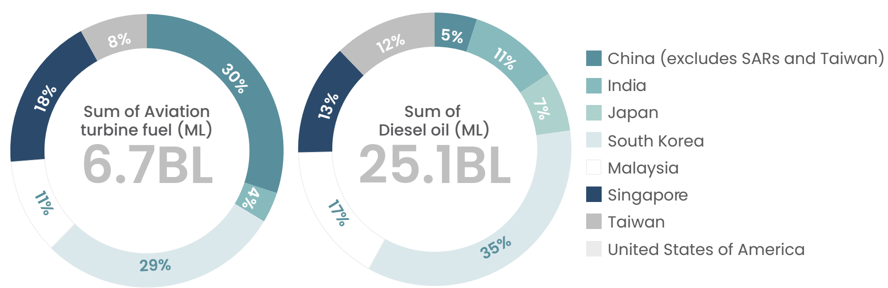


Figure 5: Country market share for Australian diesel and jet fuel imports, 2024



Source: 1. DCCEEW (**2024**), 2. Defence (**2024**).

Concentration Risk: Key sectors of the economy will continue to rely on fuel imports

Aviation, mining and long-haul freight could account for 80% of liquid fuel demand by 2050. This is almost double their share of today's fuel mix

Continued reliance on liquid fuels

Key sectors will remain dependent on liquid fuels despite electrification opportunities. While there is an opportunity to partially decarbonise our economy through electrification (such as electric passenger and light vehicles), several hard-to-abate sectors will continue to drive significant liquid fuel demand.

These sectors will increase their share of liquid fuel consumption. Aviation, heavy freight and mining made up 42% of national liquid fuel demand in 2022-2023 and are on track to reach 64% by 2040, and 80% by 2050 (see Figure 6).

Australia faces increasing fuel security challenges through to 2050. The long-term viability of domestic refineries remains uncertain, with our two remaining facilities providing approximately 14 BL of supply. Without strategic intervention, sectors dependent on liquid fuels risk complete import reliance, exposing them to global market volatility.[2]

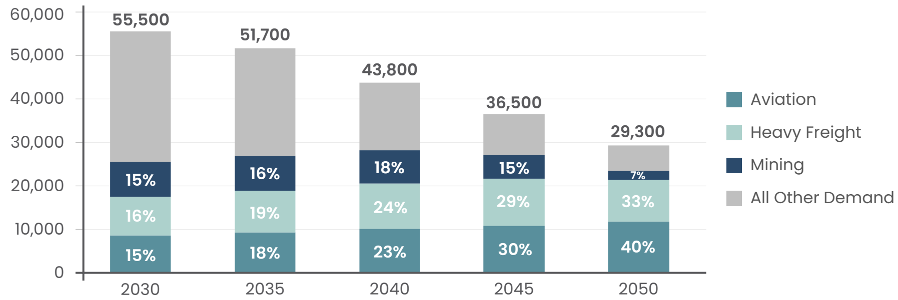
The low carbon liquid fuels (LCLFs) opportunity

LCLFs offer a strategic pathway to fuel security and decarbonisation. LCLFs, produced through chemical conversion of biomass and non-biomass resources, present a viable solution for sectors facing delayed electrification or require longer-term hydrogen alternatives.

Australia has established capabilities and growth potential in LCLF production. Australia has a substantial pipeline of announced LCLF projects including sustainable aviation fuel (SAF) and renewable diesel (RD) that build on existing first-generation biofuel production (ethanol and biodiesel). Refer to Appendix 2 for an overview of LCLFs.

Major fuel users support domestic LCLF production for enhanced fuel security. Aviation, heavy freight and mining sectors actively advocate for Australian LCLF refineries to strengthen supply chain resilience[3] which would also benefit agriculture, construction, and maritime sectors.

Figure 6: Evolution of residual liquid fuel demand by sector, ML[1]



Source: 1. Based on Deloitte modelling in Appendix, 2. The security outlook for diesel has led to some mines to transition to alternative power sources – for example those provided by **Zenith Energy**, 3. For example in submissions to a recent **DITRDCA consultation** on LCLFs

Cost and Consequence: Essential parts of the economy may remain dependent on liquid fuel

Essential parts of the economy may remain dependent on liquid fuel, with at least 375k workers in aviation and road freight dependent industries depending on ongoing liquid fuel supplies

Liquid fuel dependent sectors

Essential sectors of the Australian economy remain fundamentally dependent on liquid fuels. Table 1 analyses key downstream sectors reliant on aviation and heavy freight transport, highlighting systemic vulnerabilities in our supply chain.

Aviation dependencies span critical national services and economic drivers. The aviation-dependent sector encompasses approximately 713,000 workers across tourism, healthcare logistics, and essential services. The tourism industry's recovery trajectory depends heavily on reliable aviation fuel supply for international and domestic travel. Time-critical pharmaceutical distribution, including vaccines and sensitive biologics, requires consistent air freight capacity to maintain product efficacy and meet healthcare demands.[1]

Road freight underpins half of Australia's total freight task by value. This sector, employing approximately 69,000 workers, services essential industries including healthcare logistics. Specialised requirements like cold chain logistics demand purpose-built vehicles with refrigeration capabilities, making alternative fuel sources particularly challenging to implement.[2]

Mining sector fuel disruptions can create cascading economic impacts. Productivity constraints in mining operations due to fuel supply issues could generate significant opportunity costs, affecting Australia's ability to meet global demand for its rocks, minerals, and natural gas. These impacts extend through manufacturing, automotive, and renewable energy supply chains, all of which depend on reliable mineral production.

Maritime transport remains critical to Australia's trade position. With 87% of international trade volume moving by sea4, Australia's key export commodities - including iron ore, coal, and natural gas - depend entirely on maritime fuel security. As Australia's reliance on Asian fuel suppliers grows, so too will the exposure to geopolitical risks in the region. Instability or conflict could disrupt supply chains, causing fuel shortages, price volatility, and delays in export shipments, directly impacting Australia's economic stability and global competitiveness.

