FUELS

INPUTS OF THE FUTURE

GrainGrowers

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About GrainGrowers

GrainGrowers is a national organisation working to enhance the profitability and sustainability of Australian grain farmers. We achieve this through our focus areas of policy and advocacy, grower engagement, thought leadership and active investment in future focused activities for all growers. Australian growers are at the heart of all that we do and the focus of our work.

About the series *Inputs of the Future*

Following the success of the Inputs Roundtable held by GrainGrowers in March 2023, GrainGrowers is releasing a series of deep dive reports into farm inputs.

This third edition focuses on fuel

With fertiliser and agricultural chemicals covered in the first two editions, this edition will focus on fuel, with the final edition covering seed. This series is designed to serve many stakeholders including government policy makers, industry and growers.

The aim of this report is to examine the current fuel supply chain and what form of fuels and alternate fuel sources may be available to the grain farming sector over the short, mid-term and long-term in an Australian context. These insights are intended to inform government policy making during a transitional period for Australian grain growers. This report also provides background information for growers as they consider future investment in new farm and transport related machinery.

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Cover: Spraying day – Marlee Langfield

CONTENTS

Spraying at sunset – Kerry McFarlane

EXECUTIVE SUMMARY

Australia's agricultural sector faces a significant challenge on the path to decarbonisation. The Australian grain industry is currently highly reliant on diesel, which makes up approximately 85% of the energy used on farm.[1]

The first section of this report looks over the horizon to the possible fuels of the future for farm machinery and equipment, with the later section of this report examining the current fuel supply chain that is providing vital support to Australian grain farmers and agricultural industries.

The future farm fuel landscape encompasses technologies like hydrogen, biofuels and electric vehicles in depth. As the agricultural sector navigates this transitional period, there is a pressing need for interim technological solutions to bridge the gap between current reliance on traditional fuels and the envisioned sustainable future. It is important that government work with industry to remove barriers to the adoption of these technologies to ensure Australian agricultural industries are not disadvantaged during this transition.

Achieving net-zero emissions necessitates substantial reductions in the cost and efficiency of low-emission technologies. This economic viability is crucial for garnering market acceptance without burdening growers with excessive financial implications. Striking a balance, the Australian Government must align its ambitions with the practical availability and affordability of emerging technologies, ensuring a smooth and sustainable shift towards a greener, more secure energy future for the nation's vital agricultural sector.

It is critical government develops an agricultural-specific low emissions vehicle road map and strategy to establish a coordinated, strategic and responsive approach to the Australian fuel transition for agriculture.

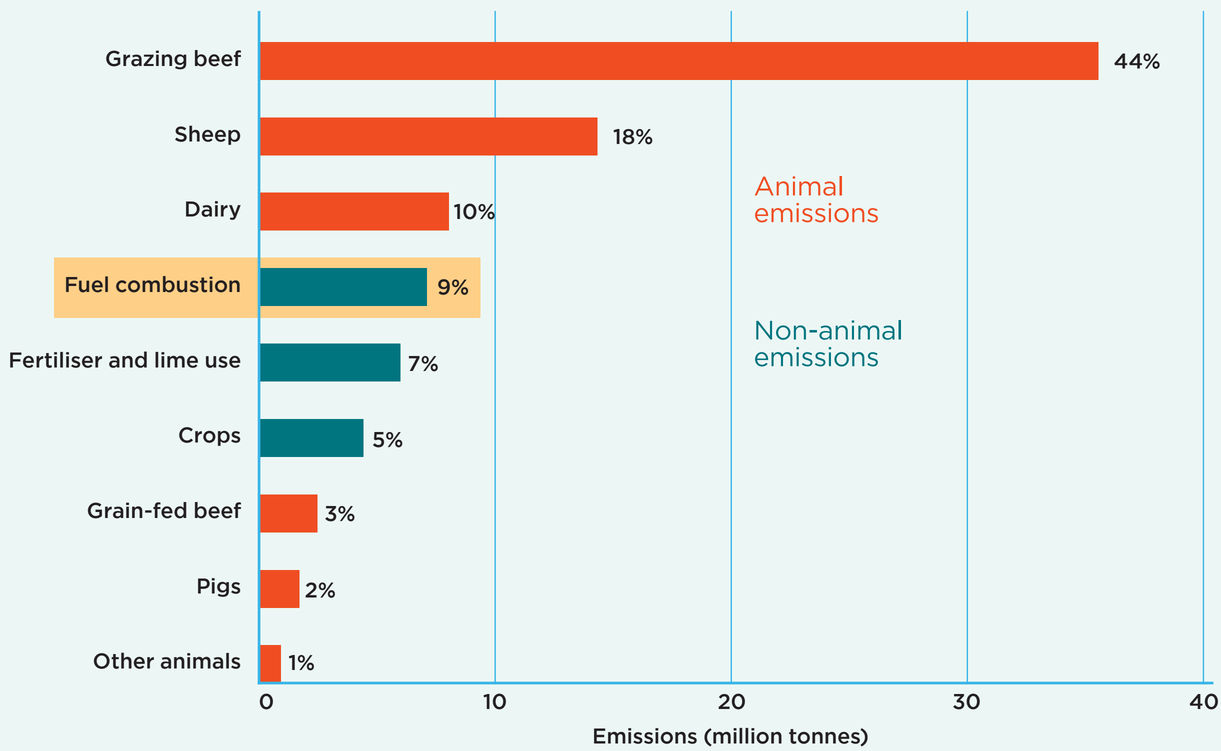

(NSW) Vic Hamilton (*Powering through the acres*)

[1] (Australian Farm Institute, 2018)

THE GRAINS INDUSTRY'S RELIANCE ON DIESEL AND WHY WE NEED TO CONSIDER OTHER FUELS

Australia's farming sector relies heavily on diesel for its energy needs, with this fuel currently accounting for approximately 85% of all on farm energy use. From sowing crops to transporting grain to market, diesel is an essential component of the entire grain production supply chain.

Fuel combustion currently represents 9%[2] of total emissions for Australia's agriculture industry.



Note: Emissions are "carbon-dioxide equivalents", estimated using the 100-year global warming potentials published alongside IPCC (2007).

Source: Grattan analysis of DISER (2020a), the most recent Federal Government projections available at time of this chart's publication (2021).

Source: **Towards net zero: Practical policies to reduce agricultural emissions (grattan.edu.au)**

There is little data available, but Marsden Jacobs estimates grain freight is responsible for 0.4% of Australia's total GHG emissions.[3]

The grain industry is considered especially hard-to-abate as grain production is typically characterised by operating in rural and remote locations, long operation cycles and with vehicles requiring high torque.

