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DEFUGO Technologies

Australian Biomass to Energy White Paper

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www.defugo.com

Executive Summary

Defugo is uniquely positioned to help Australia to build its sovereign capability in renewable fuel production to meet both its own needs and the needs of the rest of the world, through:

- its patented Universal Processing Plant (UPP) technology;
- the highly innovative kenaf biomass crop; and
- the deployment of capital through the Australia Nordic Energy Alliance (ANEA).

This trilogy of strategic elements can unlock the potential of Australia's untapped land and regions, to transform the country into a global renewable fuels powerhouse.

Background

Disruptions to global supply chains are forcing up the price of traditional petroleum-based fuels, adding to inflationary pressures in the global economy.

The lack of renewable alternatives to traditional petroleum-based fuels such as diesel, petrol, aviation fuels and natural gas sees the world stuck in an energy conundrum, and forced to pay higher world prices for these fuels and facing diminished fuel security.

At the same time, the world is striving to meet its ambitious emissions reduction goals, but progress on finding economically viable alternatives for these petroleum-based fuels in the short term has been very slow.

For example, while electric vehicles are a promising technology, they have a high price differential compared to traditional vehicles, and will take time to penetrate and ultimately replace the current fleet. There is also the issue of recharging times and the need for large-scale and costly charging infrastructure to be built.

While hydrogen is promising as a renewable transport fuel and as a replacement / blend with natural gas, its cost differential has also been prohibitive to date.

Financing Solution

Achieving the production scale required to meet domestic and export dem
a large amount of investment capital to be deployed.

To support this process, Defugo is helping to establish the Australia Nordi

Technology solution

Defugo has developed a technical solution to this global conundrum by combining two technologies.

- First, the use of biomass such as kenaf as the biomass crop for the production of renewable diesel, ethanol, A1 Avgas and hydrogen fuels
- Second, the use of Defugo's patented Universal Processing Plant (UPP) which uses counter current extraction technology to separate out the constituent chemical elements from the kenaf biomass required to produce these renewable fuels using the one integrated process.

This process can produce all of these fuels on a cost competitive basis, with the transport fuels meeting the necessary standards to be produced as drop-in replacement fuels for existing vehicles.

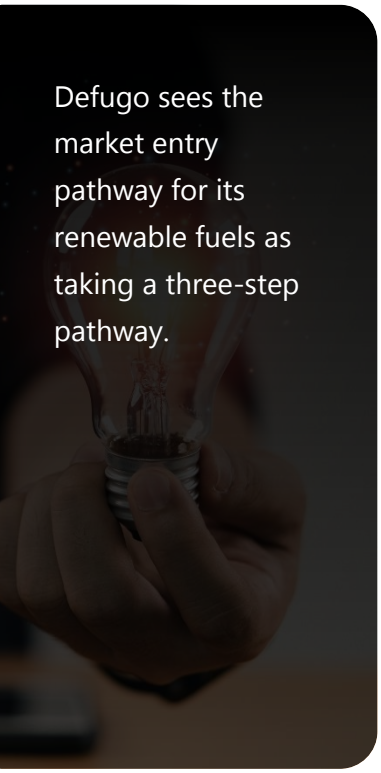
In terms of hydrogen, the UPP can reliably produce hydrogen at or below $2 per kilogram and provides the basis for low-cost and at-scale production.

The ANEA will be led by a number of sovereign funds from the Nordic states and European banks, whose goal is to invest through debt in ESG projects around the world so that renewable energy can become more freely available on a global basis.

Defugo will work with ANEA to support its market entry strategy which will at first focus on scaling production to meet the needs of the Australian market, before expanding into export markets such as in Europe, the Asia Pacific and elsewhere around the world.

Market opportunity

Market analysis has indicated that there is ample opportunity for Defugo to establish its operations by initially focussing on the domestic market for renewable fuels, and then expanding into major export markets, and particularly hydrogen, over time.



Initial stages

- For renewable liquid fuels, the initial stages of Defugo's market entry strategy will be to focus on supplying these fuels to a select number of larger users of petroleum fuels, such as major transport or mining companies or airlines. For example, it has been estimated that by supplying Qantas, Toll Holdings and BHP, volumes of around 1.7 billion litres could be achieved annually, with a value of around $2.4 billion.
- At the same time, smaller localised hydrogen projects could be pursued, for example for energy generation for local regional communities where the initial UPP facilities will be located.

Australian self-sufficiency

- Defugo can progressively expand its domestic renewable fuel production operations and support a self-sufficiency goal in renewable diesel, ethanol and A1 Avgas, as well as targeting 5% of the east coast natural gas market with renewable hydrogen.
- In this scenario the market opportunity is estimated at around 38.7 million litres of renewable liquid fuels with a value of around $59.8 million annually, and the injection of a 5% hydrogen blend into the east coast natural gas network, which would be worth around $479.5 million annually.

Export

- As the kenaf cropping and UPP capacity increases around the country, hydrogen exports could be targeted, with Australia positioning itself to win a percentage of the European, Japanese and South Korean markets which are estimated at 18.26 million tonnes annually by 2040, with a value of around $36.5 billion.

Co-Products

While noting the primary objective of these proposed investments in the kenaf – UPP production system is the production of renewable fuels products, these valuable co-products products support the overall economics of the operations and represent significant local and global market opportunities in their own right.

The other two co-products of biochar and alternative proteins will be directed at more nascent markets, which are nonetheless growing rapidly at 13.2% and 14% respectively and the options to support green steel and battery production with low cost, high quality graphene will develop. Defugo will be able to sell these co-products into these markets as they grow.

The UPP process uses 100% of the kenaf biomass to produce high value-add products. In addition to the production of renewable fuels, the process produces co-products such as renewable urea, high grade graphene and biochar from the kenaf stalk, and the same process can also produce alternative proteins from the leaf and seed of the plant.

For example, renewable urea is a direct substitute product in fertiliser market, and this co-product can be readily absorbed into this market ($8.4 billion market in Australia alone).

Key Benefits

Defugo's vision for Australia as a renewable fuels powerhouse brings with it a number of key benefits:

- New $2.4 billion renewable fuels industries created in the initial stages with potential to exceed $60 billion by 2040, supported by local and export markets.
- Reinvigoration of Australia's regions and agricultural sectors, with the creation of 19,800 new jobs in regional areas in 396 UPP modular facilities and regional farms in the initial stages, with potential to expand to over 15,000 UPP plants and around 500,000 jobs out to 2040.
- Establishment of new industries beyond renewable fuels based around co-products produced by the process such as renewable urea, biochar, high-grade graphene and alternative proteins, creating further new employment and incomes for Australia's regions.
- Dual benefit of avoiding emissions from fossil fuels, and sequestering carbon from the atmosphere through the use of the kenaf plant for biomass – for example if Australia achieved self-sufficiency in renewable diesel, A1 Avgas, ethanol and injected a 5% hydrogen blend into Australia's east coast gas supply, abatement equivalent to 62% of Australia's emissions, or to all annual emissions from the electricity and stationary energy sectors would be achieved.
- Leveraging sovereign debt investments into the Australian renewable fuels sector to build scale for domestic and export markets.
- Greater fuel security for Australia.

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Who is Defugo?

1.1 Company Background

Defugo Technologies Pte Ltd (Defugo) is a high-tech manufacturing company which has been successful in applying its innovative separation and biomass conversion technologies to either transform existing industries or create new sunrise industries for over six years.

1.1.1 Fruit juice industry

- The first transformative technology that Defugo took to market was its patented Counter Current Extraction (CCE) technology which was applied in the fruit juice industry. This CCE technology uses 100 per cent of the source fruit in the manufacture of juice and other value-added products, creating an increase in productivity of 25 per cent, compared to traditional fruit crushing technologies.
- The company has been developing and operating the CCE technology at its Mill Park facility in Australia for six years and has spent USD$50 million on research and development (R&D) to develop the technology and is about to further leverage this technical advantage to expand its Australian footprint to the USA market where it is currently establishing two 240,000 MT apple processing facilities.
- The CCE technology is being used by Defugo to reinvigorate the profitability and global growth potential for Australian fruit juice manufacturing for local and export markets and will play a key role in reinvigorating the Australian fruit growing sector.

1.1.2 Renewable fuels industry

Defugo's next wave of innovative biomass conversion technologies will be applied to address one of the most pressing issues facing the globe — the need for new renewable fuels to replace traditional power generation fuels such as gas, and transport fuels such as diesel, aviation fuel and gasoline.

Defugo has invested in R&D to develop the proprietary and patented Universal Processing Plant (UPP), which cost-effectively transforms a wide variety of biomass feedstocks into either:

- Low-cost renewable hydrogen
- ASTM-approved renewable diesel
- A1 Avgas (jet fuel)
- E10 ethanol
- Distributed or central electrical power.

The process also produces a number of valuable co-products such as renewable urea, plant-based proteins, graphene and biochar, which enhance the economics of the process.

The company and its technology partners plan to use the UPP process in the first instance to efficiently convert a high hydrogen synthesis gas into renewable hydrogen without using the Fischer-Tropsch process, catalysts, or fermentation. This is the major technological breakthrough which drives the cost effectiveness of the process. Renewable hydrogen can be reliably produced by the process at below $2 per kilogram.

Similar to the CCE technology, the UPP technology will also play a catalytic role in stimulating the horticulture sector by creating demand for the cultivation of biomass crop kenaf, which will provide the bulk of the biomass for the manufacturing plant.

Kenaf carries significant advantages over other farm-to-fuel alternatives, particularly when processed through Defugo's proven extraction equipment. Whereas other commonly utilised feedstocks used in biofuel and electricity production (such as sugarcane) place additional pressures on agri-food industries due to competing demands for the source material, Defugo can separate the various parts of a kenaf plant and extract valuable proteins from leaf matter, while simultaneously processing renewable fuel from the stalk. This is another critical differentiator from other market technologies and a process efficiency that enables the company to pursue its key objectives across food supply, waste and emissions reduction, and clean energy generation.

Defugo is targeting the establishment of its first UPP system in regional NSW and plans to progressively expand its operations throughout Australia.

1.1 Key objectives

As an organisation, Defugo is focussed on developing and applying new-to-the-world technologies to solve key sustainability, nutrition and health problems facing the world, in a cost effective an environmentally responsible way, and to reinvigorate farming supply chains and communities in a sustainable manner.

Defugo's highly efficient and zero waste UPP technology is a key enabling technology for sustainably improving yield extraction from food feedstocks, improving the capacity of the world to feed itself and to support sustainable and profitable farming and food manufacture.

The CCE process also allows waste products from food processing to be separated and used as high-value ingredients in functional foods, further supporting the sustainability of the food production supply chain.

Defugo's new UPP technology now provides the opportunity for Defugo to build upon its core objectives by utilising a new-to-the-world technology to solve a key global problem of how to replace molecule-based fossil energy such as gas, coal and petroleum fuels with hydrogen and other renewable fuels, while at the same time building a new farming supply chain for the cultivation of key biomass feedstocks such as kenaf.

Defugo is now embarking upon a partnership with the Nordic nations, their Sovereign Funds and other technical partners, to create and finance an Australia Nordic Energy Alliance (ANEA). This alliance will catalyse and finance large scale investments in Defugo's new UPP technology and kenaf-based biomass farming in Australia, that will see Australia become a major global exporter of:

- Renewable hydrogen
- Renewable liquid energy (diesel, A1 Avgas, ethanol)
- Renewable Electricity
- Valuable co-products such as botanical proteins, green urea and biochar

1.2 Key personnel

Defugo Group of Companies

Defugo's leadership team will apply its technical and management expertise to commercialise its new UPP technology in the Australian renewable fuels market.