Table 1: Sample of downstream sectors dependent on aviation and heavy freight[3]

Downstream sector	Transport segment	Dependence on transport mode (%)	Value moved ($billion)	Employment
Domestic tourism	Aviation	22%	24.3 bn	105,721
International tourism	Aviation	85%	41.1 bn	179,306
Pharmaceutical products[4]	Aviation	31%	3.9 bn	21,700
Pharmaceutical products[5]	Heavy freight	5.8%	0.7 bn	4,060
Beverages	Heavy freight	41%	1.6 bn	12,177
Cold chain	Heavy freight	14%	1.1 bn	53,011

Source: 1. Avion Australia (**2024**), 2. Transvirtual (**2024**), 3. See Appendix 3 for calculations and sources. 4. Assuming these are Australian manufactured medical products exported. 5. Assuming heavy freight accounts for imported medical products. 4. Australian Government (**2023**).

Section 2: Opportunity for low carbon liquid fuels

The emerging economics of low carbon liquid fuels offers a pathway for new Australian fuel production capacity

Key takeaways

- **Scale disadvantages and high costs meant traditional refineries were less competitive than regional Asian competitors.**
- **Australia has exceptional LCLF potential due to its significant feedstock advantage that is 40 times domestic requirements and established agricultural export infrastructure.**
- **Transitioning from traditional to LCLF refining addresses historic competitive disadvantages by leveraging Australia's agricultural strength, emerging policy support, and sustained demand from hard-to-electrify sectors.**
- **LCLF economics are fundamentally different – feedstock costs dominate up to 77% of costs, with technology, infrastructure and proximity to renewable energy crucial.**

Traditional Refining: Australian refineries became less competitive over time

The steady decline of Australian refining & rise of our biggest liquid fuel trade partners highlight 4 dimensions of competitiveness

Competitiveness Drivers for Refining

1. Feedstock availability and suitability

Australia's refineries were generally set up to refine heavy crude oils and transitioned to crude imports after Australian crude output began to decline. As a result, Australia imported crude oil from over 20 countries to meet domestic demand.1 Most crude production is located long distances from refineries and has better transport proximity to export markets in Asia.[2]

2. Scale and cost efficiencies

Australian refineries are unable to achieve economies of scale like the larger Asian refineries. Refineries in South Korea produce between 30 to 50 billion litres per annum, while Australia's current largest refinery (Geelong) has capacity of ~7.5 billion litres per year (see Figure 7). Labour costs in Australia are ~2.3 times higher than South Korea and 7 times higher than India.3 Recently, refining margins have gone low enough to trigger the Fuel Security Services Payment (FSSP).

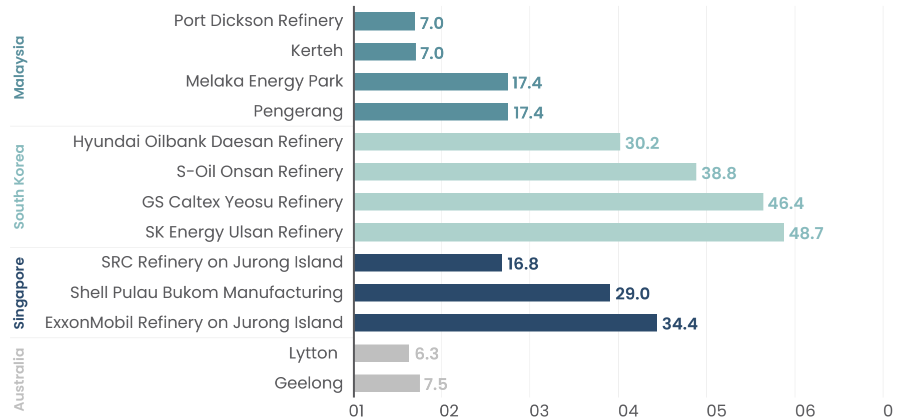
3. Domestic demand dynamics

Australia's largest fuel users (excluding passenger), face the challenge of either having fuel as a significant part of their cost base and margin pressures (for aviation and road freight) or compete on export markets (mining) where marginal costs are important in cyclical commodity markets. These dynamics make Australian liquid fuel users highly price sensitive and unwilling to recognise a premium for locally supplied product.

4. Policy support

Governments in Asia offer attractive policies for oil refineries including substantial tax rebates (up to 76% for refiners in Singapore for 2024-45[4]), deemed strategic importance under the Significant Investments Review Act in Singapore, and other tax incentives. In Australia, the FSSP was only introduced in July 2021 after the closure of BP's Kwinana refinery in Western Australia, one of the last remaining refineries.

Figure 7: Oil refinery capacity in Australia compared to large oil refineries in major liquid fuel importing countries, BL per year[5]



Source: 1. AIP (**2022**), 2. AIP (**2017**), 3. Commonwealth of Australia (**2013**), 4. ASEAN Briefing (**2024**), 5. Various sources.

New Equation: A new economics of low carbon liquid fuel refining is emerging

Feedstocks account for up to 77% of low carbon liquid fuel production costs, however, Australia could produce lower-cost fuels through using low-cost feedstocks and leveraging its comparative advantages

Definition | **Low Carbon Liquid Fuel (LCLF)**

Low Carbon Liquid Fuels (LCLFs) are low emissions alternatives to conventional fossil fuels. LCLFs can be produced from biogenic feedstocks (e.g. oilseeds, wastes, biomass and residues), or from non-biomass resources through chemical processes (e.g. combining hydrogen and carbon dioxide). Depending on the feedstock, different conversion pathways are used to convert feedstocks into LCLFs. LCLFs can serve as drop-in fuels within existing infrastructure. Sustainable Aviation Fuels (SAF) and Renewable Diesel (RD) are examples of LCLFs that provide the potential to decarbonise key sectors of the Australian economy which have been reliant on liquid fossil fuels. This includes aviation, transport, mining, and agriculture sectors amongst others.

