Licella™
HOLDINGS

Aviation White Paper February 2023

FEEDBACK SUBMISSION BY LICELLA HOLDINGS LTD.

Introduction

The following submission for the *Aviation White Paper*, published February 2023, is written on behalf of Licella Holdings Ltd.

About Licella Holdings Limited

Licella Holdings Limited (Licella) is an Australian technology development company that has since 2007 been developing its hydrothermal liquefaction (HTL) technology, the Catalytic Hydrothermal Reactor (Cat-HTR™) platform, that utilises water at supercritical conditions (between 350-450°C and circa 200 bar) to convert a range of feedstocks, including agricultural and forestry residues, into a high quality biocrude. Licella also has projects converting end of life plastics into "Plasticrude". These synthetic crudes are energy dense, stable intermediates, that like fossil crude can be upgraded into a range of fuels and chemicals including Sustainable Aviation Fuel, Renewable Diesel and renewable chemicals that can be "dropped in" to existing oil and gas infrastructure.

Licella has plants under construction and development in North America, Europe and Asia as well as our first End of Life Plastics plant in Australia, that will enable the circular economy for non-recyclable plastics, at Altona in Victoria.

With regard to biomass residues in Australia, as part of the Queensland Bio-Futures program, Licella was able to convert sugar cane residues (tops and reach) into a biocrude that was then upgraded into renewable kerosene that could, once certified, be used as a Sustainable Aviation Fuel. Collaboration with the Department of Defence has begun to certify this pathway towards Sustainable Aviation Fuel (SAF). As such, the Cat-HTR™ platform, with its ability to utilise the untapped agricultural and forestry residues market, has immense potential to accelerate development of a the SAF industry in Australia, supporting our local airlines and Defence to deliver on their decarbonisation targets, and enhance domestic fuel security.

For further information, please visit www.licella.com

Licella would like to acknowledge the financial support received from the Australian Federal Government to date. his financial support, particularly through ARENA and the DIISR Accelerating Commercialisation Scheme, has helped Licella to move through our Research-and-Development phase, and place a pioneering Australian innovation on the global stage.

Sustainable Aviation Fuel

Despite fleet design modernisation and improvements in logistical efficiency, limited progress has been made to address the primary contributor to Greenhouse Gas emissions in the aviation industry, namely ubiquitous use of fossil derived jet fuel. As a result, CO_2-equivalent emissions in the aviation industry have continued to increase.

To meet the International Air Transport Association (IATA)'s net zero emission levels by 2050, the aviation industry will need to implement the large-scale use of low-emission alternative energy supply to conventional fossil derived jet fuel. However, even the most ambitious models for electric and hydrogen-based aviation predict such technology will be limited to short-haul flights with less than 120-minute flight time by 2050. As such, electric and hydrogen-based technologies are unlikely to deliver meaningful decarbonisation goals, as more than 70% of the industry emissions result from international flights with a flight-time greater than 120 minutes.

Sustainable Aviation Fuel (SAF) therefore remains the only viable method for the industry to achieve decarbonisation commitments. The challenge is that global SAF production remains insufficient to supply the market demand, with SAF production in March 2022 estimated at 200 million gallons (~600kt). To meet the 17.5 billion gallons needed to achieve all international commitments by 2050 will require a 17.3% p.a. growth[1]. Consequently, demand has, and will continue to, outstrip supply, with current SAF prices 2 to 5 times that of fossil equivalent. This is reflected in the SAF price relative to the ICE Gas-Oil index.

Table 1 – SAF Price per Tonne, extracted from Argus Media, December 2022[2]

	Ask	Bid	+/-	7 to 28-day ICE Gas-Oil Price	Multiple
SAF Price	3216.94	3230.10	-15.84	901.15	3.57

Indeed, ongoing elevated demand and price are expected for the foreseeable future, with Government fuel mandates around the world poised to enforce minimum SAF blends with conventional fossil fuel-derived jet fuel, evident in the current 1% blend in Norway and Sweden and

[1] S&P Global, "Long-Term Demand for SAF could run into Supply Constraints", 2022, *S&P Global Commodity Insights*. Available at < Long-term demand for SAF could run into supply constraints | S&P Global Commodity Insights (spglobal.com)>

[2] Argus Media, "Daily International Market Prices and Commentary", 2022, *Argus Biofuels*, Issue 22-235. Available at <Argus Biofuels (2022-12-07).pdf>

the proposed increase in minimum SAF blend for all flights that depart European Union airports from 2025 onwards, evident in Figure 1.