The core management team is led by **David Coleman**, the co-founder and Chief Innovation Officer for Defugo Technologies Pte Ltd. An environmental sustainability entrepreneur and innovator, David leads the Defugo Group of Companies' food sustainability and renewable energy initiatives globally. David has been the driving force behind matching Defugo's innovative technologies with local and export market opportunities

with some of the world's biggest brands and assembling the team of scientists to develop and commercialise these technologies.

David's objective is to rebalance the global food supply chain by developing and supplying technology that turns today's waste into the super ingredients of tomorrow (i.e., Polyphenols/Flavonoids/Fibres/Plant Proteins). He was a Keynote Speaker at the United Nations Stockholm +50 Global ESG Conference held in Sweden in June 2022. This has been further expanded on when David presented three key notes speeches at COP27 held in Egypt in November 2022.

Steve Douglas is a Director and the Chairman of Defugo Technologies. He is the co-founder and Managing Director of Australasian Taxation Services (1995) and Chairman of SMATS Services Pte Ltd. He wrote the expatriate tax planning book "The Aussie Expat – The Luckiest Person on Earth". Steve has been featured in articles by the *Singapore Business Times*, *South China Morning Post*, *Australian Entrepreneur Magazine*, *Benchmark*, *Western Australian Property & Investment* and *Property Link* magazine.

Steve b career with EY and is a Fellow of the Taxation Institute of Australia and Registered Tax Agent.

Mark Buirski is the co-founder of Defugo and was a Senior Partner with the PwC Technology Consulting Division for almost 10 years in Asia and Australia. He has been continuously involved in many successful M&A activities in the technology sector spanning IPOs, full and partial Sales and Acquisitions, Mergers, and Joint Ventures involving small/medium and large organisations. Mark holds formal qualifications in Accounting and Computing, and has led Management Consulting, large Systems Integration, Outsourcing and Offshore IT/Technology practices across Asia-Pacific and Australasia across numerous industries over a career spanning 30-plus years.

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2.1 The Opportunity

- The pressing need to proactively address climate change and meet the 2050 goal of net zero emissions, along with severe disruptions to global supply chains for traditional fossil fuels and particularly oil and gas, is creating a unique window of opportunity for new renewable technologies to provide lower cost and more secure energy solutions on a global basis.

  In the European Union context for example, as countries move their energy requirements away from Russian gas, they urgently require new sources of reliable renewable energy. Hydrogen has been earmarked to play a critical role in this transition.

- Australia now has a unique opportunity to win a race against other countries to generate cost competitive renewable hydrogen at a large enough scale to export energy in vast quantities to meet for example, a European Union goal of using 20 million tonnes of hydrogen each year by 2030, 10 million tonnes of which would be imported[1]. This is up from 5 million tonnes before the energy crisis.

- However, participating in this race requires world-leading technology, capable of producing low-cost hydrogen, and sovereign scale capital investments to build the required infrastructure needed for global hydrogen supply chains.

  On the technology side, Defugo's UPP technology and kenaf cultivation plans present a unique and timely opportunity to produce hydrogen at under $2 per kilogram, through a modular technology that can be rapidly scaled for local and export production.

- On the capital investment side, the Nordic nations of Europe have joined together to create a sovereign scale funding group for Economic, Social and Governance (ESG) projects globally, with hydrogen projects being a particular area of focus.

- This group will be led by the largest sovereign funds in the world and coordinated by Urbs in Sweden. The group is seeking to enter into an Australia Nordic Energy Alliance (ANEA), that will be the process through which capital will be provided to build an export scale renewable hydrogen supply chain in Australia.

Through the ANEA, Defugo will access the capital required to:

- First, make the initial investments in a kenaf-to-renewable-hydrogen supply chain for the domestic Australian market; and
- Second, scale these initial investments to the level required to export renewable hydrogen to Europe, the Asia Pacific and elsewhere around the world.

2.1.1 Market entry strategy – the Australian market

As the UPP technology is modular and scalable, a pathway to building capability and scale in low-cost renewable hydrogen production can be built initially from the local Australian market.

[1] https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

As hydrogen is still a very new energy source in Australia, this flexibility in the UPP system means that the initial scale-up of the UPP technology can be based around the production of drop-in renewable liquid fuels such as renewable diesel, A1 Avgas and ethanol, as first horizon products. Increases in renewable hydrogen production from the UPP process can follow as market opportunities emerge, which are expected to include:

- Use of hydrogen to power localised energy generation in regional towns; and
- Injection of hydrogen into mainstream natural gas pipelines.

Over time, as the number of domestic hydrogen use cases increase, hydrogen production for local use can grow.

To give an indication of the horizon 1 domestic market opportunity, the following table shows the land requirement, kenaf biomass production and carbon reductions that would be achieved if:

- all of Australia's consumption of diesel, A1 Avgas and ethanol fuels were substituted for renewable fuels produced by the UPP process; and
- Australia's east coast domestic natural gas supply was blended with five per cent renewable hydrogen.

Table 1 – Current select Australian fuel consumption substituted for UPP renewable fuels

	Land (ha)	MT per ha	Biomass MT	CO2 Sequestered (tonnes)	CO2 Emissions Removed (tonnes)	Target Output	Units
Diesel	3,482,000	32	111,424,000	139,280,000	90,299,920	33,694,000,000[2]	Litres
Avgas	500,579	32	16,018,528	20,023,160	10,654,114	4,844,100,000[3]	Litres
Ethanol	21,464	32	686,848	858,560	396,707	207,700,000[4]	Litres
H2	181,848	32	5,819,136	7,273,920	1,494,036	239,748[5]	Tonnes
Total	**4,185,891**	**32**	**133,948,512**	**167,435,640**	**102,845,111**		

[2] Based on 2021-22 sales of diesel in Australia per Commonwealth of Australia, Department of Climate Change, Energy, the Environment and Water, Australian Petroleum Statistics – Data Extract June 2022 (Reissue), Sales by products tab

[3] Based on 2021-22 sales of aviation turbine fuel in Australia per Commonwealth of Australia, Department of Climate Change, Energy, the Environment and Water, Australian Petroleum Statistics – Data Extract June 2022 (Reissue), Sales by products tab

[4] Based on 10 per cent of 2021-22 sales of ethanol-blended fuel in Australia per Commonwealth of Australia, Department of Climate Change, Energy, the Environment and Water, Australian Petroleum Statistics – Data Extract June 2022 (Reissue), Sales by products tab (2,077 ML x 10 per cent = 207.7ML)

[5] Based on 5 per cent of the natural gas supplied into the east coast market of Australia of 580 PJ, per Australian Energy Regulator, State of the Energy Market 2021, pg. 182

The table above shows that less than one per cent of Australia's total land mass[6] would need to be cultivated with kenaf, for Australia to achieve self-sufficiency in diesel, A1 Avgas and ethanol fuel, and a five per cent hydrogen blend in its east coast natural gas supply.

The table also shows that this level of renewable liquid fuel production using the UPP technology and a five per cent blending of hydrogen into the east coast gas supply, would achieve carbon abatement of around 301.4 million tonnes per annum, which is 62 per cent of Australia's total emissions[7], or equivalent to all annual emissions from the electricity and stationary energy sectors.[8]

In terms of initial "first-mover" commercial targets for the supply of renewable energy from the UPP process for domestic use, the following table provides an illustrative pathway for building scale domestically, before further expanding for export growth.

Table 2 – Illustrative commercial scenarios for renewable fuels for target domestic customers

	Land (ha)	MT per ha	Biomass MT	CO2 Sequestered (tonnes)	CO2 Emissions Removed (tonnes)	Target Output	Units
Qantas[9]	79,210	32	2,534,720	3,168,400	11,238,934	766,500,000	Litres
Toll Holdings[10]	14,675	32	469,600	587,000	380,393	141,937,687	Litres
BHP[11]	86,797	32	2,777,520	3,471,900	2,250,951	839,922,048	Litres
Total	**180,682**	**32**	**5,781,840**	**7,227,300**	**13,870,278**	**1,748,359,735**	**Litres**

The table shows that a negligible percentage of Australia's total land mass would need to be cultivated with kenaf to meet these illustrative market entry strategies for A1 Avgas and renewable diesel. These scenarios also illustrate that a modest commercial market entry strategy based around a few large players would make significant impacts of Australia's carbon footprint (reduction of 21.1 million tonnes per annum) and help rapidly build scale a nd position the new industry for domestic and export growth.

[6] Australia's land mass is reported at 7.692 million square kilometres at - info.australia.gov.au

[7] Australia's annual emissions to December 2021 of 488.0 million tonnes were reported on the Department of Climate Change, Energy, the Environment and Water's website - https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-gas-inventory-quarterly-update-december-2021

[8] *Ibid*, refer to 'Emissions by sector' table.

[9] Qantas has committed to SAF representing us to 15 per cent of its annual fuel purchased out of London Heathrow Airport. This data projects requirements for 15 per cent of its annual needs, substituting in renewable fuels.

[10] Toll Group 2021 Sustainability Report. Toll disclosed 380,393 tonnes of CO2 emissions from diesel consumption, indicating 141,937,687 litres of diesel usage (at approx. 2.68kg/l rate of emissions).

[11] BHP consumed 5,282,636 barrels (i.e., 839,905,140 litres) of sold crude oil and condensate products in FY2021. All energy produced as crude oil/condensates combusted as diesel for stationary energy purposes. https://www.bhp.com/-/media/documents/investors/annual-reports/2021/210914_bhpscope12and3emissionscalculationmethodology2021.pdf

Several valuable co-products are also produced by the process such as renewable urea and biochar, which further support the cost competitiveness of the UPP technology, and present further opportunities for new regional industries and supply chains that go beyond the new renewable energy products that can be produced using the process.

2.1.2 Export markets

- The European Union's greenhouse gas emissions reduction target for 2030 is for a 40 per cent reduction on 1990 levels, and it is currently proposed that this ambition will be increased to 55 per cent on 1990 levels .
- A key action in support of this wider emissions reduction target, is the European Union (EU) setting a target for 10 million annual tonnes of hydrogen imports by 2030, guaranteeing a world scale market for first movers .

In the Asia-Pacific region, Japan and Korea are also emerging as global leaders in hydrogen usage:

- Japan has set an emissions reduction target of 46 per cent below 2013 levels by 2030, and a target of 3 million tonnes of hydrogen to be used by 2030[14]; and
- Korea has set an emissions reduction target of 40 per cent below 2018 levels by 2040, and a target of 5.26 million tonnes per annum by 2040[15].

To put this renewable hydrogen opportunity into perspective, the hydrogen opportunity for Australia when directed at a five per cent injection into the east coast gas network comes to 239,748 tonnes per annum.

By contrast, the annual renewable hydrogen opportunity into these three economies alone comes to around 20 million tonnes by 2030, and at least 25 million tonnes by 2040 – this is around 80 times the Australian east coast direct injection market opportunity estimated above.

While Australia will not supply 100 per cent of these export market opportunities, it is worth noting that the availability of land would not represent a constraint on production. As illustrated in the table below, 27,700,240 hectares of land would be required to produce 100 per cent of the kenaf biomass required to meet this volume, representing around 1.8 per cent of Australia's land mass.