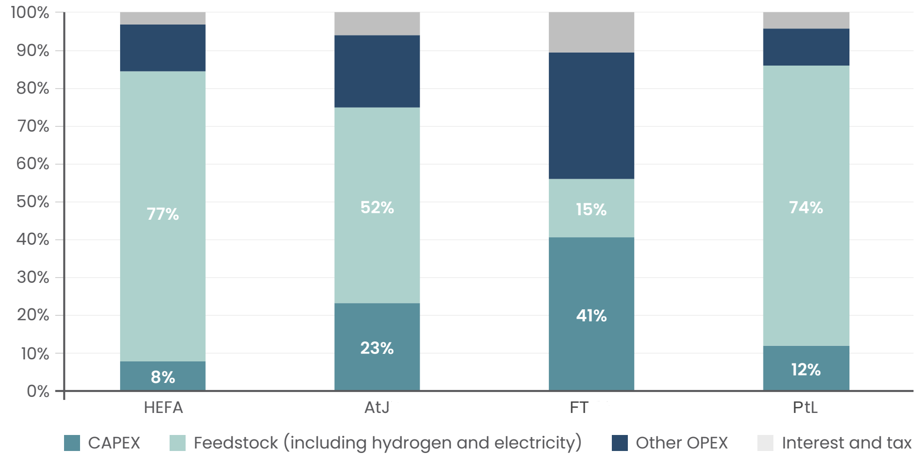
Drivers of LCLF production costs

Feedstock costs are a significant cost driver and could account for up to 77% of LCLF production costs, depending on how it is made (see Figure 8). Yield variability due to weather or unforeseen events is a major risk affecting biomass availability and feedstock costs. However, Australia has some of the most advanced farming practices in the world, and enhancing the efficiency of biomass production through our existing expertise could lower feedstock costs. The potential for novel feedstocks, such as pongamia, is also being investigated in Australia. These non-edible crops mitigate some risks, such as competition with food.

Technology and infrastructure is also a large cost component, especially around efficiency of feedstock collection and transport ecosystems, and the efficiency of processing technologies. These costs could account for up to 41% of production cost, depending on pathway.

Importantly, **proximity to variable renewable energy (VRE) and carbon capture and storage (CCS) will be key to lowering process emissions and increasing the value of fuel.** The most cost competitive regions will be able to optimise across the full value chain and integrate with other products.

Figure 8: Cost breakdown of 2030 fuel costs by production pathway[1]



Source: 1. Deloitte Low Carbon Liquid Fuel Model.

Strong Foundations: Australia has significant competitive advantages in LCLFs

Global agricultural leadership & strong participation in international supply chains offer Australia a pathway to cost-competitive LCLF supply

Australia's advantages as a leading producer

Australia possesses a decisive feedstock advantage over major LCLF producers. While the US and Brazil operate with feedstock markets that are triple their fuel markets, Australia's feedstock capacity is 40 times its fuel market requirements (Figure 9), representing a transformational difference for competitive production.1 This ratio of feedstock availability to market demand positions Australia to potentially become a dominant force in LCLF production, as it ensures stable supply chains and could provide significant cost advantages through economies of scale.

This advantage spans both established and emerging feedstocks for LCLF (Figure 10):

- First-generation sources (oilseeds and carbohydrates),
- Second-generation materials (wastes, lignocelluslosic biomass), and
- Novel feedstocks like pongamia, now under active Queensland Government research.

Australia's current market position reinforces this potential. Australia already exports 70% of its canola and over 80% of tallow and used cooking oil (UCO)2 – volumes that could pivot to domestic production under the right policy incentives.

This competitive edge extends beyond volume to sustainability credentials, with Australian grown feedstocks having higher abatement potential per tonne relative to global markets. This distinction merits recalibration of standard global carbon values (which are typically based on US GREET modelling) to capture the enhanced environmental premium of Australian feedstocks. This shift could substantially improve calculated abatement economics.

Figure 9: Australia's current main LCLF and biogenic feedstocks compared[1]

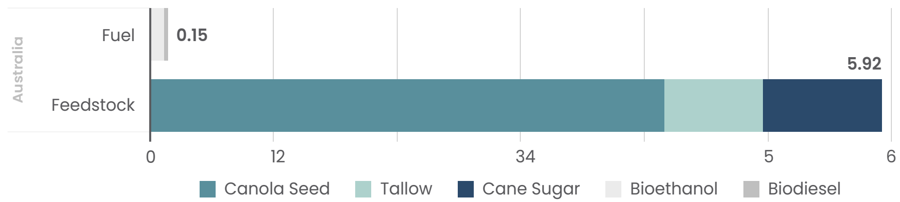
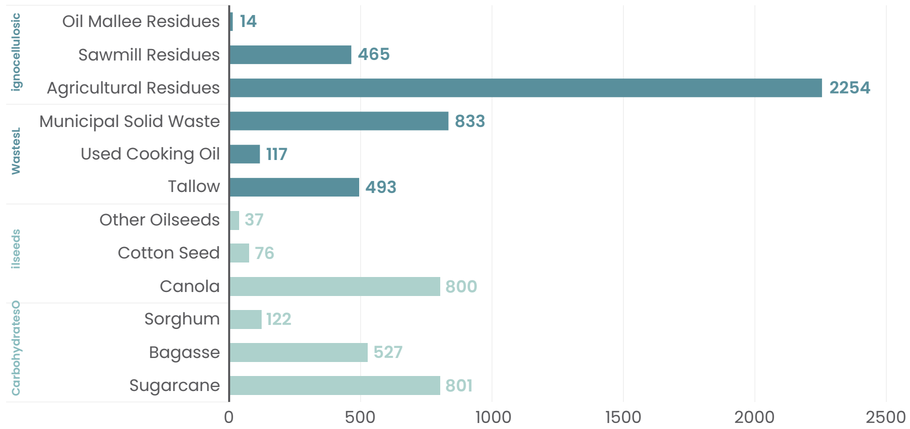


Figure 10: 2030 estimated annual LCLF production volumes, ML[3]



Source: 1. Deloitte analysis. 2. Australian Government (**2023**). 3. The projected Australian feedstock availability data is consistent with work previously completed by CSIRO; Sustainable Aviation Fuel Roadmap (**2023**).