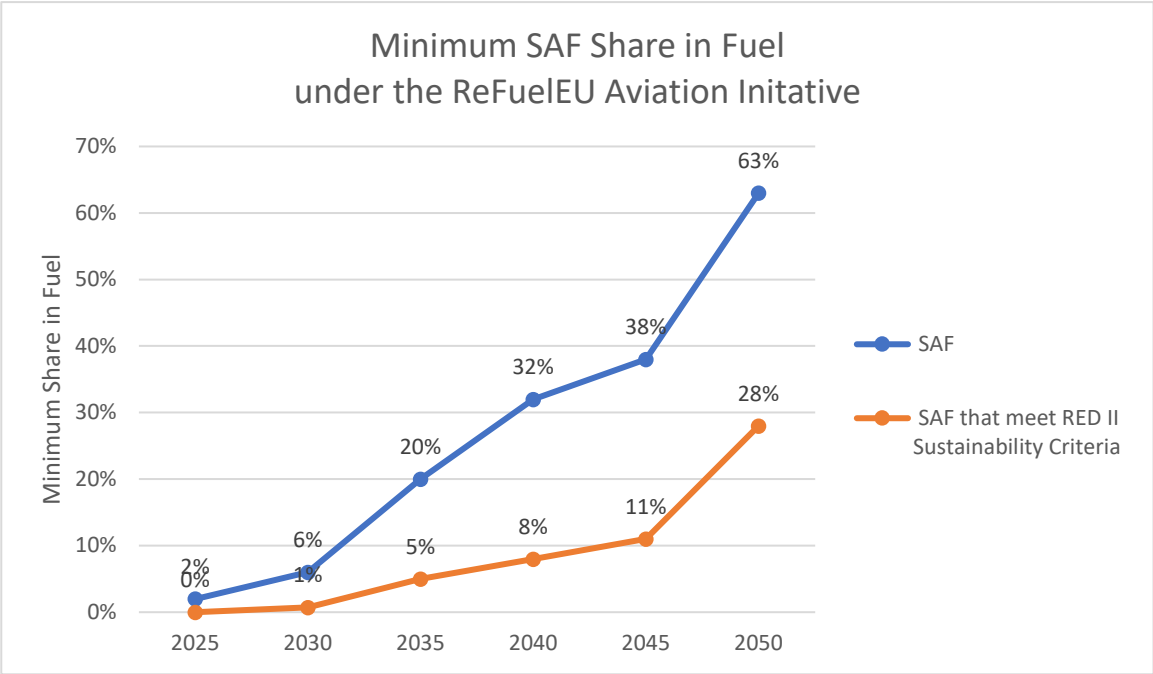

Figure 1 – Minimum SAF Share in Fuel used in EU Airport Departures[3]

Likewise, non-Government trade and transport associations reflect the emphasis on SAF as a pathway towards decarbonisation goals, with the IATA committed to fly net zero by 2050, both the largest airline companies in Japan, i.e. All Nippon Airways and Japan Airlines have also committed to a 10% blend by 2030[4], with QANTAS committed to a 10% blend by 2030 rising to 60% by 2050.

Therefore, development of a domestic SAF manufacturing industry represents a global market opportunity, able to supply the escalating domestic and international demand for a high-value commodity. Indeed, the ARENA Bioenergy Roadmap, released by the Federal Government in November 2021, estimates that early deployment of pre-commercial SAF production plants will be able to yield 1908 ML of SAF by 2030, which equates to 18% of the aviation fuel market. In addition, establishment of a domestic SAF industry would create an estimated 7,400 jobs by 2030, increasing to 15,600 jobs by 2050 and contribute $2.8 billion to GDP by 2030, increasing to $7.6 billion by 2050.