Table 3 – Select renewable hydrogen export potential for UPP renewable hydrogen

[12] https://ec.europa.eu/clima/eu-action/european-green-deal/2030-climate-target-plan_en

[13] https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

[14] https://energytracker.asia/japan-hydrogen-strategy/

[15] South Korea aims to increase its hydrogen usage to 5.26 million tonnes per annum by 2040. https://www.csis.org/analysis/south-koreas-hydrogen-industrial-strategy

	Land (ha)	MT per ha	Biomass MT	CO2 Sequestered (tonnes)	CO2 Emissions Removed (tonnes)	Target Output	Units
EU[16]	7,584,952	32	242,718,432	303,398,040	62,330,688	10,000,000	Tonnes
Japan[17]	2,275,485	32	72,815,520	91,019,400	18,699,206	3,000,000	Tonnes
South Korea[18]	3,989,684	32	127,699,888	159,587,360	32,785,942	5,260,000	Tonnes
TOTAL	**13,850,120**	**32**	**443,233,840**	**554,004,800**	**113,815,836**	**18,260,000**	**Tonnes**

- It is important to note that the flexibility of the UPP process also means that once the production capacity is established in Australia, it can also be used to produce renewable liquid fuels such as diesel, A1 Avgas and ethanol, which could also be exported to these and other markets.
- Further, the production of hydrogen and other fuels using the UPP process also generates valuable co-products such as renewable urea and biochar, which can also be sold on domestic and export markets.
- This value chain is created using the stalk of the kenaf plant.
- When the leaf and seed from the biomass is processed using the UPP, further value-added co-products in the form of botanical proteins can also be produced, further enhancing the economics of the process.
- This full range of benefits is further explored below.

[16] The European Union (EU) has an ambition to produce 10 million tonnes and import 10 million tonnes of renewable hydrogen in the EU by 2030. https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen_en

[17] Japan's *Green Growth Strategy Through Achieving Carbon Neutrality in 2050*, drafted by the Ministry of Economy, Trade and Industry (METI), seeks to increase the volume of hydrogen used in the economy from 3 million tonnes by 2030, and 20 million tonnes by 2050. https://www.trade.gov/market-intelligence/japan-focuses-hydrogen-key-renewable-energy-source

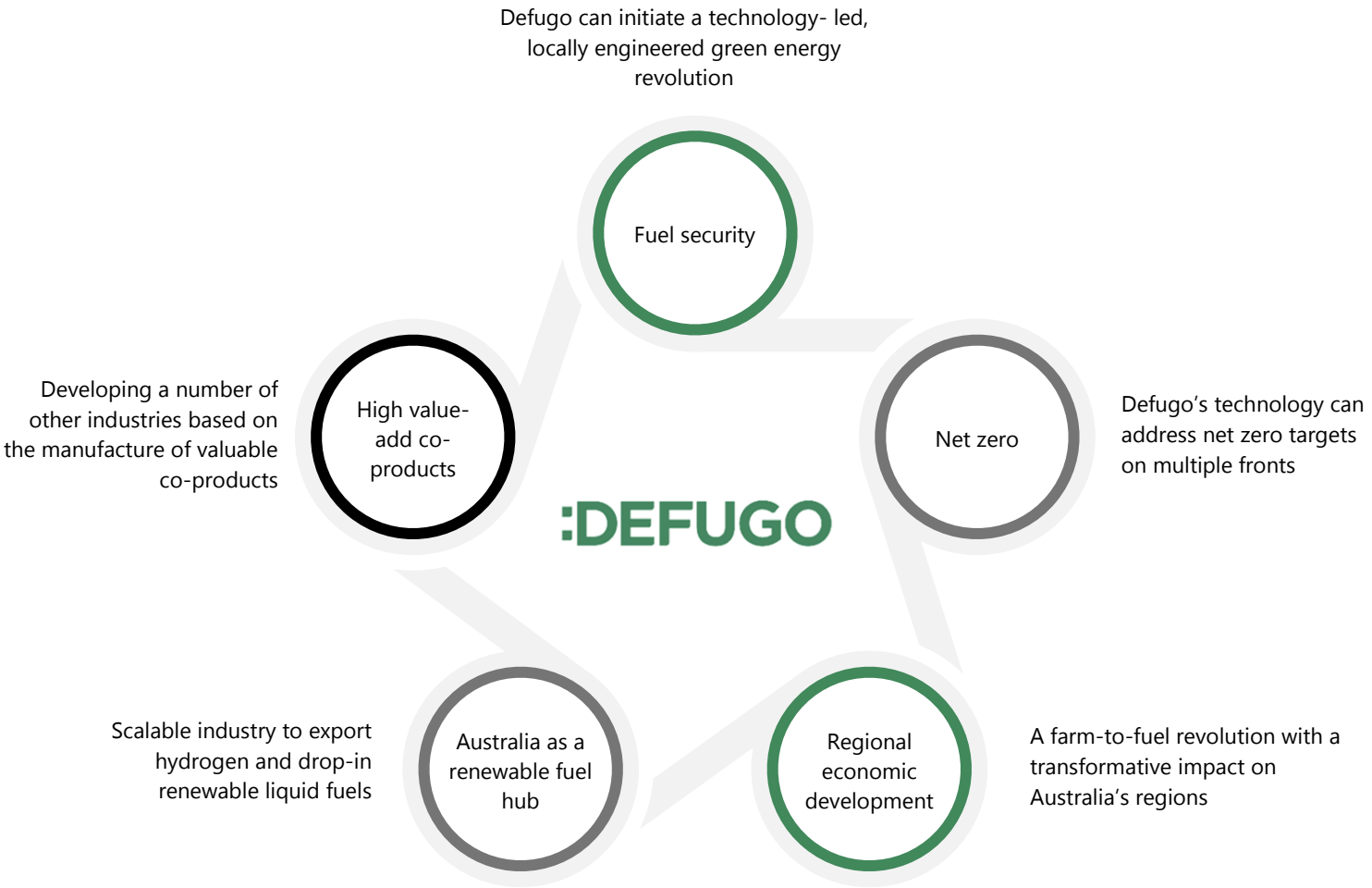
[18] South Korea aims to increase its hydrogen usage to 5.26 million tonnes per annum by 2040. https://www.csis.org/analysis/south-koreas-hydrogen-industrial-strategy

2.3 The Benefits

There are several key benefits associated with the establishment of Defugo's UPP technology in Australia. At the core of these benefits is the establishment of a world scale renewable hydrogen export industry, and the enhancement of Australia's sovereign supply chain capabilities in achieving self-sufficiency in renewable hydrogen and liquid transport fuels and growing new regionally based industries.

The details of these benefits are set out below.

Figure 1 – Key benefits of Defugo's Universal Processing Plant (UPP) technology



1.3.1 Fuel security

- Recent geopolitical and supply chain pressures have brought the issue of fuel security to the foreground. A number of Commonwealth Government initiatives have sought to address this, including purchasing additional reserves of crude oil and agreeing to store it within the United States' Special Petroleum Reserve (SPR) for an initial period of 10 years and providing short-term subsidies to local oil refineries to shore up domestic stocks.
- These measures are at best temporary and in the event of an emergency, Australia has access to an estimated 20 – 30 days' worth of petroleum and diesel reserves onshore . This fails to comply with the terms of the International Energy Program Treaty (to which Australia is a signatory) and leaves the country vulnerable to economic shocks and unforeseen events. Australia consumes 30 billion litres of diesel fuels per annum — all of which is imported. Meanwhile, only 0.5 per cent of Australia's transport fuels are sourced from renewables..
- Defugo's UPP technology can tackle the heart of the liquid transport fuel security problem by initiating a technology-led, locally engineered green energy revolution, with the potential to become self-sufficient in renewable diesel and support an expansion of ethanol blended fuel and renewable aviation fuels into the future.
- Renewable hydrogen could also be produced using the process, which would assist with longer term transitioning of transport technology to hydrogen powered vehicles.

1.3.2 Net zero

- Defugo's UPP technology can tackle the net zero emissions by 2050 target on two main fronts.
- First, the transport fuels that can be produced using the technology, including renewable diesel, A1 Avgas, E10 ethanol and renewable hydrogen, all address the problem of how to find replacement renewable molecule fuels for use in the transport sector. These have a direct and substantial impact on reducing the 18.1 per cent of emissions produced by the transport sector. These fuels reduce NOx emissions by 14 per cent, particulates by 34 per cent and achieve a 97 per cent reduction in carbon emissions.
- To illustrate the scale of this opportunity, if all of Australia's diesel transport fuels were transitioned to renewable UPP-derived fuels, around 90.3 million tonnes of carbon[19] would no longer be emitted into the atmosphere each year.
- Second, the kenaf crops used as feedstock for the UPP are highly effective in sequestering carbon in the soil and can sequester carbon at a rate of 20 tonnes per hectare. To give an indication of the scale of the carbon sequestration which can be achieved from the propagation of a kenaf renewable fuel crop, if 100 per cent of Australia's diesel was produced in this way (i.e. 33.7 billion litres), 139.3 million tonnes of carbon would be sequestered annually, reducing Australia's overall carbon footprint by more than 25 per cent[20].
- The equivalent carbon sequestration figure that could be achieved if all of Australia's diesel, ethanol and aviation liquid transport fuels were transitioned to renewable UPP-derived fuels, would amount to around 160.2 million tonnes annually.

1.3.3 Regional economic

- The farm-to-fuel revolution which can be brought about through Defugo's UPP technology will have a transformative impact on Australia's regions.
- The most direct impact on regional development will be through employment.
- Each 52,000 litre UPP system module will directly employ around 35 people on site. To put this into perspective, if the volumes for the initial Australian market entry opportunities for renewable liquid fuels shown in Table 2 were to be produced locally, this would equate to 396 UPP plant modules, employing around 13,860 people around Australia.

[19] Calculation: 2.68kg CO2/litre in emissions from diesel, approx. 33.7bn litres of diesel consumed pa, = 90,300,000,000 kgs of emissions, =

[20] Based on available data as at December 2021, reflecting annual emissions of 488 MT: https://www.industry.gov.au/data-and-publications quarterly-update-december-2021

- By contrast if Australia achieved self-sufficiency in the production of renewable diesel, A1 Avgas, ethanol for fuel blending and a 5 per cent blend of renewable hydrogen in the east coast gas supply as shown in Table 1, this would equate to around 9,175 UPP plant modules nationally, employing around 321,125 people nationally.

- When the global opportunity represented by hydrogen exports to Europe, Japan and South Korea shown in Table 3 is considered, if Australia could win 20 per cent of these opportunities by 2040, this would require 6070 UPP plant modules and employ around 42,500 people nationally.

- When the employment generated in the farming sector is considered, the employment outcomes are significant. In particular, it is estimated that each farm would need to employ around 15 people on an ongoing basis to produce the kenaf crops on a rotational basis, for each 52,000 litre UPP module[21]. Based on these estimates, the farming jobs created in each scenario could be estimated as follows:

  - for the initial Australian market entry opportunities for renewable liquid fuels shown in Table 2, an estimated 5,940 farming jobs would be created nationally;
  - for the self-sufficiency scenario shown in Table 1 for the domestic production of renewable diesel, renewable A1 Avgas, ethanol for fuel blending and a 5 per cent blend of renewable hydrogen in the east coast gas supply, an estimated 137,625 farming jobs would be created; and
  - if 20 per cent of global opportunity represented by hydrogen exports to Europe, Japan and South Korea shown in Table 3 could be met by Australian UPP production (3.652 million tonnes), an estimated 18,214 farming jobs would be created.

- It should be noted that the employment figures for the above scenarios do not take into account the many flow-on jobs that would be created in other ancillary sectors such as transport and logistics for example.