Reducing the road transport industry's emissions has been identified as a key step by the Australian Government to achieve Australia's emissions reduction target of 43% of 2005 levels by 2030 and reaching net zero emissions by 2050.

Similarly, governments worldwide have implemented, or are implementing, stricter emissions regulations and targets to address climate change and air quality issues.

What does the future of fuel look like for Australian grain farms?

The future of fuel will likely involve a shift towards a combination of renewable fuels such as biofuels, green hydrogen and renewable electric power.

As noted by AgriFutures, "No one-size-fits-all solution or 'silver bullet' fuel will meet the energy needs of a diverse set of industries and communities in Australia. Industry and place-specific energy solutions will further develop over time."

The transition away from diesel on farms will likely involve a mix of these alternatives, based on factors such as availability, cost, infrastructure, and technological advancements over time.

The following sections explore the technological maturity, cost and applicability of potential technologies.

[2] Towards net zero: Practical policies to reduce agricultural emissions (grattan.edu.au)

[3] A4 Portrait Report (graintrade.org.au)

[4] AgriFutures | The Diesel Transition

(VIC) Mark Merrett *(Grain Cleaning)*

GREEN HYDROGEN

The two main types of hydrogen technology used for machinery and transport equipment are **fuel cell electric vehicles (FCEVs)** and **hydrogen internal combustion engine vehicles (HICVEs)**.

FCEVs use hydrogen to produce electricity through a chemical reaction with oxygen, powering an electric motor. They emit only water vapor and have a higher energy efficiency when compared to HICVEs. HICVEs burn hydrogen in a traditional combustion engine, similar to gasoline engines, emitting water vapor and small amounts of nitrogen oxides. FCEVs are quieter and have fewer mechanical parts.

Currently, HICVEs appear to have faster adoptability into farm machinery applications, despite slightly lower power conversion efficiency versus FCEVs as they can essentially replace traditional diesel power plants with relatively minor structural changes to machinery design.

Creating hydrogen currently is an energy intensive process that uses the process of electrolysis. In this process electric current is applied to water to produce hydrogen and oxygen.

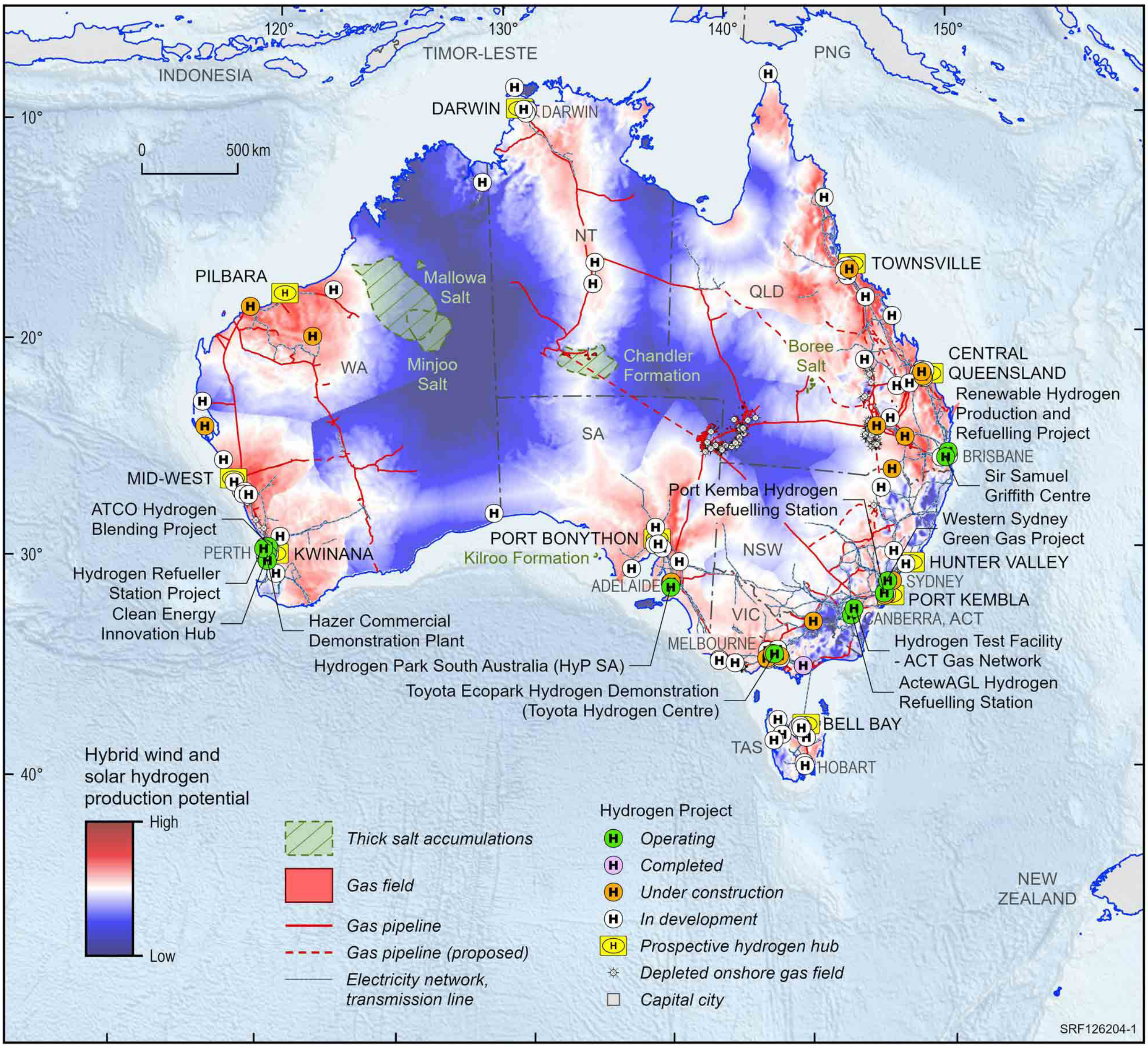
Hydrogen may also offer greater promise to remote and rural areas with hydrogen distribution and refuelling infrastructure potentially being more compatible in these settings when compared to electrical recharging infrastructure.