[3] Council of the European Union, "Regulation of the European Parliament and of the Council on Ensuring a Level Playing Field for Sustainable Air Transport", 2022, Issue 9805/22, pg. 35. Available at <pdf (europa.eu)>
[4] All Nippon Airways Co. Ltd. Japan Airlines Co. Ltd. "Joint Report – Achieving a Carbon Neutral Future in Aviation by 2050", 2021. Available at <共同レポート_10.07 FNL2_EN_ANA (jal.co.jp)>

Conversely, despite substantial reliance on fossil crude oil to facilitate trade and transport and to act as a feedstock for the chemical manufacture of petrochemical products and road components, Australia exhibits limited liquid fuel self-sufficiency. Indeed, net oil imports and domestic refinery production are calculated by the International Energy Agency (IEA) to only be able to sustain supplies of fuels for 62 days. The aviation industry in Australia is especially susceptible to supply issues, with fuel demand at about 10,000 megalitres each year relative to domestic production capacity of about 1000 megalitres each year, representing only 10% of the local market demand.

As such, a domestic SAF industry will provide an additional benefit to fuel security in Australia and reduce reliance on overseas fuel sources and refineries. Such enhanced fuel security will provide simultaneous benefits to both transport and Defence, through a more stable supply chain and consistent operational costs.

How to establish a new industry?

Development of a new industry starts with an initial commercial plant, a so-called pioneer plant. Unfortunately, such pioneer plants always cost more than subsequent facilities, due to contingencies and teething challenges. Specifically, capital investment in pioneer SAF plants is expected to be in excess of $100m; as an example, Fulcrums Sierra plant in Nevada, which is expected to produce ~30kt p.a. of fuels, is estimated to cost in excess of US$260m (~A$340m).

With the perceived risk associated with first-of-a-kind technology reduced by pioneer plant construction, capital-raising for subsequent plants is always easier than it is for the first. Indeed, such barriers extend to Australian Government investment, with the Clean Energy Finance Corporation (CEFC) investment mandate demanding a reference plant of similar scale and feedstock before investment can be made. This means that, despite Licella having a plant under construction in Canada (our Arbios Biotech JV), because it is running on forestry residues the CEFC cannot provide finance for a facility under development here, which may run off an alternate biomass feedstock.

As such, first-of-a-kind technology facilities with these higher capital costs find it difficult to traverse the so-called “Valley of Death”, as they are unable to attain the required hurdle rate needed by investors to enable investment decisions to be approved.

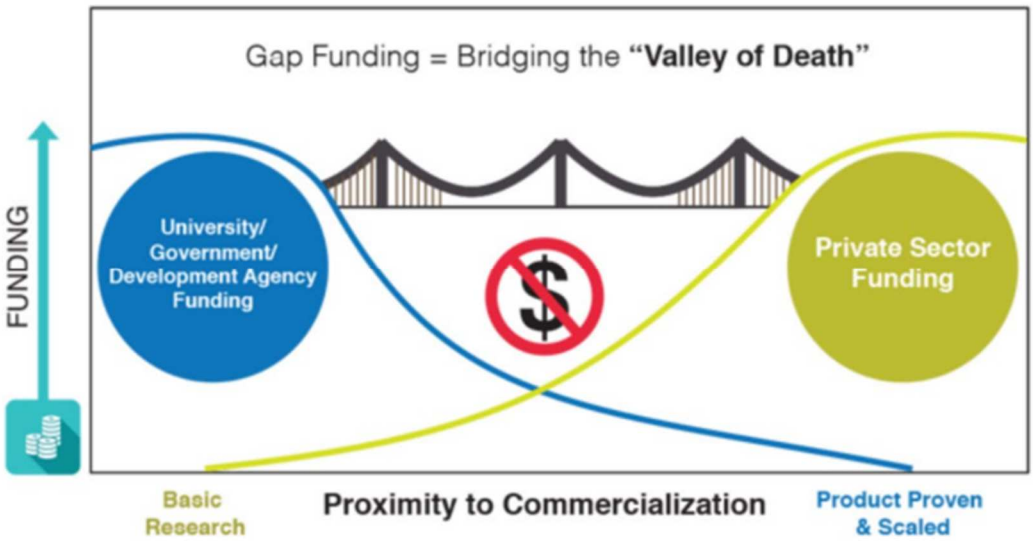

Figure 2 – Impact of Government Funding and Private Sector Investment on Technology Commercialisation.