These investments would also be responsible for a significant increase in regional output[22]:

For the initial market entry opportunities for renewable liquid fuels shown in Table 2, the additional annual regional output by product type is estimated at $1.6 billion for renewable diesel for Toll Holdings and BHP as illustrative examples, and $76.6 million for renewable A1 Avgas for Qantas as a further illustrative example;

For the self-sufficiency scenario shown in Table 1 for select renewable fuels produced using the UPP technology, the additional annual regional output by product type is estimated at $54.4 billion for renewable diesel, $5.1 billion for renewable A1 Avgas; $330 million for ethanol and $483 million for renewable hydrogen used as a 5 per cent blend in east coast gas supply; and

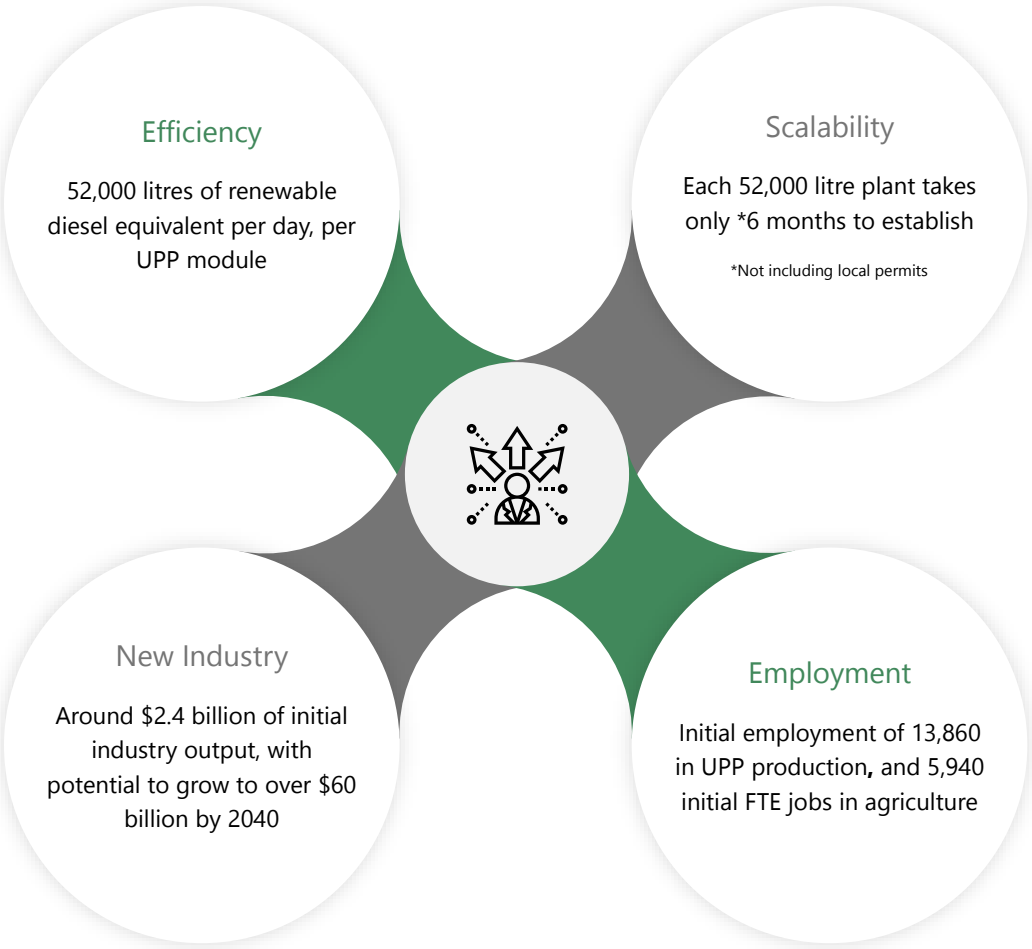
For a scenario where 20 per cent of global renewable hydrogen export opportunities shown in Table 3 are produced by Australia using the UPP technology for Europe, Japan and South Korea, additional annual regional output of $7.3 billion would be the target out to 2040.

Some of the key regional economic opportunities from UPP technologies are summarised in the diagram below:

Figure 2 – Key regional economic opportunities

[21] ABARES data for 2020-21. Avg. of 135,000 workers for horticultural farming (seasonal peak of 146k in summer/autumn). Total population of horticulture farms = 10,403. Rounded up to 15 persons per farm for clarity.

[22] Note, the detailed calculation for these output figures are provided in Section 4 of this report.


Efficiency
52,000 litres of renewable diesel equivalent per day, per UPP module
Scalability
Each 52,000 litre plant takes only *6 months to establish
*Not including local permits
New Industry
Around $2.4 billion of initial industry output, with potential to grow to over $60 billion by 2040
Employment
Initial employment of 13,860 in UPP production, and 5,940 initial FTE jobs in agriculture

1.3.4 High value-add co-products

- In addition to the opportunity to develop a globally significant renewable hydrogen and renewable liquid transport fuels industry for Australia, there is also an opportunity to develop a number of other industries based on the manufacture of valuable co-products, generating further income and employment for Australia's regions and the nation. These products include:

Renewable area;

Plant based proteins; and

Graphene & biochar.

- The production of these valuable co-products does not require any additional land for production of the kenaf crops, and the UPP technology can separate out these co-products in the one vertically integrated process.
- This means that they can be produced with high efficiency and form the basis of new economically and environmentally sustainable Australian industries.
- Taking the self-sufficiency scenario shown in Table 1 where Australia produces 100 per cent of its renewable diesel needs, A1 Avgas, ethanol for fuel blending and sufficient renewable hydrogen to inject a 5 per cent blend into the east coast gas supply, this would equate to annual urea production of around 31 million tonnes and biochar of around 18 million tonnes. These co-products which are derived from the kenaf stalk would in time create two further multi-billion dollar industries, as these are high-value commodities in their own right. This is before the value adding to the kenaf leaf and seed biomass is considered. These parts of the kenaf plant are used to manufacture plant-based protein products, which further enhance the value adding of the kenaf crop using the UPP process.

1.3.5 Australia as a global renewable

- As outlined above, Australia has the opportunity to be a major exporter to countries leading the transition to renewable hydrogen as an energy source, such as the EU countries, Japan and South Korea, and share in markets forecast to be around 18.26 million tonnes annually by 2040.
- If Australia could supply 20 per cent of this renewable hydrogen volume (3.652 million tonnes), then by 2040 it would have:
  - 5.54 million hectares of land under cultivation with kenaf
  - 6,071: 8 Unit modular UPP plants in regional areas around the country
  - 42,500 new jobs in UPP plants and 18,214 additional farming jobs nationally
  - $7.3 billion of new export revenue for the country annually
  - Sequestering 110,800,960 Metric Tons of Carbon into the soil
  - Revenue of $5.3 billion in biomass sales to Australian Farmers
- In addition to this progressive scaling of an Australian hydrogen export industry, the initial investment stages in the establishment of the kenaf crops and UPP plants will support the production of renewable liquid transport fuels such as renewable diesel, renewable A1 Avgas and ethanol, helping to build self-sufficiency in these key fuels for domestic use.
- In time these drop-in renewable liquid fuels also present an opportunity for large scale production for export markets. If Australia could supply one per cent of global markets, this would represent around $14.8 billion[23] USD of export revenue per annum would require either a dialling down of the production of renewable liquid transport fuels, or additional cultivation of kenaf.

[23] Refer to footnote 33 (diesel); footnote 40 (ethanol), and to https://www.databridgemarketresearch.com/reports/global-gasoline-market (gasoline)

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3

Technology Overview

3.1 Defugo technology – two key elements

Defugo's breakthrough process for the manufacture of renewable hydrogen and renewable liquid fuels combines two key technologies to create the opportunity for Australia to become self-sufficient in hydrogen and renewable liquid fuel production, and a major exporter to the world.

1

The first element is the use of the kenaf plant as the feedstock for the process. The kenaf plant has a number of features which make it highly productive as a feedstock for the manufacture of renewable hydrogen and renewable liquid fuels, ranging from its chemical properties through to its fast crop cycles and ease of propagation. Defugo is currently working with 355 genomic sequences of kenaf to further optimise its cultivation and effectiveness as a feedstock.

2

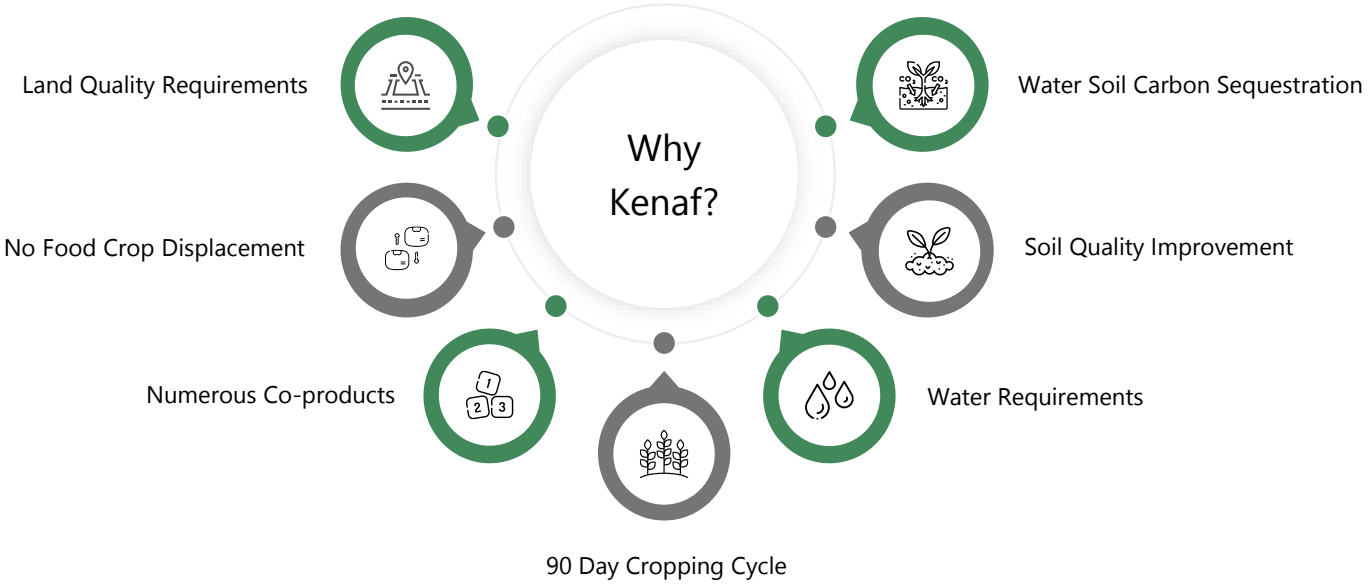
The second element is the patented UPP which with its technology partners, efficiently converts the biomass derived from the stalk of the kenaf crop into a high hydrogen synthesis gas which is converted into hydrogen and other renewable liquid fuels, without using the Fischer-Tropsch process, catalysts, or fermentation. This is the major technological breakthrough which drives the cost effectiveness of the process.

Further details of these two complementary elements of the Defugo UPP system are provided below.

3.2 Why kenaf?

- Historic efforts to accelerate decarbonisation with renewable fuels from cropping have been fundamentally constrained by the requirement to divert higher quality arable land away from the cultivation of crops for food, and instead diverting these crops towards the production of fuel. This problem has undermined the sustainability of this method for obtaining renewable fuels and has at times been challenged on moral grounds.
- The use of kenaf as the feedstock to produce renewable liquid fuels overcomes these more fundamental problems and has a number of key properties which enhance its candidacy as a crop of choice for use in the manufacture of renewable fuels. These properties are summarised in the diagram below.

Figure 3 – Key beneficial properties of the kenaf plant



3.2.1 Land quality requirements

- The kenaf plant can grow in low quality soils which would not usually be suitable for cropping. One of kenaf's many advantages as a potential biomass feedstock is its resilience as a crop, being able to withstand a variety of adverse conditions. For example, kenaf's versatility is evident in its ability to tolerate and overcome drought conditions, modest soil fertility and flooding.
- Hence, expansion of kenaf production can occur in less conventional areas, with land quality not acting as a constraint on industry growth. This also provides opportunities to conserve the utilisation of land for other food crops as necessary.