Reversal of Fortunes: Low carbon liquid fuels are a pathway to new domestic refining capacity

Rising demand for low carbon liquid fuels is a tailwind for a new wave of advanced domestic refining capacity

Competitiveness divers	From traditional refining	To LCLFs	Why Australia is strongly placed
1. Feedstock availability and suitability	Declining production of crude oil and unsuitable crudes for production in Australian refineries	Producer and exporter of a diverse range of suitable feedstocks for LCLFs	Australia is currently already a major feedstock producer, exporting substantial volumes of agriculture-based feedstocks to the US, EU, and Singapore. For example, Australia is a major exporter of canola to the EU biodiesel market and around 60% of domestically produced canola is exported annually to European countries[1,2]
2. Scale and cost efficiencies	High costs of production due to subscale refineries	Cost competitiveness in a global market due to strong agricultural industry, R&D, and new economics	Australia has an abundance of biomass and feedstock to support the production of LCLFs. The country's large landmass, climate, and advanced farming practices position it well to expand existing feedstock supplies. Existing expertise and skills in grain and oilseed production practices offer a scalable source of low-carbon feedstock with established supply chains
3. Domestic demand dynamics	Fuel as a significant component of cost base and thin margins	Scaled demand from mining, aviation, and other later to electrify sectors	Electrification cannot remove the need for fuel imports and liquid fuel use will remain dominant over the next two decades. Aviation, heavy freight, mining, maritime, agriculture and construction sectors will demand a significant amount of liquid fuel out to 2050.
4. Policy support	Delayed and minimal policy incentives for refining capacity and capability	Introduction of several targeted federal and state government measures to develop a LCLF industry	The Australian Government has identified LCLFs as a key enabling technology that will be considered in its six sectoral emissions reduction plans under the Net Zero Plan. The six sectoral plans cover electricity and energy, transport, industry, agriculture and land, resources, and the built environment. The LCLF industry has also been identified as a priority industry under the Future Made in Australia agenda, and the ARENA is playing a key role in supporting LCLF projects, such as through the $30 million SAF initiative. State governments are also investing to support investigation of potential feedstocks.

Source: 1. CSIRO (**2023**). 2. Australian Export Grains Innovation Centre (**2025**).

Section 3: Securing our fuel future through low carbon liquid fuels

We can secure our future by accelerating deployment of low carbon liquid fuels to build resilient supply chains with reduced exposure to international forces

Key takeaways

- **LCLF could displace 19% of Australia's fuel imports by 2040 and 47% by 2050, through a diversified LCLF production technology portfolio.**
- **Australia's planned 1,975 ML of LCLF production capacity is globally significant, and underutilised capacity at existing facilities shows immediate scale-up potential.**
- **Planned biorefining capacity rivals competitors in Asia, with a strategic advantage: their demand mandates create a protected export market for Australian LCLF.**
- **The employment multiplier potential of LCLF runs deepest in regional and rural Australia – a US case study shows one facility can create over 1,400 high-value jobs.**

Scaling Up: Australia has the potential to develop significant new LCLF refining capacity

CSIRO estimate that Australia could produce 8,100 ML of LCLFs by 2040 and 12,800 ML by 2050; enough to displace almost 20% of expected imports required in 2040

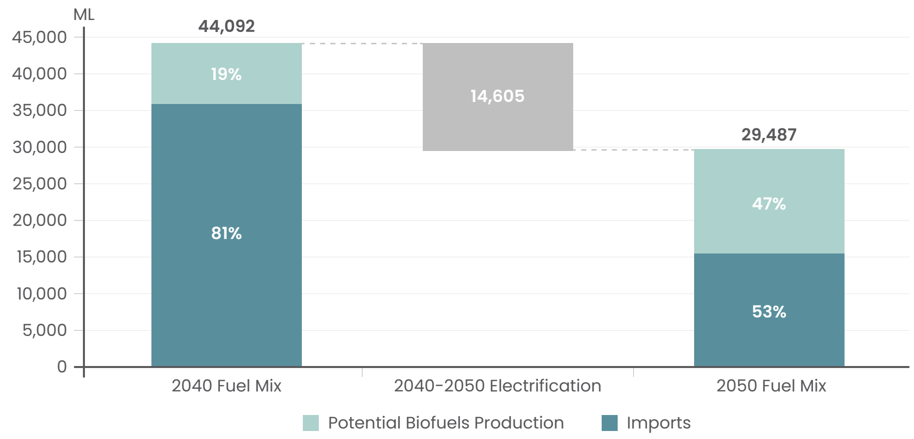
Australian production potential

Australia's domestic LCLF potential represents a strategic opportunity to reshape our fuel security architecture. CSIRO projections for the aviation sector outline Australia's natural competitive advantages and biomass availability could support large-scale production facilities of up to 300 ML per year, and projects underway expect 450-500 ML per year.1 CSIRO's analysis (Figure 11) indicates this could deliver ~8,200 ML of biofuel production by 2040, scaling to ~14,000 ML ML by 2050 – sufficient to displace approximately 20% of forecast imports in 2040, up to 47% in 2050. **Combined with electrification, LCLF deployment could reduce fuel imports by 60% between 2040 and 2050.**

This production potential would be diversified across four distinct production technology pathways – HEFA, Alcohol-to-Jet, Fischer-Tropsch and Power-to-Liquid. These pathways which draw on varied feedstock sources will enhance system resilience by reducing technological risk and enabling optimisation of production scales across different feedstock types.

The strategic value of scaled domestic production extends beyond fuel security to significant economic benefits. Displacing fuel imports represents substantial economic opportunity through reduced exposure to international market volatility, billions in avoided fuel import costs, increased domestic investment potential, and enhanced economic resilience.

Figure 11: Theoretical contribution of biofuels to Australia's residual fuel mix in 2040 and 2050, ML[1]



Source: 1. CSIRO (**2023**).