As a consequence, first-of-a-kind technologies struggle to progress from the Research-and-Development phase into the commercial deployment phase in Australia, which is why many companies, including Licella, have to go overseas to commence commercial deployment and industry innovation in Australia lags. To overcome this challenge, governments in other countries e.g. the US, Japan and Europe, where first-of-their-kind commercial plants are being deployed, assist with grants and concessional finance arrangements to help de-risk investments for other equity investors. For example, Fulcrum received more than $US100m in concessional finance from the **US Government**.

Given the pivotal role the emergent domestic SAF industry will have in decarbonisation, economic revitalisation and job creation in the aviation sector, Licella believes the solution should mirror the example set by other countries, with pioneer plant deployment supported by funds like the National Reconstruction Fund, Powering the Regions Fund or the Northern Australia Investment Fund.

This investment will assist with the incremental scale-up, with subsequent facilities demonstrating a marked reduction in production cost, which will help drive down SAF cost in Australia. As such, timely Government funding towards pioneer technology will allow Australia to realise the economic

growth and job creation outlined in the ARENA Bioenergy Roadmap and meet the net zero carbon emission target by 2050 set by the *Aviation White Paper*.

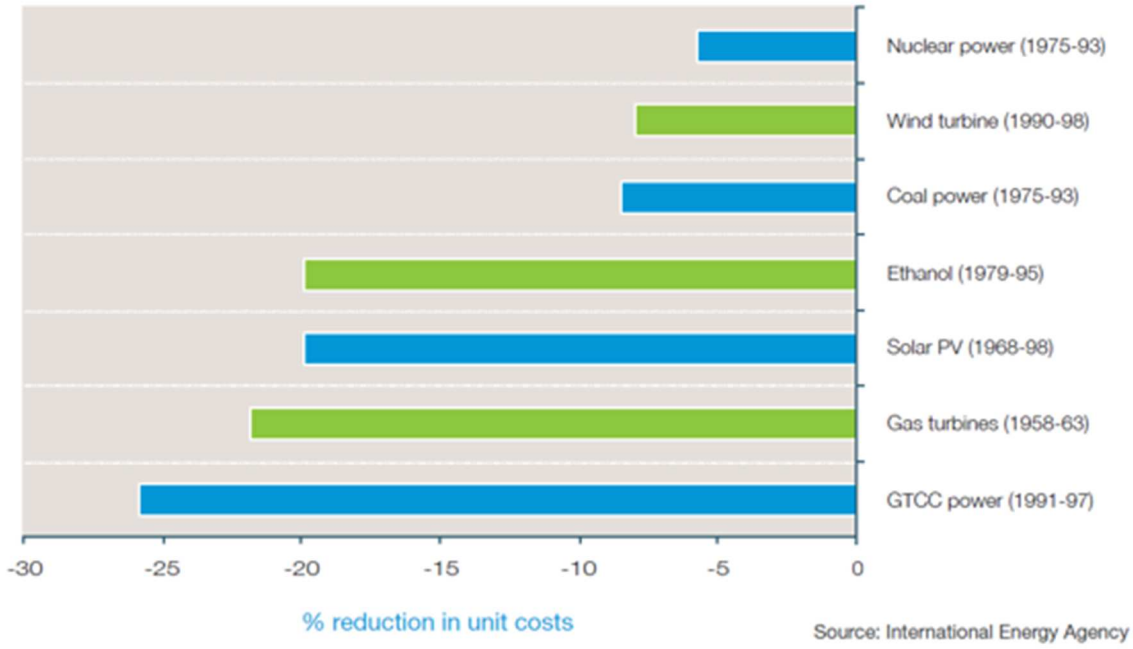

Figure 3 – Reduction in Production Cost with each Doubling in Capacity

Licella would like to again acknowledge the financial support of the Federal Government to date. This financial support, particularly through ARENA and the DIISR Accelerating Commercialisation Scheme, and helped us to place an Australian innovation on the international stage, which Licella now aims to make a domestic reality.

Licella believes that the *Aviation White Paper* may best contribute to long-term decarbonisation and revitalisation of the aviation industry through immediate investment in the development of a domestic SAF industry, which will drive economic growth in domestic and international markets.

We welcome the opportunity to discuss the above with you, and any questions you may have regarding our company or technology. We would also like to extend an invitation for you to visit our commercial demonstration facility in Somersby, on the NSW Central Coast.

Kind Regards,

Dr. Len Humphreys

CEO, Licella Holdings Limited