3.2.2 Soil carbon sequestration

- The kenaf plant is highly efficient at delivering soil carbon sequestration. The deep root system of the kenaf plant which extends down deep into soil, reflecting what's above the ground as in Figure 4, to sequester carbon, storing 20 MT of CO2 per hectare in every 90-day crop cycle. This is a significant co-benefit from a carbon emissions reduction point of view that is additional to the CO2 that is saved by substituting the renewable hydrogen, diesel, A1 Avgas or ethanol for fossil fuels. For example, the production of 33.7 billion litres of renewable diesel saves 90.3 million tonnes of CO2 in use, that is on top of a further 139.3 million tonnes of CO2 that would be sequestered in the soil by the kenaf crop.

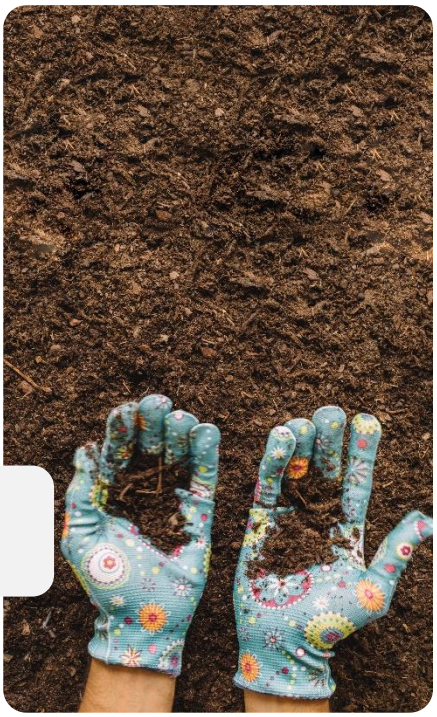


Figure 4 – Illustration of soil sequestration properties of the kenaf plant through its root system

3.2.3 Soil quality improvement

- Defugo has worked with the University of Sydney to conduct research into the significant soil quality impacts of kenaf cropping on soil. This research has shown that kenaf serves a critical function in restoring soil quality through its strength in sustaining high rates of soil carbon sequestration. Transferring atmospheric carbon through the kenaf plant to deep within the soil through its deep root system improves soil health (by promoting greater water retention, increasing soil carbon and helping retain and regenerate other nutrients), and supports the 90 day kenaf cropping cycle on a sustainable basis.
- In addition, as the UPP system also manufactures biochar and green urea, these co-products can be used to further support soil health. Fungi and microbe inoculated biochar is the breeding ground for the next generation of biomass and remains active in the soil for thousands of years to come.

3.2.1 Water requirements

- The kenaf plant does not require large quantities of water to support its cultivation, which is supported by its deep root system and carbon sequestration properties which helps the soil's capacity to retain water.
- Kenaf is also capable of drawing significant per cent of its water requirements through atmospheric moisture.

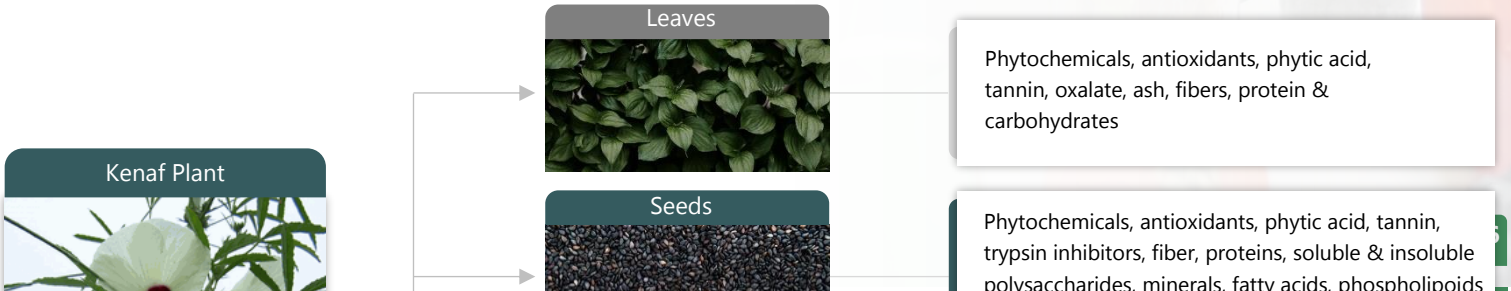
3.2.2 90-day cropping cycle

- The kenaf plant is a vigorous growing plant, which can reach maturity within 90 days. This reduces the amount of land required to cultivate the plant due to its high yield and fundamentally supports the economics of the process. As a rich, fibrous plant with a narrow and tall stalk, kenaf can reach heights greater than three metres within its targeted 90-day cropping cycle, with harvesting best conducted immediately prior to flowering to avoid the production of unwanted branches.
- The kenaf crop delivers 20 tonnes per hectare every 90 days, with sewing and harvesting perpetually staggered on a daily or weekly basis, so that there is a steady flow of feedstock from the farm to the UPP system each day.
- This perpetual year-round cycle provides the basis for consistent year-round employment on farms, as opposed to seasonal employment opportunities, with matching year-round income streams for farmers. This continuous production cycle provides the economic basis for growing larger and more sustainable regional populations, in a number of high value-add supply chains. The more regular and certain cash flows for fa rmers also improves the sustainability and certainty of farm incomes.

3.2.3 Numerous co-products

- Kenaf's diverse properties underpin the development of a range of industries beyond biomass for energy utilisation.
- The plant can be used for numerous nutritional and pharmacological co-products such high value protein supplements for livestock, and valuable acids, oils, and proteins captured in the seeds that can be employed in the manufacture of cosmetic, food and pharmaceutical products for human use and consumption. Oil extracted from the seeds of the kenaf plant is edible, containing key omega-3s, 6s and 9s with a full spectrum of proteins at 87 per cent purity at concentrate, possessing aromatic qualities not dissimilar to that of peanut oil. Due to the Defugo UPP processing the concentrate can be separated down into protein isolates, which has not previously been achievable in plant proteins.

Figure 5 – Uses of different elements of the kenaf plant



The UPP process also extracts lysine, the super protein, from the kenaf plant. Lysine is an essential amino acid as the human body cannot make it, and so it needs to be obtained from food. Lysine is important for normal growth and muscle turnover and is used to form carnitine, a substance found in most cells of the human body. Using kenaf as an abundant source of lysine is a big step forward in the replacement of bovine serum in lab meats and other processes that require protein media, such as vaccines and medicines.

The leaf and seeds from the kenaf plant will be used initially to produce plant-based proteins used in animal protein supplements, with the potential for a range of new and innovative plant derived products for human consumption to be produced in the future.

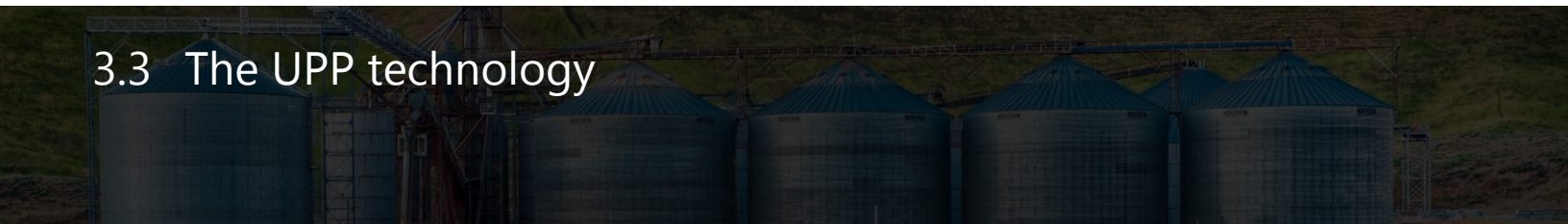
Dried stalks which contain the bulk of the value for renewable fuel production will be utilised to produce renewable hydrogen and renewable liquid fuels including diesel, A1 Avgas and ethanol.

In the initial phases renewable biochar and urea will also be produced as by-products of the renewable fuel production process. The biochar also contains high grade graphene which can be separated from the biochar and used in new battery and green steel technology as they develop.

Defugo is working closely with The University of Sydney's CAFE team to integrate research breakthroughs into its kenaf investments and expedite the commercial opportunities associated with these co-products.

3.2.4 No displacement of food crops

- The use of kenaf as the source of biomass for the production of the full range of products which can be produced using the UPP technology means that traditional food crops are not diverted into fuel production and away from human consumption. In fact, greater farming of the kenaf plant will increase the amount of valuable alternative plant-based protein available in the market, and support the production of more food, not less.
- Further, as the kenaf crop can be grown in a wide variety of soils and climatic conditions, it is not necessary to compete for land which is currently used for the production of traditional foods in order to produce products such as renewable fuels. This will also ensure that food crops are not displaced by the production of kenaf.



3.3 The UPP technology

3.2.5 Overview of UPP technology

The patented UPP technology provides an efficient way to convert the biomass from the kenaf plant into a range of value added outputs. Energy related outputs can include for example:

Low cost renewable hydrogen;

Renewable liquid fuels such as renewable diesel, A1 Avgas and ethanol

Distributed or central station electrical power

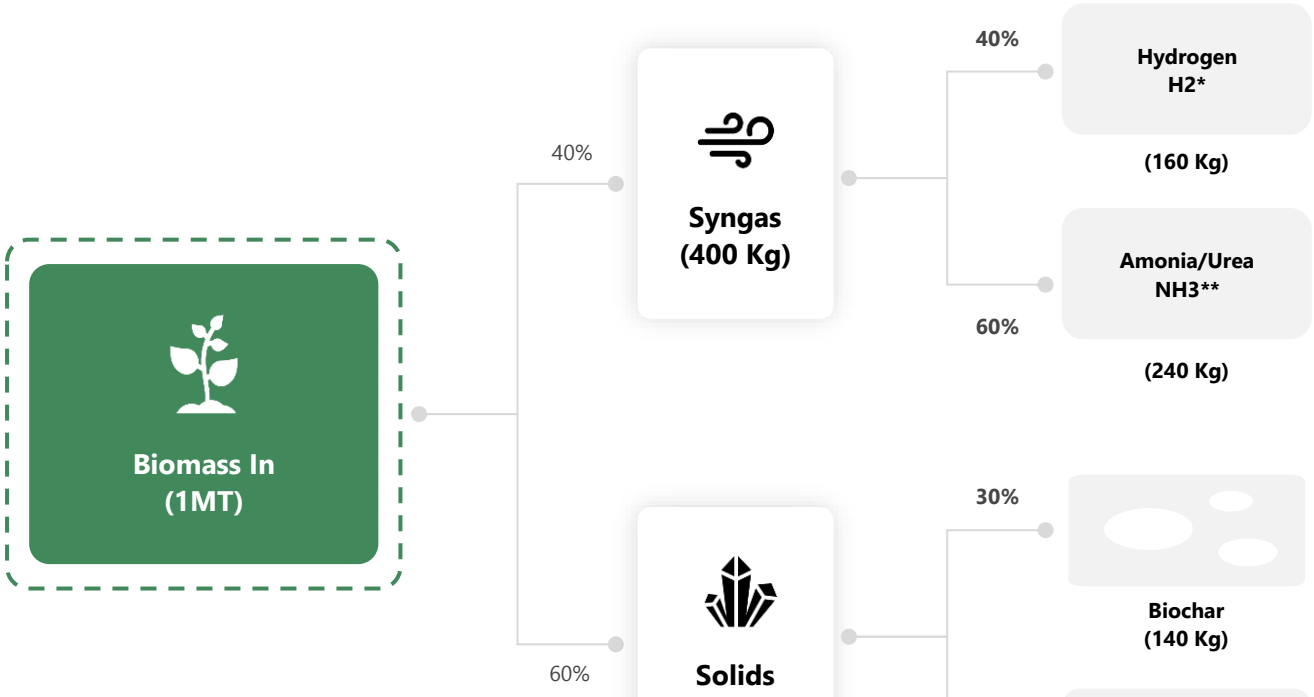
Other co-products to be produced alongside renewable fuels in the initial stages of Defugo introducing the UPP technology to Australia will include:

- Renewable biochar and urea, both of which are a by-product of the fuel manufacturing process; and
- Plant protein for use in animal feed, with plant proteins for human consumption to follow.