Current Governmental policy regarding green hydrogen

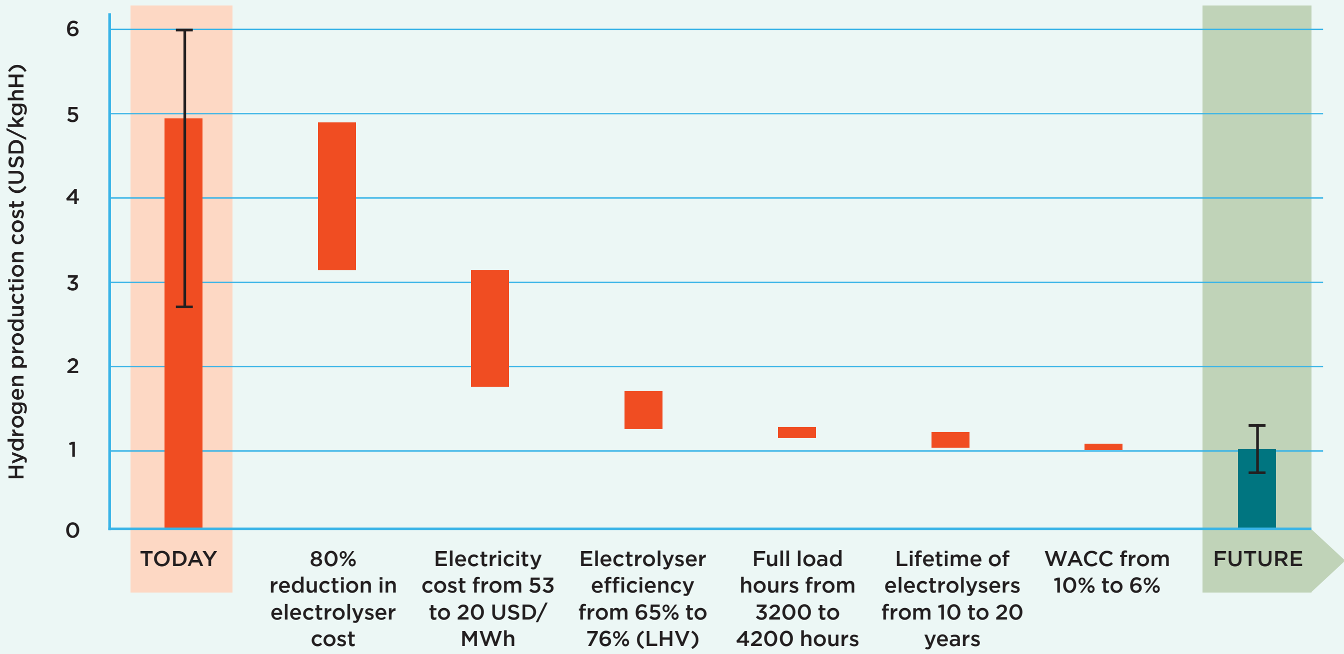
In Australia, hydrogen vehicle technology is receiving investment from both federal and state governments. The Australian Government has recently announced the ‘Hydrogen Headstart Program’, investing $2 billion for successful applicants in the form of a production credit. This funding credit will cover the current commercial gap between the cost of producing renewable hydrogen and its market price, enabling hydrogen to be offered at a competitive price to encourage usage.

State programs include South Australia’s Hydrogen Action Plan, Western Australia’s Renewable Hydrogen Strategy, Queensland’s Hydrogen Industry Strategy and Tasmania’s Renewable Hydrogen Action Plan. A map of current hydrogen projects and proposed ‘Hydrogen Hubs’ are shown on the following page along with the production potential.

This map identifies current hydrogen projects (as of September 2023) and areas of high suitability for hybrid wind and solar hydrogen production in Australia, which were identified using the Hydrogen Economic Fairways Tool (ga.gov.au/heft).



Source: Australia's hydrogen production potential | Geoscience Australia (ga.gov.au)



Note: 'Today' captures best and average conditions. 'Average' signifies an investment of USD 770/kilowatt (kW), efficiency of 65% (lower heating value - LVH), an electricity price of USD 53/MWh, full load hours of 3200 (onshore wind) and a weighted average cost of capital (WACC) of 10% (relatively high risk). 'Best' signifies investment of USD 130/kW, efficiency of 76% (LHV), electricity price of USD 20/MWh, full load hours of 4200 (onshore wind) and a WACC of 6% (similar to electricity today).

Based on IRENA analysis.

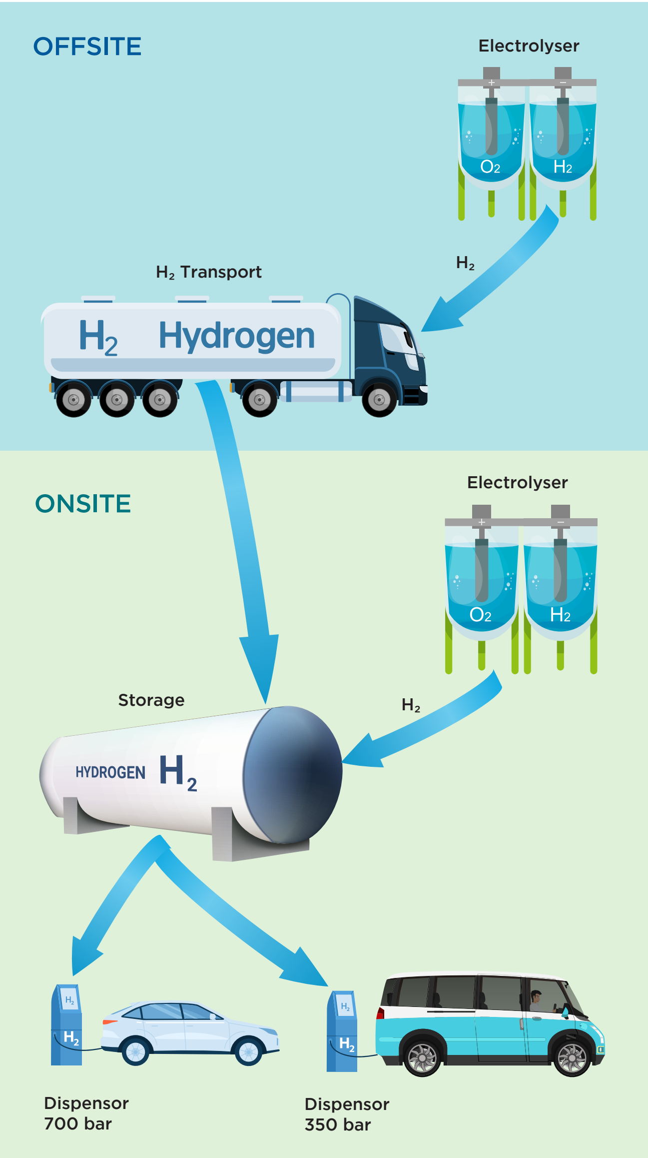
Source: **Making the breakthrough: Green hydrogen policies and technology costs (irena.org)**

(VIC) Kerry McFarlane *(Making Hay)*

Potential forms of refuelling and distribution models

As noted in the CSIRO Hydrogen Vehicle Refuelling Infrastructure Report (July 2023), the lowest cost form of production and distribution appears to be offsite hydrogen production due to economies of scale that are achieved versus onsite production models which can be almost double.