Immediate Term: Biodiesel and ethanol

Existing biofuel capability and capacity presents an immediate opportunity to diversify Australia's fuel mix

Existing fuel production

The majority of this report is focused on the potential to scale up of LCLF production capacity in Australia between now and 2030. However, the opportunity to contribute to fuel security from existing ethanol and biodiesel production should not be overlooked.

In 2022, Australia's ethanol refineries produced approximately ~175 ML from two facilities located in Sarina, Queensland, and Nowra, New South Wales. The Dalby bio-refinery in Queensland, which has an ethanol production capacity of 76 ML, has been mothballed since 2020. There exists latent production capacity to increase domestic ethanol production to ~436 ML annually providing opportunities for this fuel to be blended with petrol for road transport or be utilised as a feedstock for conversion to Sustainable Aviation Fuel (SAF). The absence of effective State and Federal policy to support, means ethanol production remains below capacity due to the absence of a strong market domestically.

While Australia has three biodiesel refineries, their combined production in 2023 is estimated at around 1,500 L only.6 This is around 1.5% of installed biodiesel annual refining capacity of 110 ML. The processes to produce biodiesel are mature and this fuel is compatible with existing infrastructure and vehicles including in the mining, shipping, heavy road and construction industries.

Enhancing Australian production of ethanol and biodiesel presents an immediate opportunity to enhance Australia's fuel security.

However, in the absence of effective policy to create the market conditions for the increase in production from these facilities, it is likely that the domestic production volumes of biodiesel and ethanol will remain similar to current levels.

Table 2: Commercially operating Gen-1 Biofuel facilities in Australia

Name	State	Liquid Fuel	Capacity (ML)	Feedstock
Wilmar Sugar – Sarina Refinery[1]	Qld	Ethanol	60	Sugar by-products (molasses)
Manildra Group – Shoalhaven Starches[2]	NSW	Ethanol	300	Wheat starch
Eco Tech Biodiesel[3]	Qld	Biodiesel	30	Waste streams and by-products
Biodiesel Industries Australia[4]	NSW	Biodiesel	20	Used Cooking Oils (UCO)
Just Biodiesel[5]	Vic	Biodiesel	60	Tallow, UCO

Opportunity **Immediate fuel security**

Australia's Gen-1 biofuel facilities are running at low utilisation and could substantially scale up. If Australia needs to respond to fuel supply disruptions, these facilities could potentially help preserve Australia's fuel reserves through blending with conventional fuels.

Australia could produce up to 212 ML of SAF if our two ethanol facilities are producing at capacity (this is assuming 100% SAF production). Similarly, if the three biodiesel facilities are producing at capacity, approximately 1,100 ML of fuel could be supported, assuming a B10 blend.

Modest investments would be required to realise these opportunities.

Source: 1. Wilmar (**2024**), 2. Manildra (**2022**), 3. Eco Tech (**2025**), 4. Australian Biodiesel Producers (**2024**), 5. ARENA (**2025**), 6. DCCEEW (**2024**) – note, the Guide to Australian Energy Statistics (**2024**) assumes biodiesel consumption is equal to Australian production.

Near to Longer Term: SAF and renewable diesel

Australia's LCLF pipeline represents 1,975 ML in new capacity – equivalent to all the fuel we imported from Japan in 2024

Announced project pipeline

Australia's pipeline of SAF and renewable diesel (RD) projects offers potential to scale up LCLF production in the medium to longer term.

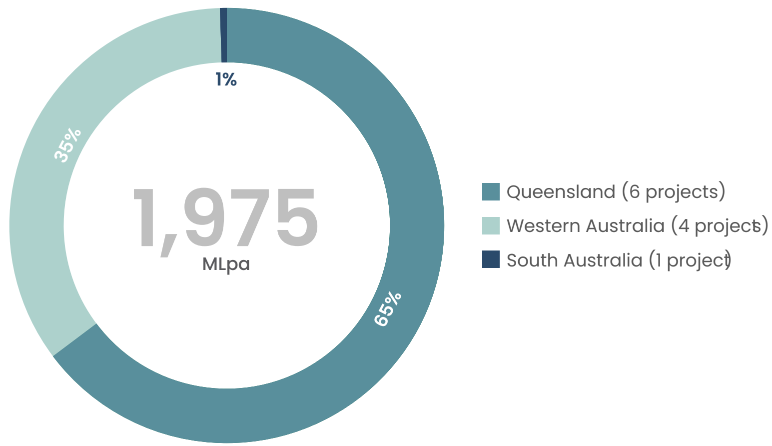
10 LCLF projects have been announced across Australia. Around half of these projects are at an advanced development stage, with project concepts now transitioning to engineering development stage. These projects could leverage existing Gen-1 facilities as feedstock suppliers, accelerating their commercial development.

Queensland is strongly positioned as an emerging LCLF hub in Australia, with 6 announced projects representing ~65% of total announced capacity and 3 projects at an advanced stage of development (see Figure 12). These projects will use a range of biomass, oilseed, waste oil, wastes, and bioethanol feedstocks, which will be converted into LCLF through Hydroprocessed Esters and Fatty Acids (HEFA), Hydrothermal liquefaction (HTL), Alcohol-to-Jet (AtJ) or Fischer Tropsch (FT) pathways.

Western Australia represents approximately 35% of the announced LCLF capacity nationally with four projects underway. These projects will use canola oil, biomass, and waste lignocellulose and use one of the HEFA, FT, or AtJ pathways to convert feedstock into fuel. The project in South Australia will use green hydrogen and the PtL pathway.

Australia's project pipeline represents a transformational scale. At 1,975 ML per year (Figure 12), these projects are equivalent to fuelling Australia's Rail and Maritime sectors for a year. The range of feedstocks for these projects also demonstrates future sector resilience through a diverse feedstock base.

Figure 12: Capacity of announced LCLF projects in Australia[2]



Source: 1. CSIRO (**2023**). 2. ARENA (**2025**).