In the future, cosmetic, food and pharmaceutical products can be produced from chemistry present in the leaves and seeds of the kenaf plant.

The efficiency of the UPP process in converting one metric tonne (MT) of kenaf stalk into multiple co-products is Illustrated in the following diagram (with renewable hydrogen as the target fuel output).

Figure 6 – Conversion of the kenaf stalk into valuable outputs



- The UPP process can be fine tuned to produce hydrogen, renewable diesel, A1 Avgas or ethanol fuels. The diagram illustrates a scenario where hydrogen is the target renewable fuel being produced

  ** Amonia can be produced as an end product or can be converted into renewable urea, or re-cracked into hydrogen

- It should be noted that the above diagram only shows the conversion of the kenaf stalk into valuable outputs. The plant proteins from the kenaf plant are derived from the plant's leaves and seeds, which represents an additional value stream. These parts of the kenaf plant can also be processed through the UPP technology.

- The UPP with its technology partners works by converting a high hydrogen synthesis gas into a range of renewable fuels such as hydrogen, renewable diesel, A1 Avgas and ethanol, without using the Fisher-Tropsch process, catalysts, or fermentation. Instead, the process uses pyrolysis in multiple reactors to achieve this outcome.
- This represents the major technological breakthrough for the UPP. The tightly controlled UPP process is illustrated below, post plant protein extraction.

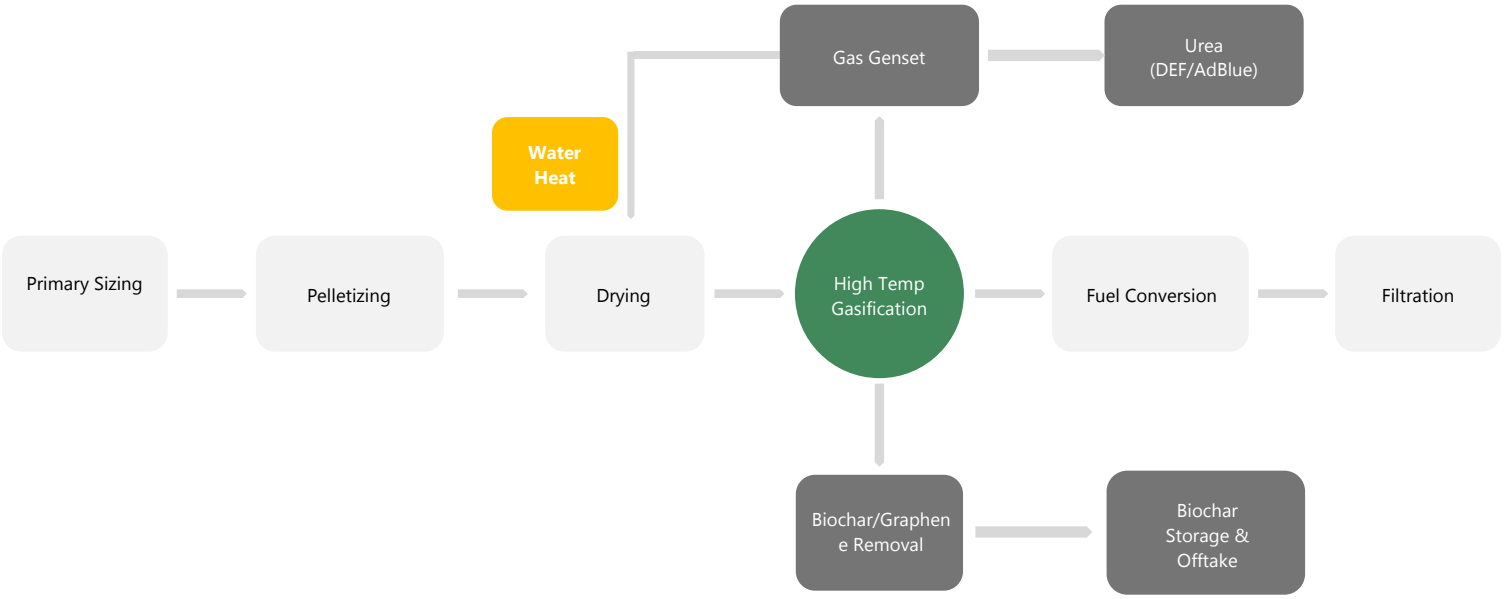


Figure 7 – Illustration of UPP process

The biomass being fed into the process goes through a precise chipping and sizing process to before being dried to the required moisture content. For example, biomass feedstock for renewable diesel is dried to a point where it has only 14 per cent moisture content when fed into the process, whereas feedstock for other target renewable fuel outputs will target higher moisture content levels. Achieving the optimal level of moisture content in the feedstock early in the process assists managing downstream water levels, which is important for the manufacturability and quality of the target renewable fuels.

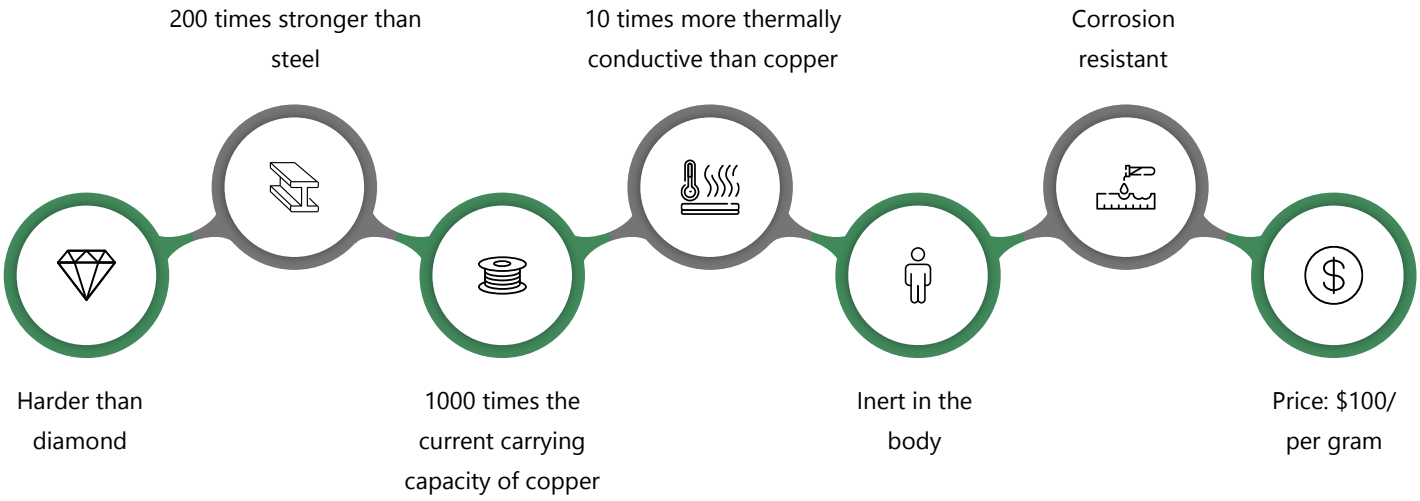
The pyrolysis and gasification processes operate under high temperature at 1,100 degrees Celsius, with energy coming from solar. The hydrogen synthesis gas then goes through a fuel conversion stage and final filtration before emerging as a drop-in fuel, which means that it can be blended with (or replace) petroleum-based diesel in any ratio.

The tight controls applied to the process ensures that the water and oxygen content of the processes' hydrocarbons is extremely low at 0.04 per cent and 1.0 per cent respectively, compared to other biofuels which are high in water and oxygen content of around 30-35 per cent. This is a key feature which gives the renewable fuels produced by the UPP their drop-in properties. For these reasons, the renewable diesel for example is a preferred product under California's Low Carbon Fuels Standard.

The process also recovers significant amounts of water, with each tonne of biomass generating half a tonne of water, making the process water positive and able to be established with no net additional water required to make the process work.

The biochar emerges as a by-product of the high temperature pyrolysis process and has only 2 per cent volatiles, making it stable in the soil for centuries when used as a soil amendment. The biochar has also been shown to have graphene properties providing future potential for higher value applications of this material, as illustrated below.

Figure 8 – Beneficial properties of graphene



The other key by-product generated by the process is the production of a renewable biochar product, which when fed to cattle as a 0.5 per cent supplement to feed reduces methane emissions by 22 per cent and increases the weight of the cattle by 25 per cent.

The entire fuel production cycle when using the kenaf feedstocks and its activated biochar as a soil amendment is carbon negative.

3.2.6 Scalability of UPP technology

- The UPP system is modular, with a daily capacity of 52,000 litres of renewable diesel (or other liquid fuels),or around 4,500 kgs of renewable hydrogen.

- Hence, for 1 year, assuming a single shift and only one crop rotation, each module can produce around 13.5 million litres of renewable diesel or other renewable liquid fuels, (or around 1,2m Kgs of renewable hydrogen), with flow on co-products shown in Figure 6 above. These products are derived from the kenaf stalk alone, with further value adding possible through the use of the leaf and seed from the kenaf plant, to produce products such as plant-based proteins.
- As the process has zero waste, zero odour and no visible distillation towers, it is environmentally inert and is easy to locate flexibly near to feedstock and a labour supply.
- For these reasons expansion of the industries based on the UPP technology can be planned and scaled across the country

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4

Commercial Outlook

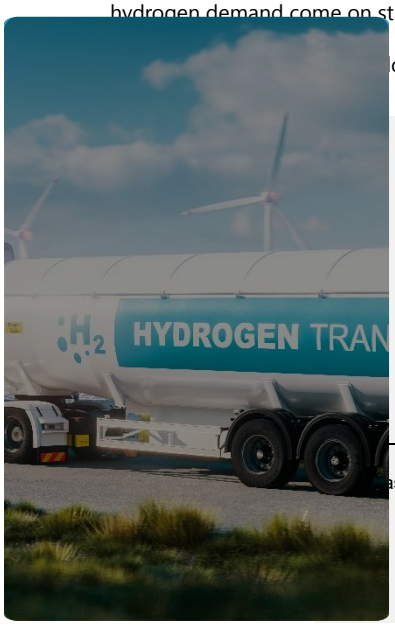
4.1 Overview

The commercial outlook for both renewable hydrogen and renewable liquid fuels produced by Defugo's UPP technology and the valuable co-products including renewable urea, biochar and plant-based protein is strong, with good growth prospects over time.

The following discussion examines the market opportunities for renewable hydrogen, renewable liquid transport fuels as a product group, and the valuable co-products which are produced by the UPP process.

4.2 Renewable hydrogen

- The primary focus of renewable hydrogen production from the UPP process will be for export markets, particularly for countries and regions which have ambitious national stated goals for increased use of renewable hydrogen in their economies. In this regard, the focus will be on the EU, Japan and Korea.
- Assuming a $2 per kilogram target price for hydrogen into these markets, the combined annual scale of the Japanese and EU markets by 2030 is estimated at a target volume of 13 million tonnes, valued at around $26 billion.
- By 2040, South Korea is targeting a further 5.26 million tonnes of hydrogen being used in its economy, providing a further long-term opportunity for export market growth. At $2 per kilogram, the value of this export market can be estimated at $10.52 billion per annum.
- The global scale of these emerging hydrogen markets will provide opportunities for Defugo to position itself as one of the early movers in seeking supply contracts for renewable hydrogen exports, particularly given the efficiency of the UPP process.
- In terms of the domestic market, it will be possible to seek opportunities to inject renewable hydrogen into natural gas pipelines. This opportunity could also be of strategic significance given the forecast gas shortage on the east coast of Australia by 2030.
- Assuming five per cent injection of hydrogen into the domestic natural gas network on the east coast was feasible, this would represent an opportunity for the supply of around 29 PJ[24] (239,748 tonnes) of hydrogen gas into the domestic market. Given the forecast shortage of natural gas for the east coast Australian market by 2030, this would represent a strategic contribution to domestic energy security. At an assumed price of $2 per kilogram, the market opportunity can be estimated at around $480 million per annum.
- While large scale hydrogen supply is viewed as the key long-term market driver for the UPP technology, there will clearly be a ramp-up over time as the nascent hydrogen market both at home and abroad will need time to grow and mature.
- It is for this reason that the flexibility in the UPP technology in being able to produce renewable liquid fuels in the intervening period is so crucial to building a viable pathway to at-scale hydrogen production. The production of these renewable liquid fuels will provide the opportunity to commence the process of investing in UPP plants and kenaf-farming supply chains in the short term, making it easier to scale for much higher volumes as hydrogen demand come on stream.



ook for these renewable liquid fuels is set out in more detail below.