This means that future hydrogen transport storage and refiling supply chains that resemble the 'offsite' model shown in the diagram below are likely unless market dynamics change.



Source: Hydrogen vehicle refuelling infrastructure - CSIRO

CASE STUDY

Geelong New Energies Service Station Project by Viva Energy

Viva Energy received $22.8 million funding from the Australian Renewable Energy Agency (ARENA) and $1 million from the Victorian Government's Renewable Hydrogen Commercialisation Pathways Fund to develop Australia's first commercial hydrogen refuelling station in Geelong.

As green hydrogen is currently not commercially available in Australia, Viva Energy's delivery model involves the production of green hydrogen onsite using recycled water from Barwon Water's Northern Water Plant.

The site will produce green hydrogen using a 2.5-megawatt PEM electrolyser with a generation capacity of up to 1,000 kilograms of hydrogen per day.

This project will be the first hydrogen refuelling station open to the public in Australia, with the single site project cost estimated at $43.3 million. The facility will include renewable hydrogen and EV infrastructure, with the deployment of 15 commercial hydrogen fuel cell electric vehicles operating in road freight, public transport, municipal waste management, water treatment and general fleet.

Current farm hydrogen prototypes

Fuel cell electric vehicles (FCEVs)

Current prototypes include the H2Agrar project by Fendt in Germany, which is a hydrogen fuel cell electric vehicle (HFCEV). It comprises 5 hydrogen storage tanks mounted on the roof of the vehicle. Each tank holds 4.2 kilograms of hydrogen at 700 bar pressure. The hydrogen pressure is reduced to 10 bars before entering the hydrogen fuel cell on board the vehicle. The cell then produces electricity via the fuel cell, which is then used to propel the tractor's electric drive train. The tractor also has a small battery of around 25 kilowatt hours.

The prototype produces about 140 horsepower and has an operational range of 4-7 hours depending on duties performed. The tractor is refueled from a refilling station in a nearby farming community as part of a larger project. It is envisioned tractors like this could easily be scaled into larger tractors and harvesters with a range suitable for Australian cropping conditions in the near future.

Source: Fendt hydrogen tractor in use | H2Agrar project, Lower Saxony; Germany (youtube.com)

Fendt hydrogen tractor in use | H2Agrar project

Source: Fendt hydrogen tractor in use | H2Agrar project, Lower Saxony; Germany (youtube.com)
graincentral.com-Electric tractors leads charge, hydrogen in the wind.pdf (dropbox.com)

(NSW) Jossy McNamara *(Blue tractor farm only)*

Hydrogen internal combustion engine vehicles (HICVEs)

Shown below are the prototype tractors from JCB, which use internal combustion motors that very closely resemble the performance and operation of traditional diesel combustion engines. Similar to the Fendt prototype, they carry comparable amounts of hydrogen onboard, but with a focus on refilling on site using a tank that is delivered. Refilling in this manner takes around 6-7 minutes and is comparable to the refuelling time for current diesel equipment. Operational range is similar to a conventional diesel-powered machine (depending on tank size).

Left: JCB's Hydrogen Internal Combustion Motor (youtube.com)

Below: JCB's Fleet of Internal Combustion Hydrogen powered machinery (youtube.com)

BATTERY ELECTRIC VEHICLES

Battery electric vehicles (BEVs) are powered entirely by electricity stored in rechargeable batteries that then operate an electric drive train.

Unlike hybrid vehicles, which use a combination of an internal combustion engine and an electric motor, BEVs rely solely on electric power for propulsion. They produce zero tailpipe emissions and like hydrogen, provide another emissions reduction solution if recharged by renewable sources.

Challenges inhibiting adoption and possible solutions

Battery Electric Vehicles (BEVs) are nearly competitive with existing fossil fuel energy. The major limitation to mass production and adoption of BEVs on farm is the operational range and efficiency for heavy machinery platforms. This is largely due to the power dynamics of farm and transport machinery where most of the power from the drivetrain is required most of the time, as opposed to light electric vehicles where only potentially 5-10% of the total output of the powerplant may be used per hour (e.g. during highway driving).

For example, a grain harvester is typically operating at 65-90% of its total potential output depending on the task at hand. Often grain harvesters and tractors are required to operate 24 hours a day over several days or weeks at times, only stopping to change driver and clean down the machine.

This is the case in many transport settings with heavy vehicles. Currently, recharging infrastructure is not available in most rural areas and time spent recharging heavy electric vehicles is a large financial and operational cost.

In addition to the technology not commercially existing, this stands as the largest obstacle to proliferation and adoption of electric harvesters, tractors and trucks. This issue for farm machinery may be largely overcome through autonomous tractors and harvesters using swap in and out batteries as this greatly reduces the opportunity cost of labour by way of having no human operator and minimal downtime for charging. In the case of autonomous vehicles, farms could in fact gain efficiencies as it is foreseeable that an operator that used to be restricted to the operation of a single piece of farm machinery could in future control multiple units from a remotely-located hub and drive further economies of scale in farm operation.

Prototypes

A John Deere prototype is shown at right.

Source: John Deere New Autonomous Battery Electric Tractor (youtube.com)

Italians develop autonomous electric tractor with tethered power supply

Looking at other range issues, the prototype here also partially solves this problem by using an extension cable tethered to the machine back to a power source. However, in Australian grain farming settings this could be problematic due to the scale of production and proximity to a charging source.

Source: Italians develop autonomous electric tractor with tethered power supply – Future Farming

Source: John Deere New Autonomous Battery Electric Tractor (youtube.com)

BIO AND RENEWABLE FUELS

Noting that the transition to electric and hydrogen-based machinery is still developing, the need to reduce emissions now while still maintaining agricultural productivity and profitability is a fine balance.

Biofuels present an opportunity to reduce carbon equivalent emissions using existing machinery and infrastructure. For grain growers, this reduces immediate capital outlay for machinery upgrades (to new electric or hydrogen technologies under development and not available at scale to market) while participating in emission reduction benefits. The possible growth of domestic crop-based biofuel production could lend support to Australia's hard-to-abate industries such as agriculture and transport.

Biofuel could fill the technological gap between Australia's current agricultural machinery base and a zero net emission future state.

Several commercial businesses are embarking on projects to develop biofuel production capacity, which may provide significant opportunities for the oilseed industry as well as other feedstock producers.

Using Australian crop-based feedstocks for biofuel production could bolster Australia's fuel security and create further market diversification for Australia's grain and oilseeds through the development of alternate domestic markets. Furthermore, biofuel production in regional areas could aid regional industrial development and facilitate job creation.