Regional Advantages: Australia's pipeline is comparable to our major fuel trading partners

Australia has a comparable project pipeline to our major fuel trade partners, with rising regional demand offering export potential

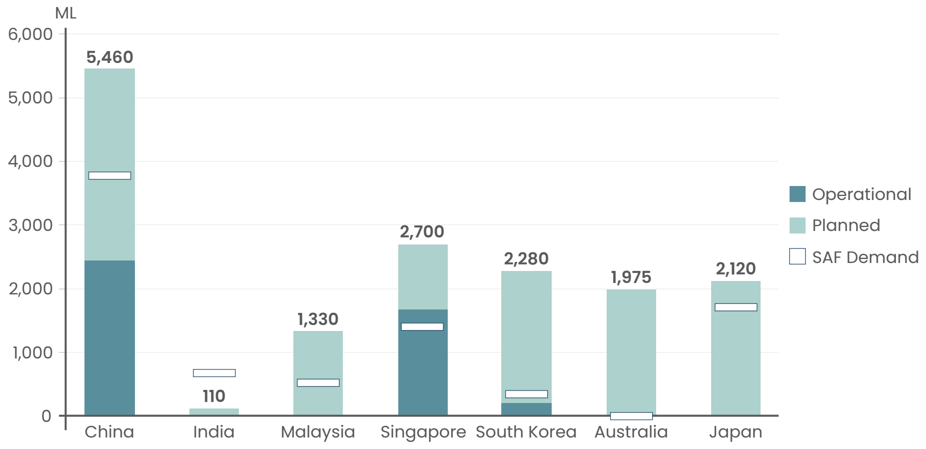
Australia is positioned to be a significant regional market participant, with emerging LCLF production capacity aligned with regional market dynamics (Figure 13). Current project pipelines show Australia developing nearly 2,000 ML of capacity, comparable to other emerging regional players like South Korea (2,300 ML) and Japan (2,100 ML).[1,2]

Emerging regional supply-demand dynamics may create a market opportunity for Australia. While planned capacity across Asia shown in Figure 13 is substantial, these volumes will largely be committed to meeting mandated demand2 in each of the countries, creating a gap in export availability. This presents two interconnected advantages for Australian production:

1. **Regional producers' inward focus on domestic mandates will create protected demand for Australian LCLF exports** through reduced competitive pressure during critical early-stage market establishment.
2. **Australia's LCLF production capacity could serve as a regional buffer,** providing supply security to trading partners when their production is constrained or disrupted.

Australia's natural advantages support this market position and the broader potential to be a low-cost producer of LCLFs in the long-term. Current feedstock exports – including 70% of canola and 80% of used cooking oil (UCO) production – demonstrate potential .[1]

Figure 13: Operational and planned LCLF facilities by market and estimated mandate demand, ML1, [2]



Source: 1. Based on Deloitte LCLF Project Database. 2. Projections based on 2023 jet fuel uptake escalated to 2030 and announced mandates from the **SAF Observatory**.

Dividend: Regional Australia stands to benefit the most from a low carbon liquid fuels industry

Benefits of LCLF refining include new feedstock contracts, direct investment, ongoing supply chain jobs, and avoided emissions

Developing domestic LCLF production capacity holds compelling potential for regional Australia's agricultural and industrial sectors, with several key impacts.

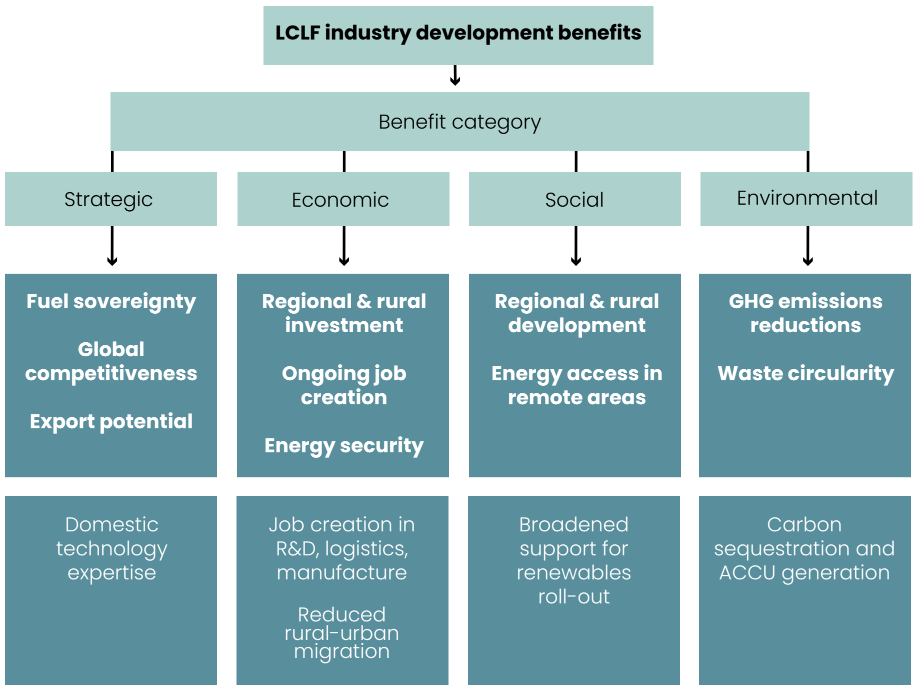
LCLF production would create new revenue streams for Australia's agricultural producers and waste generators. Rather than competing with existing commodity markets, LCLF feedstock demand would create premium offtake opportunities for agricultural residues, energy crops, and waste biomass feedstocks that can either be expanded or have limited commercial value currently. Projections by the Rhodium Group of a single 190 ML facility in the US show the feedstock supply chains can generate ongoing revenue for hundreds of regional producers.[1]

Substantial capital requirements would attract investment to regional and rural areas with feedstock supply potential. Infrastructure requirements would span feedstock aggregation, pre-processing, facilities, and refining capacity, generating thousands of jobs annually during construction across engineering, manufacturing, and technical services.[1]

Most significantly, developing LCLF production capacity creates long-term regional employment extending well beyond plant construction and operations. US projections indicate a single facility could support 1,440 ongoing jobs, with 38% in direct operations and 62% in supporting supply chains. The employment profile is diverse – from agricultural workers (25% of positions) to skilled trades, engineers, and logistics roles.[1] **This would align with Australia's existing industrial capabilities while creating new high-value technical positions that would be anchored in regional areas.**

These economic drivers – expanded agricultural markets, infrastructure investment, and sustained job creation – position LCLF as a strategic opportunity for regional development.