4.3 Renewable liquid transport fuels

Australia's consumption of liquid fuels is overwhelmingly reliant upon imports, with more than 90 per cent of refined products consumed in FY2021 being sourced from abroad.

The UPP technology when combined with widespread kenaf cropping can be used to replace around 70% of the liquid fuels used in Australia, via renewable diesel, renewable A1 Avgas

as supplied into the east coast market of Australia of 580 PJ, per Australian Energy Regulator, State of the Energy Market 2021, pg.

and ethanol. Given the rising cost of petroleum based fuels globally, this switch to local supply also provides the opportunity to reduce downward pressure on the Australian dollar.

The market potential for each of these three renewable liquid fuels which can be produced by the UPP process are set out below.

4.3.1 Renewable Diesel

- The renewable diesel produced by the UPP is a direct substitute for petroleum diesel, meeting the ASTM D975 international standard for diesel oils. This means that it can be used directly in existing diesel engines as a drop-in fuel and can be distributed through existing transport refuelling infrastructure. Therefore, penetration into the domestic market can occur swiftly as production capacity is brought online.
- Australia uses around 33.7 billion litres[25] of diesel annually, and key underlying factors influencing the level of demand remain strong. In particular, there has been a doubling of the national fleet of diesel vehicles (including freight, light commercial and passenger) over the last decade to 5.3 million[26], and the Federal government forecasts a 25 per cent[27] growth in domestic freight volumes between 2018 and 2040.
- Defugo's initial market entry strategy for renewable diesel will be to focus on one initial contract for supply to a large diesel user such as Toll Holdings for example, which used an estimated 141,937,687 litres[28] of diesel fuel from 1 April 2020 to 31 March 2021. If the national average Terminal Grate Price (TGP) for diesel in 2021-22 of 161.5 cents per litre[29] is applied to this volume, this would represent initial annual revenue of around $229.2 million.
- If another large user of diesel such as BHP were to be targeted, around 840 million litres[30] of diesel could be substituted for renewable diesel each year, with a value of around $1.4 billion.
- The total addressable domestic market for 33.7 billion litres of renewable diesel would be valued at around $54.4 billion annually, providing scope for growth in the supply of renewable diesel over time.
- There is also export opportunity for renewable diesel to the global diesel market, which is estimated to reach $1,269.87 billion by 2027[31].

4.3.1 A1 Avgas

The UPP system can also be configured to produce aviation fuel which is compliant with the international ASTM D1655 standard, making it a drop-in renewable fuel for the aviation industry.

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25 Based on 2021-22 sales of diesel in Australia per Commonwealth of Australia, Department of Climate Change, Energy, the Environment and Water, Australian Petroleum Statistics – Data Extract June 2022 (Reissue), Sales by products tab

26 Based on ABS Motor Vehicle Census, Australia - https://www.abs.gov.au/statistics/industry/tourism-and-transport/motor-vehicle-census-australia/latest-release

27 Commonwealth of Australia, 2019, Australian aggregate freight forecasts – 2019 update, Bureau of Infrastructure, Transport and Regional Economics, Department of Infrastructure, Transport, Cities and Regional Development, pg. xix

28 Toll Group 2021 Sustainability Report. Toll disclosed 380,393 tonnes of CO2 emissions from diesel consumption, indicating 141,937,687 litres of diesel usage (at approx. 2.68kg/l rate of emissions).

29 https://www.aip.com.au/pricing/terminal-gate-prices

30 BHP consumed 5,282,636 barrels (i.e., 839,905,140 litres) of sold crude oil and condensate products in FY2021. All energy produced as crude oil/condensates combusted as diesel for stationary energy purposes. https://www.bhp.com/-/media/documents/investors/annual-reports/2021/210914_bhpscope12and3emissionscalculationmethodology2021.pdf

31 https://www.globenewswire.com/en/news-release/2022/03/24/2409228/0/en/Global-Diesel-Market-Size-To-Surpass-US-1269-87-Billion-By-2027-Europe-Having-Share-About-25-Leading-Players-Strategies-Covid-19-Outbreak-Growth-Opportunities-Emerging-Trends-Segme.html

Major airlines such as Qantas have indicated their plans to progressively increase their use of Sustainable Aviation Fuel (SAF) to help achieve a net zero emissions goal by 2050. Prior to COVID-19, Qantas operated over 1,500 flights each day using around 14 million litres of fuel each day. SAF has been identified as providing the opportunity to reduce lifecycle emissions by up to 80 per cent compared to conventional jet fuel. Qantas is targeting the use of 10 per cent SAF in its overall fuel mix by 2030 and announced a plan to fulfil up to 15 per cent of its annual fuel needs out of Heathrow Airport with SAF.[32]

Based on these high-level numbers, if 15 per cent of Qantas' aviation fuel was targeted for production using Defugo's UPP technology, this would equate to around 766.5 million litres of SAF to be supplied in a year. At current aviation fuel prices this volume would represent revenue of around $803 million[33], which would be a significant steppingstone into this market.

The total addressable domestic market for 4.8 billion litres of SAF would be valued at around $5.1 billion[34] annually, providing scope for growth in the supply of SAF over time.

Importantly, the new Federal Government has stated its intention of establish a government-industry body to advise and develop policies and strategies to transition the aviation sector to a net zero greenhouse gas (GHG) emissions industry by 2050, modelled on the Jet Zero Council in the UK and the Council for Sustainable Aviation Fuels in Canada[35]. This policy position will further underpin growth within the Australian SAF market.

[32] https://www.qantas.com/au/en/qantas-group/acting-responsibly/our-planet/sustainable-aviation-fuel.html

[33] Based on an FOB jet fuel price (FOB) averaged over the 6 months to June 2022 of $1.048 AUD per litre, per Index Mundi data - https://www.indexmundi.com/commodities/?commodity=jet-fuel&months=12&currency=aud

[34] Based on 2021-22 sales of aviation turbine fuel in Australia per Commonwealth of Australia, Department of Climate Change, Energy, the Environment and Water, Australian Petroleum Statistics – Data Extract June 2022 (Reissue), Sales by products tab, multiplied by an FOB jet fuel price (FOB) averaged over the 6 months to June 2022 of $1.048 AUD per litre - Index Mundi data - https://www.indexmundi.com/commodities/?commodity=jet-fuel&months=12&currency=aud

[35] https://www.argusmedia.com/en/news/2350671-australia-plans-net-zero-jet-fuel-body-to-drive-saf

4.3.1.1 Ethanol

- Ethanol can also be produced by Defugo's UPP technology, and around 2.1 billion[36] litres of this blended fuel is currently used in Australia each year.
- Assuming a 10 per cent ethanol blend is used in these fuels, this represents an annual domestic market of around 210 million litres, with a value of around $330 million, based on the average 2021-22 Terminal Gate Price of 158.5 cents per litre[37].
- While the renewable diesel market is Defugo's main commercial focus for land transport fuels, the ethanol market does represent a sizable secondary market for the ethanol that is produced as a by-product of the UPP process.
- In the longer term, the substantial $90.3 billion (USD)[38] global market for ethanol presents substantial export opportunities for Defugo.
- The domestic and international market for ethanol fuels has great potential for growth if the Brazilian experience can be used as a guide. In particular, while the current Australian practice is to blend up to 10 per cent ethanol with petroleum-based motor spirit, countries like Brazil have shown that far higher ethanol blends are readily achievable. In particular, Brazil have been utilising incremental regulation for ethanol blending which currently stands at a 27 per cent mandate. This mandate means that imported cars are adapted to run on an E27 fuel blend, with minor engine modifications. Some vehicles in the Brazilian fleet have flex fuel engines which can run on up to 100 per cent ethanol[39].
- Changes in regulations and technologies as seen in the Brazilian context provide great opportunity for domestic and international growth in the use of ethanol as a transport fuel.

4.3.3 Co-products

In addition to the primary market opportunities around renewable liquid fuels, the UPP technology also produces a range of valuable co-products, each with significant and growing domestic and international addressable markets.

The market opportunities for the key co-products derived from the UPP process are set out below.

4.3.3.1 Biochar

- The global agricultural industry is starting to understand the regenerative properties of biochar and its wide range of applications in enhancing soil quality, erosion control, combating nutrient losses and the sequestration of carbon in the soil.
- The Intergovernmental Panel on Climate Change has also recognised the significant role that biochar can play in global carbon abatement, with its Special Report on Climate Change and Land estimating that between 300 million and 660 million tonnes of global carbon emissions could be sequestered annually by 2050 through biochar.
- However, the biochar industry is still relatively nascent, with 5,000 tonnes currently produced annually in Australia. Overseas the leading producers are Europe (20,000 plus tonnes p.a.), USA (50,000 tonnes p.a.) and China (300,000 plus tonnes per annum) .
- Despite this, the size of the global biochar market is forecast to grow to USD $3.1 billion by 2025, thanks to a compound annual growth rate (CAGR) of 13.2 per cent . This buoyant global outlook presents an opportunity for Australia to position itself as export hub for biochar into the Asia-Pacific region.

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[36] Based on 2021-22 sales of ethanol-blended fuel in Australia per Commonwealth of Australia, Department of Climate Change, Energy, the Environment and Water, Australian Petroleum Statistics – Data Extract June 2022 (Reissue), Sales by products tab

[37] https://www.aip.com.au/pricing/terminal-gate-prices

[38] https://www.globenewswire.com/en/news-release/2022/06/17/2464579/0/en/117-5-Billion-Global-Ethanol-Market-with-Rising-CAGR-at-4-5-by-2028-Increasing-Consumption-of-Alcoholic-Beverages-is-Driving-the-Market-Ethanol-Industry-Size-Trend-In-depth-Outlook.html

[39] ETEnergyWorld, April 19,2022, Brazil's Ethanol Journey: From 'a fuel of the future' to the 'future of fuel'

Further, biochar has significant economic benefits compared to traditional soil amendments and fertilisers. Urea currently sells for around $1,000 per tonne compared to biochar which sells for around $800 per tonne . Apart from the favourable price differential, biochar has other advantages relating to:

Longer retention of nutrients in the soil

A lower application rate being required, compared to urea

Carbon remains in the soil for at least 1,000 years , making it a leading form of carbon sequestration.

Given the growth forecast for the global market and economic advantages of biochar, Defugo is confident it can sell its production to progressively more mature domestic and export markets over time.