Bio and renewable and bio diesel present a bridge to zero emissions technologies

As electrification and hydrogen technologies are scaling up, renewable diesel provides a possible short-term solution to reduce lifecycle emissions in the order of 60-80% per unit of energy. The cost of this trade off is an increased cost in the price of renewable liquid diesel, versus conventional fossil fuel derived diesel. Due to the cost difference, there may be a role for government to consider positive incentives to help underpin the success of the biofuels industry.

The difference between bio diesel and renewable diesel

While both fuels can be made from the same materials, biodiesel and renewable diesel have different manufacturing processes that result in products with different molecular structures. Biodiesel is a methyl ester and renewable diesel is a hydrocarbon. The difference in the chemical properties of biodiesel is what limits the amount that can be blended with petroleum diesel, which is also a hydrocarbon. However, there is no limit as to the amount of renewable diesel that can be blended with petroleum diesel because they are chemically identical. Renewable diesel is known as a 'drop in' fuel, as opposed to biodiesel, which can only be blended in at relatively low rates with petroleum diesel (e.g. around 20% maximum before the fuel encounters performance issues).

Current biofuel technologies

Conventional Biodiesel

Conventional biodiesel technology involves the trans-esterification of oil with sodium methylate and holds a significant share of current usage. Its operational success is contingent upon high-quality feedstocks with low free fatty acids (FFAs), predominantly relying on refined vegetable oils.

Acid/Base Technology

An evolutionary step from conventional transesterification biodiesel, Acid/Base technology introduces a re-esterification step. This advancement enables the processing of waste feedstocks with elevated FFAs, like distillers' corn oil. However, the technology demands a costly pre-treatment step. Despite the expense, it results in lower carbon intensity, especially when using waste feedstocks.

Renewable Diesel

Renewable diesel, produced through the hydrotreating of fats and oils, has gained prominence in Europe and the US. It effectively uses waste feedstocks, generating drop-in diesel and jet fuel. Its economic viability is notably linked to refinery retrofit or large-scale greenfield projects due to relatively high capital costs compared to conventional biodiesel.

Solid State or Enzymatic Catalysts

In this category, technologies employ solid-state or enzymatic catalysts for biodiesel production. These processes, while having a small footprint with few operational plants, offer flexibility in accepting various feedstocks. Challenges, however, arise due to the elevated costs associated with enzymes and the complexities of purifying the product downstream.

(QLD) Chloe Micallef *(Sorghum Harvest 2023)*

FUEL AGNOSTIC VEHICLES

The uncertainty of which technologies may win the race for powering farm machinery and transport means it is likely that there may be at least, in the near to mid-term, an increased share of fuel agnostic vehicles that come into development and enter the Australian market.

This is already occurring in a number of key sectors such as mining where heavy vehicles have a long service life. Here, the evolution of technology is solved by vehicles having electric drive trains, and are designed in such a way that they can be retrofitted with another power plant (e.g. hydrogen or battery) should technology become economically viable over the span of the equipment's remaining life.

Similarly, some diesel engine manufacturers for heavy applications such as trucking are also developing internal combustion engines that can run on multiple fuels such as diesel or hydrogen combustion.

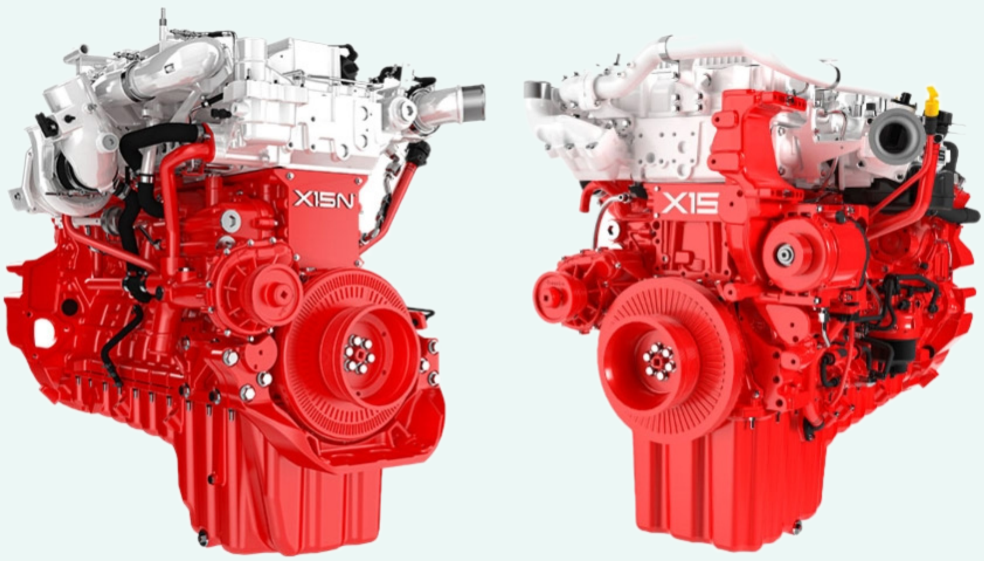
Although the above forms of fuel agnostic vehicles offer more flexibility regarding future fuel or energy source use, this strategy may also in some cases increase the capital cost of machinery acquisitions due to complexity in design and manufacture and during the equipment's lifetime should its configuration require changing or retrofitting.

Fuel-agnostic internal combustion prototypes

Cummins Inc. is currently the market leader in introducing its fuel-agnostic 15-liter engine platform (shown below) with hydrogen, natural gas and advanced diesel engines offering low-to-zero carbon fuel capability. Cummins Inc. showcased this technology in 2023:

''The fuel-agnostic architecture of the 15-litre platform utilises a common base engine with cylinder heads and fuel systems specifically tailored for it to use carbon-free hydrogen or biogas with up to a 90 percent carbon reduction. Cummins' 15-liter hydrogen has ratings up to 530 hp (395 kW) and natural gas up to 510 hp (380 kW).''

''The diesel X15 will be compliant with U.S. EPA and CARB 2027 aligned regulations at launch. The next generation X15 diesel engine in North America will serve the heavy-duty on-highway market.''