Figure 14: Framework of benefits in developing a domestic LCLF industry



Source: 1. Rhodium Group (2023)

Appendix

Glossary

Term	Full name
ARENA	Australian Renewable Energy Agency
AtJ	Alcohol-to-Jet
CCS	Carbon capture and storage
CSIRO	Commonwealth Scientific and Industrial Research Organisation
FSSP	Fuel Security Services Payment
FT	Fischer-Tropsch
GREET	Greenhouse gases, Regulated Emissions, and Energy use in Technologies life cycle assessment models (US Department of Energy)
HEFA	Hydrotreated Esters and Fatty Acids
HTL	Hydrothermal liquefaction
LCLFs	Low Carbon Liquid Fuels
MSW	Municipal Solid Waste
UCO	Used Cooking Oil
VRE	Variable Renewable Energy

Appendix 1 – Modelling Future Liquid Fuel Demand and Electrification

Inputs and assumptions

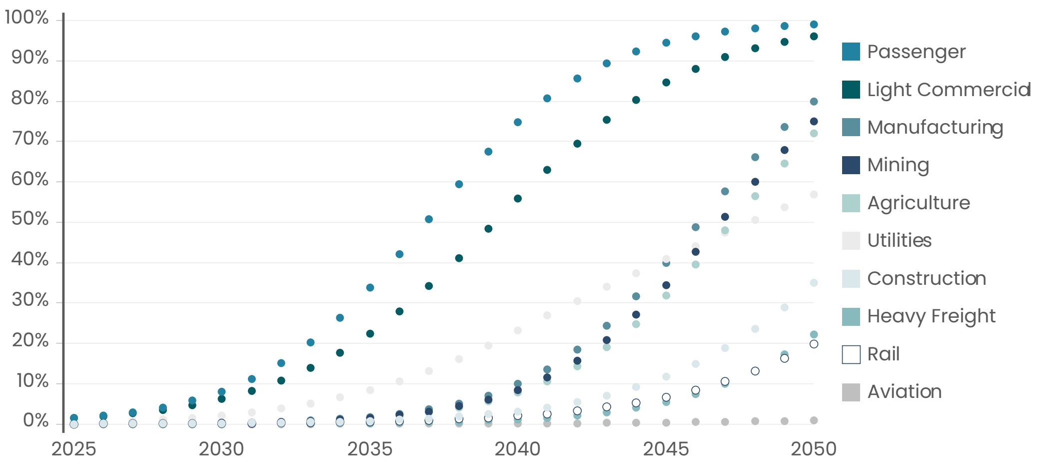
Methodology

Projection of fuel demand to 2050 is derived using growth projection multiplied by electrification rate fitted to an adoption curve for each of the 11 sectors.

The adoption curve is derived based on current electrification rates and 2050 electrification rates and assumes electrification will be lower in the earlier years (e.g. 2025 to 2030) and grow at a faster rate afterwards as technologies become more mature and commercially available for uptake.

See assumptions and notes on next page.

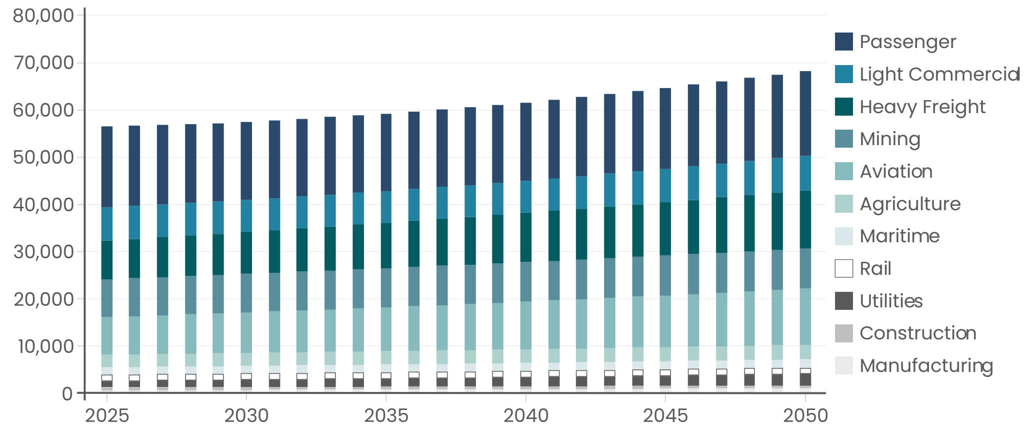
Figure A.1: Assumed electrification adoption curve[1]



Example of calculation

Current fuel demand for the beginning year (2025) is based on Australian Energy Statistics (2023) (Table F). For every year to 2050, an annual growth rate and efficiency rate is assumed (see assumptions and notes on next page).

Figure A.2: Demand growth by sector



Note: 1. Maritime sector is excluded as no electrification is assumed (see inputs and assumptions on next page).

Appendix 1 – Modelling Future Liquid Fuel Demand and Electrification

Inputs and assumptions

Assumptions and notes

Sector	Annual growth (%)	Efficiency (%)	Current electrification (%)	Expected 2050 electrification (%)	Notes
Manufacturing	1.54%		0.05%	80.00%	Annual growth based on Statista; current electrification based on market data; 2050 electrification based on McKinsey.
Construction	2.00%	0.80%	0.05%	35.00%	Annual growth based on GlobalData; efficiency rate based on IEA; current electrification based on market data; 2050 electrification based on Shell.
Utilities	2.38%		0.05%	50.01%	Annual growth based on calculation using AEMO; current electrification based on market data, 2050 electrification informed by Shell and NREL.
Rail	0.18%	0.40%	0.05%	20.00%	Annual growth based on BITRE; efficiency rate informed by Aurizon Holdings Limited, Appendix from Preliminary Financial Report; current electrification based on market data; 2050 electrification informed by theAustralasian Railway Association.
Maritime	0.50%		0.00%	0.00%	Annual growth based on National Freight Data Hub; current electrification based on market data.
Agriculture	1.30%	0.70%	0.05%	72.00%	Annual growth based on Department of Agriculture, Fisheries and Forestry; efficiency rate informed by analysis based on NSW Department of Primary Industries; current electrification based on market data; 2050 electrification informed by NREL and AgriFutures.