4.3.3.2 Alternative Protein

- Defugo's market entry strategy for plant proteins is to commence operations with production of proteins for the animal feed market, which is well established, worth $2.3 billion[40] annually in Australia. Overseas markets are also very large, with the US market for example, valued at around $34.4 billion[41] annually.
- The annual animal protein tonnage demand in Australia of around 13.58 million tonnes[42] can readily absorb Defugo's planned alternative protein production as it progressively increases. Importantly Defugo's cost of production will be highly competitive due to the highly efficient UPP technology which generates the high-quality protein as a by-product of other value adding processes.
- It is important to note that the capability of Defugo's UPP technology extends well beyond the production of animal protein and can produce highly specialised protein compounds for human consumption. This would be the second horizon alternative protein product that Defugo would manufacture using kenaf as the biomass feedstock.
- Defugo will be targeting the creation of advanced plant-based meat and dairy mimetics along with other functional ingredients. In the longer term, medicines will also be targeted for development.
- Local and global markets for these human alternative protein products are growing.
- In Australia, the size of the plant-based meat sector grew by one-third in the 12 months from 2018-19 to 2019-20, generating $185 million in sales[43]. It is forecast that growth will continue, reaching consumption levels of $6 billion by 2030[44].
- The global alternative protein market for human consumption is expected to reach $290 billion by 2035 and is forecast to grow at a Compound Annual Growth Rate of around 14 per cent[45].
- The structural growth in these alternative protein markets will provide Defugo with an opportunity to progressively diversify its production from the initial animal protein market into high-value alternative protein products for human consumption.

4.3.3.3 Renewable Urea

40 IbisWorld, Ekaterina, Ezhova, Industry Report OD5090, July 2022, Farm Animal Feed Production in Australia, pg. 11

41 IbisWorld, Curran, Jack, September 2021, Industry Report OD4613, Farm Animal Feed Production: cheap cheap, slowed demand for animal feed prices have hurt revenue, pg. 13

42 Stock Feed Manufacturers Council of Australia estimate for the 2017-18 year, sourced from JCS Solutions - https://www.sfmca.com.au/industry-overview#:~:text=The per cent20latest per cent20estimate per cent20(2017 per cent2D18,tonnes per cent20(Source per cent20JCS per cent20Solutions).

43 Austrade Insights - https://www.austrade.gov.au/news/insights/insight-a-13bn-investment-opportunity-in-australian-protein#:~:text=In per cent202019 per centE2 per cent80 per cent9320 per cent2C per cent20Australia per cent27s per cent20plant,world per cent20are per cent20investing per cent20in per cent20Australia.

44 CSIRO Future Protein Mission - https://www.csiro.au/en/about/challenges-missions/future-protein-mission/plant-protein-production

45 https://www.bcg.com/press/23march2021-alternative-protein-market-reach-290-billion-by-2035

- A further valuable by-product of the Defugo process is the production of a renewable urea product. Urea is used most commonly as a fertiliser but can also be converted into a fuel additive (AdBlue) for use in diesel engines which reduces nitric oxide emissions.
- The Australian market for fertilisers is a mature one, valued at around $8.4 billion, with around 63 per cent of the market serviced by local manufacturers[46]. Around 50.4 per cent[47] of locally manufactured products are nitrogenous fertilisers such as urea. There are around 5 to 6 million tonnes of fertiliser used in Australia each year[48].
- However, the rising price of natural gas is putting cost pressure on urea producers, which presents a strategic market opportunity for a green alternative such as Defugo's green urea product, which doesn't use natural gas in its manufacture. Further, as the UPP system is fundamentally more efficient than existing urea manufacturing processes, Defugo will be able to meet the prevailing market price points.
- Hence, Defugo is confident that it can sell its planned production in the Australian fertiliser market, as its output increases over time.
- Over the longer term, the global market will present export opportunities for Defugo's renewable urea product. The global market is constituted by around 181 million tonnes[49] per annum of urea fertiliser valued at around $41.68 billion[50] USD (2021).
- There is also the potential to fine tune Defugo's process to enable the local production of AdBlue for use in diesel engines. This would bring benefits of sovereign capability and security to the Australian fuel supply chain and provide a further value adding avenue for Defugo's investments in its world leading technology in Australia.

46 IbisWorld, Richardson, Arna, March 2022, Fertiliser Manufacturing in Australia, pg. 13

47 IbisWorld, Richardson, Arna, March 2022, Fertiliser Manufacturing in Australia, pg. 8

48 IbisWorld, Richardson, Arna, March 2022, Fertiliser Manufacturing in Australia, pg. 9

49 Statista, Fernandez, Lucia, Global Production of Urea 2009-2020

50 Maximise Market Research – Urea Market - Global Industry Analysis and Forecast (2022-2029)

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5

Conclusion

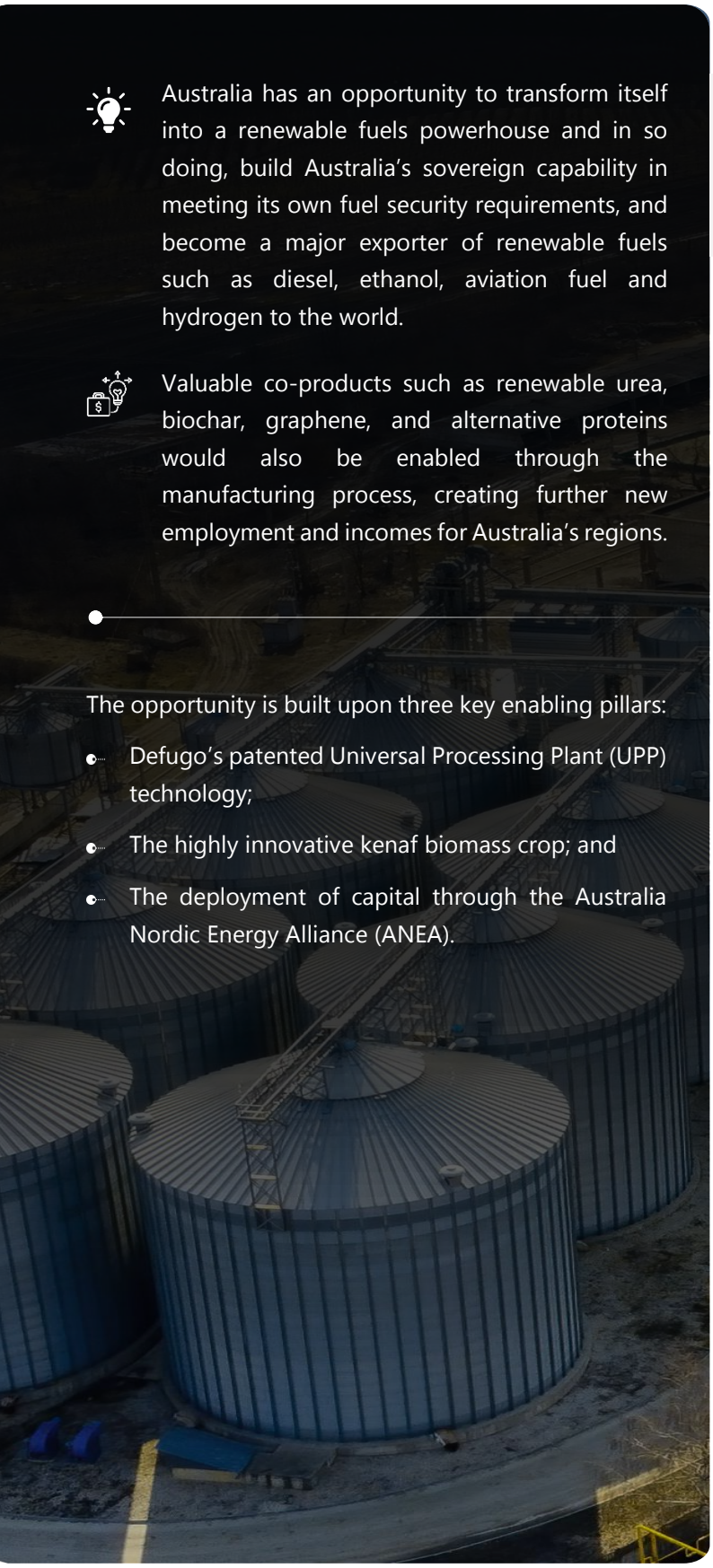
5.1 Conclusion

Australia has an opportunity to transform itself into a renewable fuels powerhouse and in so doing, build Australia's sovereign capability in meeting its own fuel security requirements, and become a major exporter of renewable fuels such as diesel, ethanol, aviation fuel and hydrogen to the world.

Valuable co-products such as renewable urea, biochar, graphene, and alternative proteins would also be enabled through the manufacturing process, creating further new employment and incomes for Australia's regions.

The opportunity is built upon three key enabling pillars:

- Defugo's patented Universal Processing Plant (UPP) technology;
- The highly innovative kenaf biomass crop; and
- The deployment of capital through the Australia Nordic Energy Alliance (ANEA).



The key benefits unlocked through this opportunity include:

- New $2.4 billion renewable fuels industries created in the initial stages with potential to exceed $60 billion by 2040, supported by local and export markets.
- Reinvigoration of Australia's regions and agricultural sectors, with the creation of 19,800 new jobs in regional areas in 396 UPP modular facilities and regional farms in the initial stages, with potential to expand to over 15,000 UPP plants and around 500,000 jobs out to 2040.
- Establishment of new industries beyond renewable fuels based around co-products produced by the process such as renewable urea, biochar, high-grade graphene and alternative proteins, creating further new employment and incomes for Australia's regions.
- Dual benefit of avoiding emissions from fossil fuels, and sequestering carbon from the atmosphere through the use of the kenaf plant for biomass – for example if Australia achieved self-sufficiency in renewable diesel, A1 Avgas, ethanol and injected a 5% hydrogen blend into Australia's east coast gas supply, abatement equivalent to 62% of Australia's emissions, or to all annual emissions from the electricity and stationary energy sectors would be achieved.
- Leveraging sovereign debt investments into the Australian renewable fuels sector to build scale for domestic and export markets.
- The scale and significance of these benefits are substantial from an environmental, economic and societal point of view, with a pivotal role to be played by Australia's farmers and regional communities in enabling this transformation.

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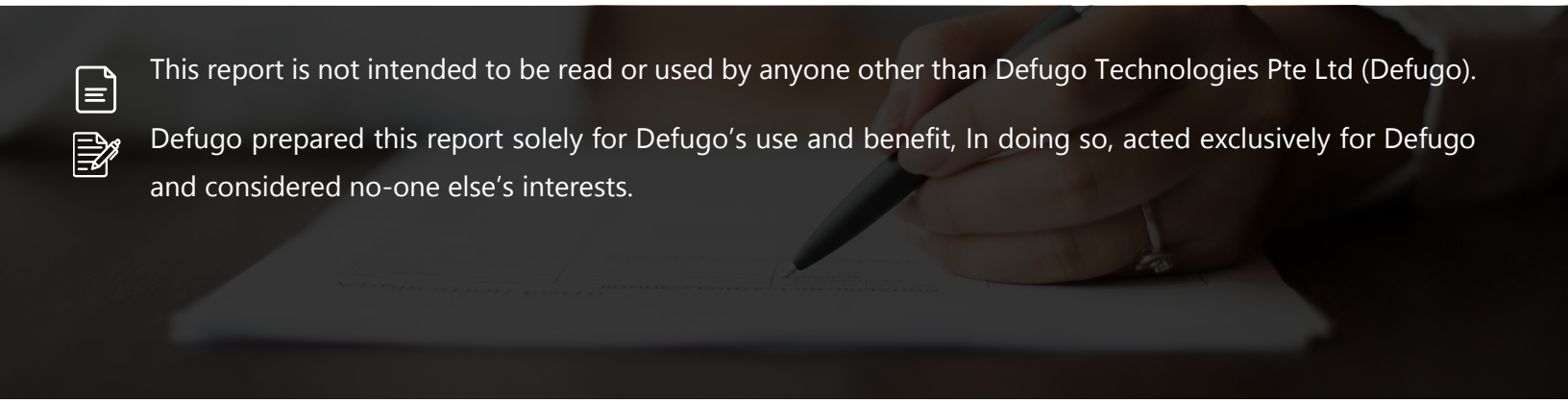

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