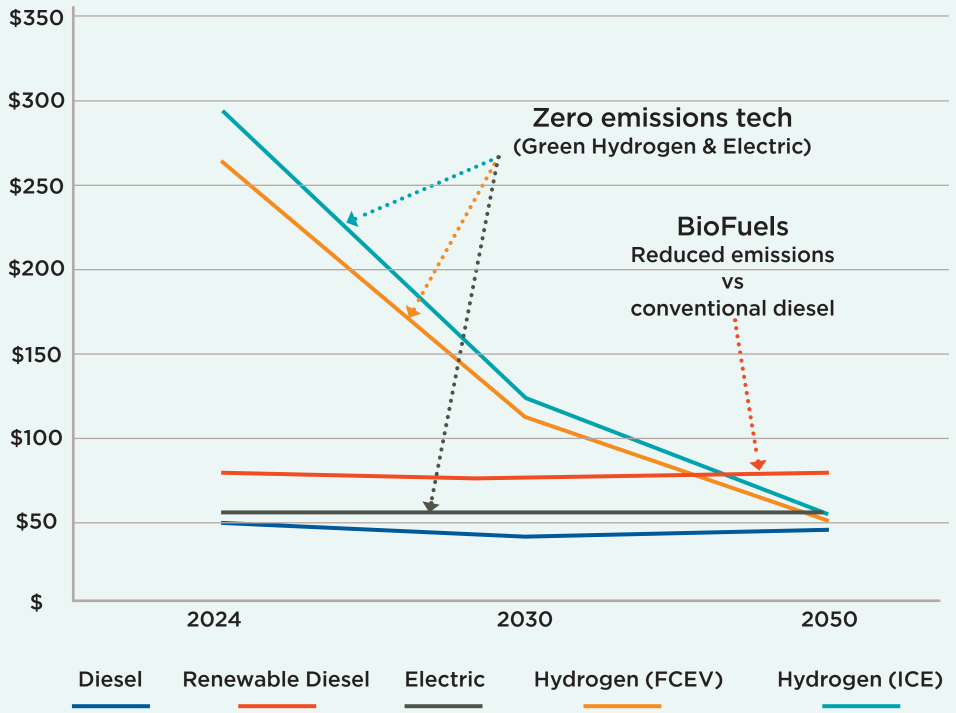
Cummins fuel-agnostic engine platform delivers low-to-zero carbon fuel capability | Cummins Inc.

Image Source: Cummins announces innovative next generation X15 diesel engine, part of Cummins HELM™ 15 liter fuel agnostic platform, launching in North America to meet aligned 2027 regulations | Cummins Inc.

LOOKING AHEAD

Cost curves and emissions profiles of various fuels to 2050

Projection – hourly operating cost by fuel/energy type for a large tractor undertaking spraying



To create this chart, GrainGrowers used the midpoint price of the high and low values in the CSIRO Hydrogen vehicle refuelling infrastructure report (July 2023) to derive the current price of 'green' hydrogen at $11.19/kg. The cost of grey and blue hydrogen for the purpose of this report are not considered. For the 2030 forecast, $4.60/kg is derived from the halfway point between $11.19/kg and $2/kg, noting that the CSIRO states in its report that electrolyser technology will begin to influence cost reduction curve partway between 2030 and 2050. $2/kg hydrogen is assumed for the 2050 state as per governmental targets. As many of the technologies are in development or prototype stage, theoretical assumptions are made in regard to running cost.

Having considered the pipeline of technology options possibly available to Australian growers in the future, the costs and timelines of adoption are finally considered. Noting the pros and cons of each technology mentioned, cost comparisons (shown above) give an indicative running cost per hour for a typical commercial scale tractor used in grain farming systems in Australian dollars for each technology. This allows a high-level timeline regarding the economic viability of adoption of various technologies.

As shown above, there is currently a large cost divergence between current fossil fuel-based energy sources and hydrogen, however many countries such as the US, UK and India along with Australia are strategically striving for low-cost green hydrogen production that is then cost competitive with traditional fossil fuels.

Alternatively, electric vehicles at current power prices are close to competitive against fossil fuel derived diesel, with the major barrier to adoption being that electric farm machinery technology is still very much in a developmental stage and is confronted by considerable range and recharging challenges.

Hydrogen eventually being produced at $2/kg and becoming cost competitive by 2050 relies on several factors including sizable improvements in electrolyser technology and reductions in domestic electricity prices. Given this near-term conundrum, biofuel presents a potential opportunity to bridge the gap between existing and emerging technologies. While this would be with a higher running cost base in comparison to fossil fuel diesel, it would also have reduced exhaust emissions when compared to conventional fossil fuel derived diesel. Additionally, unlike hydrogen and electric technologies, another advantage of biofuel being an attractive interim solution is that in most circumstances no modifications are required to be made to existing farm or transport machinery to use renewable biofuels.

SUMMARY

There are several factors currently inhibiting the transition from fossil fuels to renewable fuels in the grain freight supply chain, including technological availability and maturity, operational complexity, and asset investment life cycles. Agriculture's transition to zero emissions vehicles will require a coordinated, strategic and responsive approach with collaboration across the supply chain. For net zero fuel ambitions to be fully realised, policy makers must continue to consider ways to incentivise farmers to transition to low emission technology. It is equally important that government considers its ambitions and targets in the context of the technological availability of low and zero emissions farm and transport machinery being available in market at scale and at cost levels comparable to, or superior to, higher emissions technology platforms.

It is therefore essential the Australian Government develops an agriculture-specific low emissions vehicle road map and strategy that establishes a coordinated, strategic and responsive approach to the Australian fuel transition for agriculture.

(VIC) Kerry McFarlane *(Canola Harvest Cannie Ridge)*

APPENDIX

Examining the current fuel supply chain that is vital to support Australian grain farmers and agricultural industries

Australia's current fuel source

Australia's farming sector currently relies heavily on fossil fuel, particularly diesel for its energy needs. Diesel currently accounts for approximately 85% of all on farm energy use in the grains sector.