Appendix 1 – Modelling Future Liquid Fuel Demand and Electrification - Continued

Sector	Annual growth (%)	Efficiency (%)	Current electrification (%)	Expected 2050 electrification (%)	Notes
Aviation	2.60%	0.96%	0.01%	1.00%	Annual growth based on BITRE; efficiency rate based on ICAO Environmental Trends in Aviation to 2050; current electrification based on market data; 2050 electrification informed by IEA.
Mining	1.04%	0.80%	0.05%	75.00%	Annual growth based on BITRE; efficiency rate informed by IEA; current electrification based on market data; 2050 electrification informed by stakeholder consultations and Rio Tinto, Transitioning our Diesel Fleet (2024).
Heavy Freight	2.22%	0.60%	0.01%	22.23%	Annual growth informed by National Freight Data Hub; efficiency rate informed by ABS (2010-2020) Survey of Motor Vehicle Use, Australia; current electrification based on market data; 2050 electrification based on Mission Possible Partnership; Making Zero Emissions, 1.5°c-aligned Trucking Possible (2022) and BITRE, 2024 Road Vehicles in Australia January 2024
Light Commercial	2.10%	2.90% (2025-30) decreasing to 1.20% (2045-50)	1.50%	96.00%	Annual growth informed by CEIC; efficiency assumed same as for passenger vehicles; current electrification based on Electric Vehicle Council; 2050 electrification informed by CSIRO Electric Vehicle Projections (2023).
Passenger	2.10%	2.90% (2025-30) decreasing to 1.20% (2045-50)	1.50%	99.00%	Annual growth informed by CEIC; efficiency based on ICCT/Global Fuel Economy Initiative; current electrification based on Electric Vehicle Council; 2050 electrification based on CSIRO Electric Vehicle Projections (2023).

Appendix 2 – Primer on Low Carbon Liquid Fuels (LCLFs)

LCLFs overview

LCLFs are produced by different methods and feedstocks, such as waste materials, biomass, or combining hydrogen with captured carbon dioxide. An overview of the properties of different LCLFs are provided below.

	Biogenic LCLFs	Synthetic LCLFs
LCLF type	Biogenic fuels (biofuels) are derived from biological materials such as plant biomass, agricultural residues, and waste oils.	Synthetic LCLFs are produced from non-biomass resources through chemical processes. These include electrofuels (eFuels) made from hydrogen and captured carbon dioxide.
Production	Common examples of biofuel production pathways include: • Hydrogenated Esters and Fatty Acids (HEFA); • Alcohol-to-Jet (AtJ); • and Fischer-Tropsch (FT) Gasification	Common examples of e-fuels include: • E-Kerosene (also referred to as Power-to-Liquid (PtL)); • eDiesel; • and eMethanol.
Maturity	Medium to High: HEFA is currently the most mature and commercialised technology, while AtJ and FT Gasification are in the commercial pilot stages.	Low: PtL is currently in the proof-of-concept stage and heavily relies on the availability of affordable and reliable supply of high-volume renewable energy.
GHG reduction potential[1]	• 73% to 84% reduction through HEFA • 85% to 94% reduction through AtJ and FT	• 99% reduction through PtL
Sector uses	Aviation, Mining, Maritime, Road and Rail, and Stationary Power	

Source: 1. World Economic Forum (2020).

Appendix 3 – Other sources

Section 1 – Cost and consequences – notes

Downstream sector	Transport segment	Dependence on transport mode (%)	Value moved ($ billion)	Employment	Notes
Domestic tourism	Aviation	22% = Air transport trips/total trips in 2024	24.26 bn =110.28 bn *22%	105,721 =tourism jobs (domestic split) *22%	Dependence on transport mode calculated using data for the year ending Sep 2024 (interstate/intrastate), based on the Australian Trade and Investment Commission; employment figure includes full time and part time jobs); employment calculated using National Tourism Satellite Account, split by domestic and international total tourism expenditure
International tourism	Aviation	85% = Airfare expenditure/total transportation expenditure	41.14 bn = 48.4 bn *0.85	179,306 =tourism jobs (international split) *0.85	Dependence on transport mode based on data from Australian Trade and Investment Commission; employment figure includes full time and part time jobs); employment calculated using National Tourism Satellite Account, split by domestic and international total tourism expenditure
Pharmaceutical products	Aviation	31% = A$3.9 bn(=US$2.66 bn)/ 12.7 bn	3.9 bn =12.7 bn *31%	21,700 =70000 *31%	Calculations based on the assumption that all exports of pharmaceutical products are by air freight; currency conversion based on 5-year historical average rate of 0.678 USD/AUD (OFX).
Pharmaceutical products	Heavy freight	5.8% =0.74 bn / 12.7 bn	0.74 bn	4,060 =70000 *5.8%	Data mostly retrieved from 'freight task costs by commodity' dashboard from CSIRO's Transport Network Strategic Investment Tool (TraNSIT).
Beverages	Heavy freight	41% =1.6 bn / 3.9 bn	1.6 bn	12,177 =29700 *41%	Data mostly retrieved from 'freight task costs by commodity' dashboard from CSIRO's Transport Network Strategic Investment Tool (TraNSIT).
Cold chain	Heavy freight	14% =1.1 bn / 8 bn	1.1 bn	53,011 = 378,648 *14%	Data mostly retrieved from 'freight task costs by commodity' dashboard from CSIRO's Transport Network Strategic Investment Tool (TraNSIT).

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Securing our Fuel Future: Resilience Through Low Carbon Liquid Fuels

This report was written by

Deloitte.