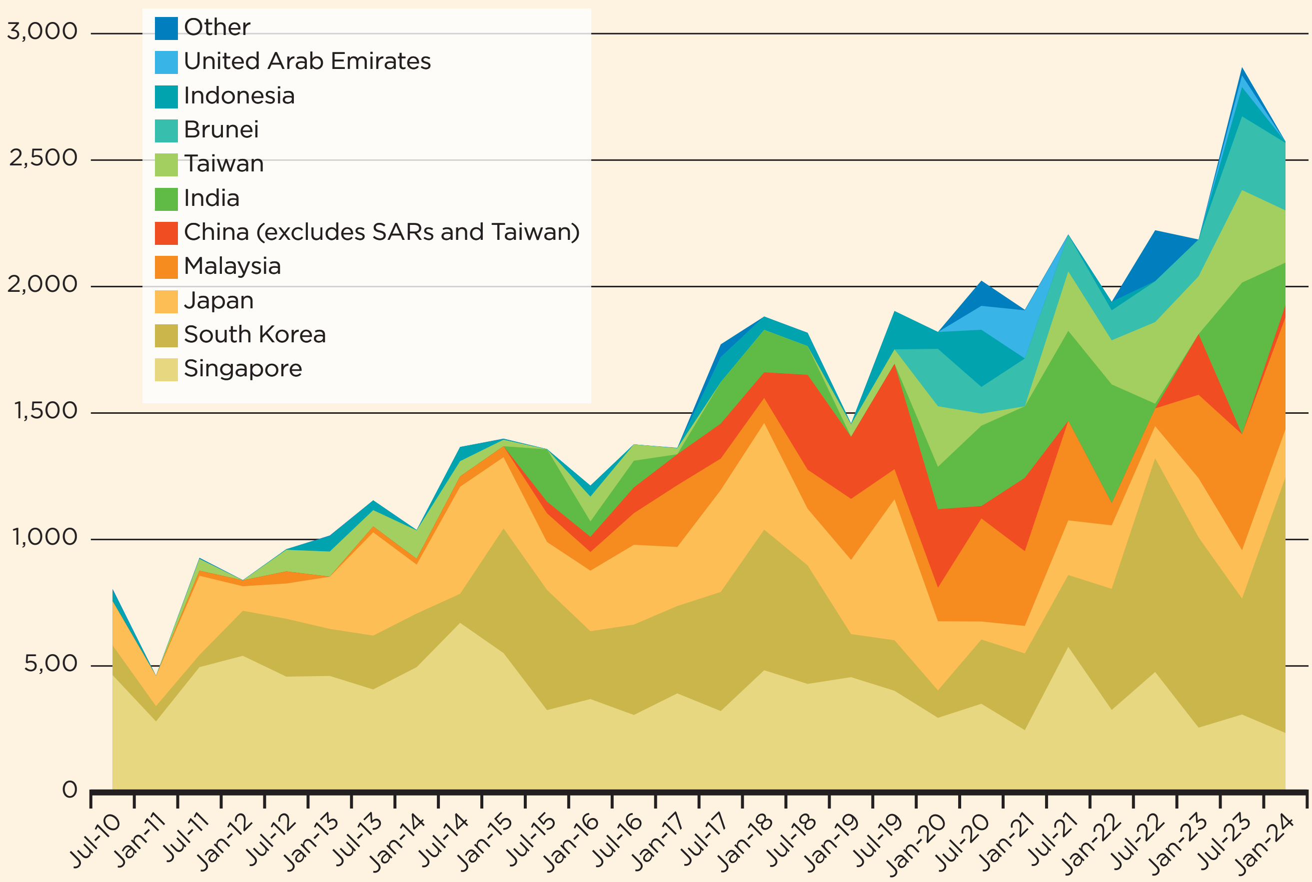
Since the mid-1980's Australia has been a net importer of refined oil products, as well as crude oil and other refinery feedstocks. Approximately 90% of all of Australia's liquid fuel needs are met by imports, with on average two vessels a day arriving at Australian ports with imported fuel.

Large overseas-based refinery complexes are able to export ready-to-use petroleum products at much more competitive rates than domestic sources.

As a result, Australian operating oil refinery capacity has fallen drastically in the past decade with now just two refineries still operating (the Lytton refinery and the Geelong refinery). These two remaining refineries only have the capacity to produce less than a quarter of the volume of petroleum products consumed by Australia.

The main sources of imported petrochemical products (including diesel) are shown below. Although Singapore is traditionally the largest provider of petrochemical fuels, supplier countries are well diversified with Australia not relying on any one country, although the supply is dominated by Asian nations.

Total diesel import share by country July 2010 - January 2024



Source: Australian Petroleum Statistics | energy.gov.au
Imports and Exports | National Freight Data Hub (freightaustralia.gov.au)

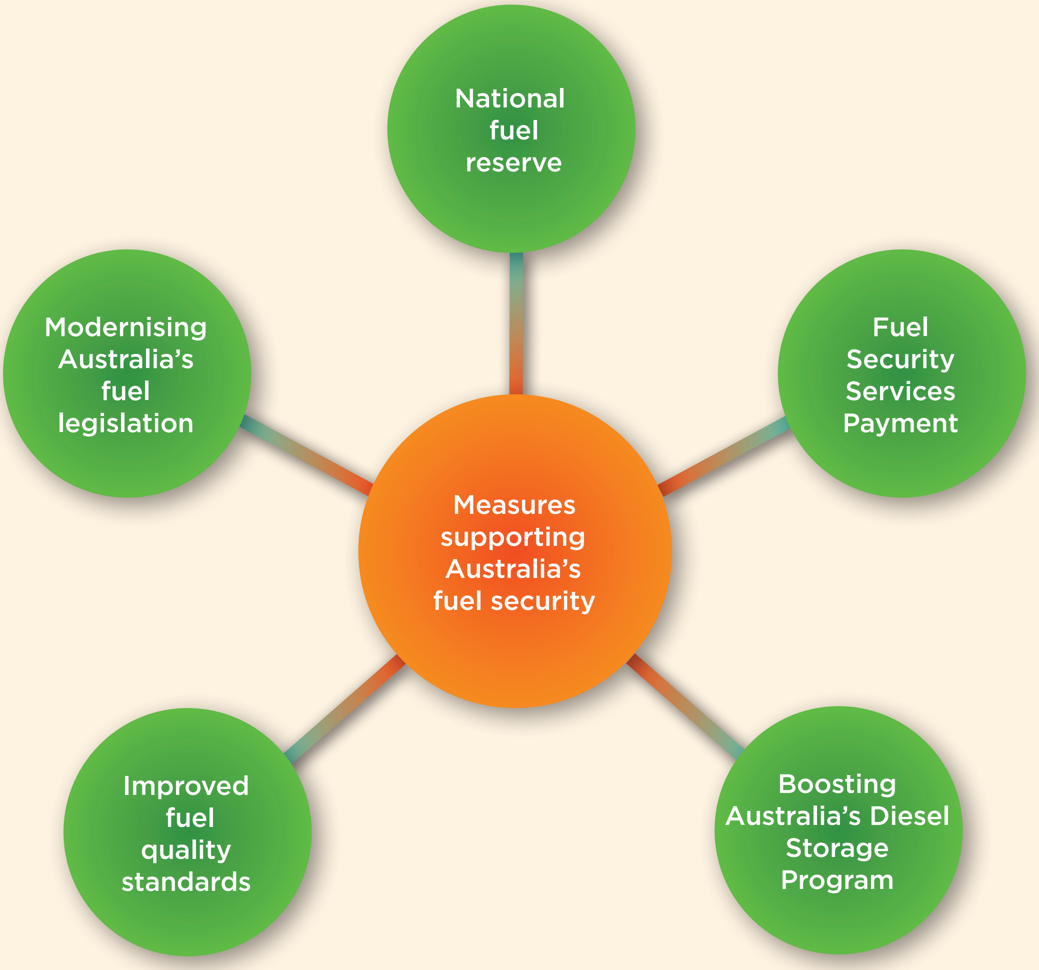
Australian fuel security

Australia has seen a decreasing production base in oil production and domestic refining, leading to greater reliance on importation of both crude oil and refined fuels. This trend is unlikely to reverse.

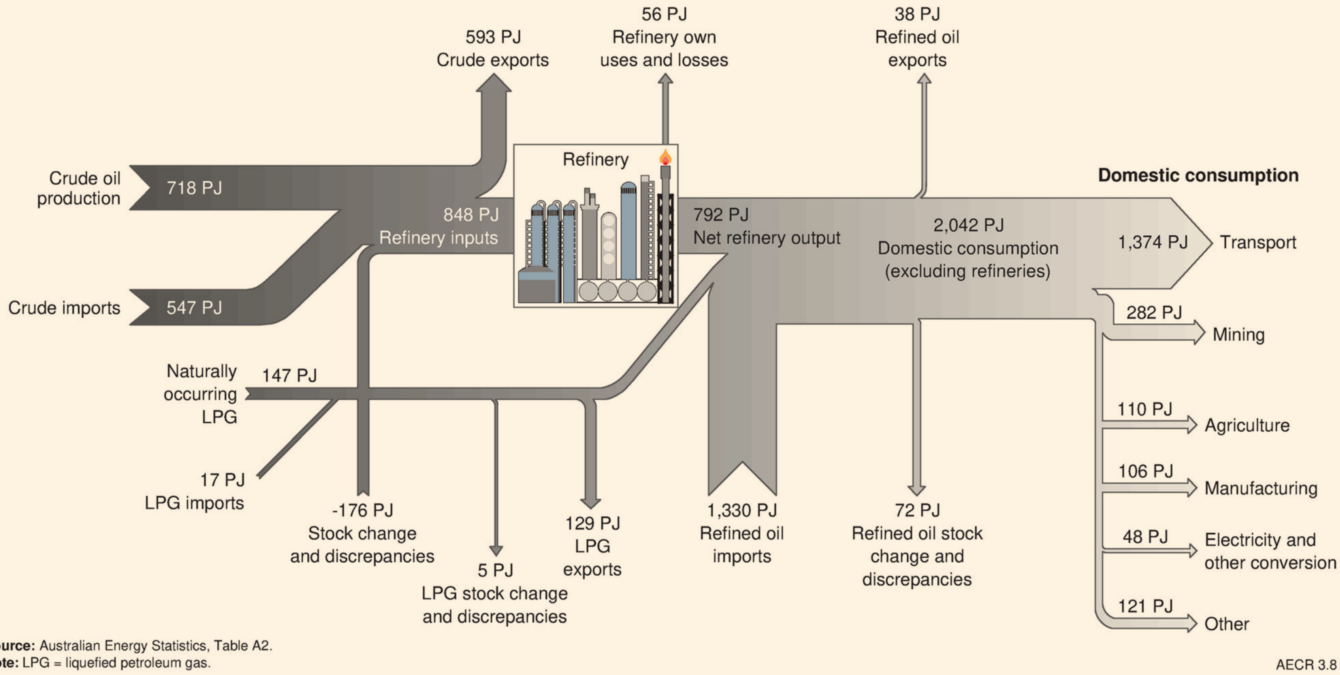
A cornerstone initiative is the Fuel Security Act 2021, which focuses on ensuring the nation's fuel resilience. The Act establishes a national fuel reserve through a minimum stockholding obligation and the 'Fuel Security Services Payment' which supports refining capabilities by providing refiners production payments during loss-making periods.

Additionally, under the Fuel Security Act the Minimum Stockholding Obligation was increased as of July 2024 to now require Australia's two refineries and major importers of refined fuels to hold baseline stocks of 27 days for petrol (increased from previous 24 days), diesel 32 days (increased from previous 20 days) and jet fuel 27 days, (increased from previous 24 days).

Additionally, the 'Boosting Australia's Diesel Storage Program' (BADSP) is a grant-based program that aims to increase diesel storage capacity by an estimated 780 megalitres through matched funding to industry in order to construct new diesel storage. Under the BADSP, the storage must be constructed by 30 June 2024. Another program, the Refinery Upgrades Program, accelerates the introduction of high-quality fuel, aligning with international standards.



The above diagram shows the Australia's fuel security - DCCEEW plan



Source: Australian Energy Statistics, Table A2.
Note: LPG = liquefied petroleum gas.

Oil | Australia's Energy Commodity Resources 2023 (ga.gov.au)

Technical Grade Urea (TGU), the weakest link in Australia's fuel supply chain

TGU is a liquid-based urea solution, which is injected into the exhaust system of diesel vehicles to convert the air pollutant nitrogen oxide (NOx) into nitrogen and steam. Although TGU does not fully eliminate NOx emissions, emissions are greatly reduced because of the treatment.

TGU is currently the weakest link in the Australian fuel security chain as many modern-day diesel vehicles are not able to operate without TGU, with vehicle computer system(s) programmed to not allow the running of the vehicle's engine where the supply of TGU is not present in the vehicles fuel system.

China banned the export of urea and TGU in mid-2021 due to economic factors, including the Covid-19 pandemic and to lower Chinese domestic prices of fertiliser. With China typically supplying around 80% of all of Australia's TGU needs, China ceasing exports saw Australia critically short on TGU and in late 2021 was facing the prospects of rationing and stock outs. Ultimately, in December 2021 the Australian Government provided a $29.4 million temporary subsidy to Incitec Pivot to produce 5,000 tonnes of technical grade product ahead of Australia's forecast date to run out of TGU in January 2022. This temporary subsidy was effective in temporarily securing Australia's TGU supply, but since then the Incitec Pivot plant in Gibson Island QLD (Australia's only remaining domestic manufacturer of Urea) closed in late 2022, due to no longer being economically viable to operate. This has left Australia completely reliant on imports of TGU, of which imports have resumed mainly from China as a result of China re-allowing exports of Urea. Potential projects that would allow TGU manufacture in Australia are not planned to commence until 2027 at the earliest (i.e. Perdaman, Strike Energy and NueRizer).

In order to avoid the event of another scenario as described above, it is imperative that Australia produces TGU domestically. Without a reliable domestic supply of TGU the only remaining option of last resort, if faced with stock outs, is the temporary suspension of the mandate to use TGU in modern equipment. Such measures would have severe environmental impacts and operationally this would be very difficult to implement as overriding computer systems onboard heavy vehicle systems to allow them to continue to operate is complex and would create warranty issues by way of breaches.