**18 July 2024**

**Stralis Aircraft Submission for the**
**Low Carbon Liquid Fuels Consultation**

Dear Sir / Madam,

**HYDROGEN ELECTRIC AVIATION IN AUSTRALIA**

Stralis Aircraft welcomes the opportunity to provide a submission to the Low Carbon Liquid Fuels Consultation, and supporting the submission provided by the Hydrogen Flight Alliance, as we work collectively to advance hydrogen electric flight to decarbonise aviation in Australia.

The IATA Aircraft Technology Net Zero Roadmap (2023) clearly illustrates liquid hydrogen as a key energy solution that runs in parallel to Sustainable Aviation Fuel. Stralis Aircraft are recognised in this roadmap, and are an Australian manufacturer of hydrogen-electric propulsion systems and are working to retrofit existing aircraft, and design new aircraft into the future, alongside other key international leaders such as Airbus and ZeroAvia, and other domestic leaders such as AMSL Aero and Dovetail.

Stralis Aircraft is based in Queensland and our propulsion system will produce no harmful emissions, be quieter, and have a reduced direct operating cost compared to other sustainable aircraft solutions, such as Sustainable Aviation Fuel.

Green liquid hydrogen, produced locally from renewable energy sources in Australia, will be used as the low carbon liquid fuel, which is converted to electrical power using a hydrogen fuel cell. The electrical power feeds a lightweight aerospace electric motor to drive a propeller and deliver thrust to the aircraft.

Clean hydrogen plays a crucial role in aviation decarbonisation, not only can it be used for direct combustion or used with fuel cells to power aircraft, but it is also used in SAF production pathways, and is a raw material in power-to-liquid fuels (synthetic fuels).

Stralis Aircraft are working closely with customers, governments, community, and stakeholders, including the Civil Aviation Safety Authority (CASA). This is being supported by the Hydrogen Flight Alliance (HFA) which brings together a range of critical Australian organisations and stakeholders to facilitate the hydrogen flight ecosystem required to enable operation of Australian made hydrogen-electric powertrains and emission free aircraft.

The HFA members, include:

1. Stralis Aircraft
2. Skytrans Airlines
3. Brisbane Airport
4. Gladstone Airport
5. Aviation Australia
6. AMSL Aero
7. Royal Flying Doctors Service QLD
8. Toowoomba Wellcamp Airport
9. BOC, a Linde Company
10. H2 Energy Company (h2ec)
11. Griffith University
12. Central Queensland University
13. Queensland University of Technology
14. Hypersonix
15. Fabrum Liquid Hydrogen Solutions

The alliance's key purpose is to create a collaborative environment to advance hydrogen electric flight technology, which includes liquid hydrogen production, storage, transportation, and fuel logistics in Australia. The initial focus will be to enable Australia's first commercial emission free hydrogen powered flight between Brisbane Airport and Gladstone Airport in 2026. This route will be operated by Skytrans Airlines, our launch partner, using a 15 seat Stralis B1900D-HE aircraft, designed, and built in Brisbane, Australia.

We provide some responses to the most relevant sections and strongly encourage the Australian Government to recognise green liquid hydrogen as a LCLF and a key opportunity to decarbonise the hard-to-abate aviation sector. We believe this would support the objectives of the Jet Zero Council, the Aviation White Paper, and assist decarbonisation of the transport and tourism sectors more broadly in Australia.

We look forward to hearing from you and if you have any questions, please contact me on the details below.

Yours sincerely,

**Bob Criner**

**Co-Founder & CEO, Stralis Aircraft**
**Hydrogen Flight Alliance Convenor and Member**
[redacted]

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## *Consultation Response*

### Low Carbon Liquid Fuels Opportunity

1. Australia is well placed to produce low carbon liquid fuels because it can generate the abundant zero carbon energy necessary to produce them at globally competitive prices.
2. There is more than one low carbon liquid fuel and Australia should differentiate between them based on their environmental credentials and their suitability for different aviation applications.
3. As a starting point, the Australian aviation community should aim for and include zero greenhouse gas liquid fuels not just zero or low carbon liquid fuels.
4. Even if some forms of SAF achieve net zero carbon emissions by using natural sources of carbon, the combustion of SAF will still generate other greenhouse gas emissions.
5. Green liquid hydrogen emits zero greenhouse gases when consumed in a fuel cell and the government should recognise green liquid hydrogen as an official low carbon liquid fuel.
6. If the Australian aviation sector is to address climate change responsibly, it should adopt zero greenhouse gas liquid fuels as a priority, then zero carbon liquid fuels, and only if there are no other options, low carbon liquid fuels.
7. The Consultation Paper makes ten references to hydrogen but none of them to liquid hydrogen. This is despite the fact that IATA's Energy and New Fuels Infrastructure Net Zero Roadmap recognises liquid hydrogen as a key fuel and sets out the need for investment into hydrogen infrastructure now, not later.
8. Many Australian and international aviation companies such as Airbus, ZeroAvia, Joby, Stralis Aircraft, AMSL Aero, Hypersonix and Dovetail are in the process of developing aircraft that will be powered by liquid hydrogen on the basis of its environmental credentials and its eminent suitability as an aviation fuel.

### Options to Support Australian Domestic Low Carbon Liquid Fuel Production

1. There is a broad consensus in the energy literature that SAF will cost somewhere between three and six times as much to produce as fossil kerosene. The national and global aviation markets are expected to contract significantly if these costs are all transferred to the consumer.
2. The round-trip efficiency of liquid hydrogen (LH2) is fundamentally much more efficient than SAF. Only 12% of the renewable energy produced makes it to propulsion via SAF in comparison to 25% of the renewable energy making it to propulsion via LH2.
3. Airlines are lobbying their respective governments to subsidise the production of SAF, a cost that will fall on all taxpayers rather than just passengers raising issues around equity.
4. Equity aside, this might be justified by airlines with legacy aircraft that have significant remaining operating life, but it will not make sense for retrofit or new hydrogen-electric aircraft operating over distances that can be flown using less expensive zero-emission fuels, such as liquid hydrogen. Note that companies advancing hydrogen-electric aircraft such as Stralis Aircraft, ZeroAvia and Dovetail, have business plans that incorporate or target aircraft retrofits which enable legacy aircraft to also transition.
5. It should be in everyone's interests to reduce the cost of aviation and we urge the government to include liquid hydrogen as an official low carbon liquid fuel so that it reduces the overall cost of future aviation for Australians.
6. Stralis Aircraft challenges the assertion on Page 6 of the Consultation Paper that medium distance aviation in Australia is projected to remain reliant on SAF out to 2050.

7. On 24 Jun 24, Joby flew 523 miles in California with an aircraft powered by liquid hydrogen and a fuel cell. The market capitalisation of the company increased by US $1 billion (30%) – a testament to confidence in the market (medium range electric planes) and in the technology (liquid hydrogen and fuel cells).
8. Unlike SAF, liquid hydrogen does not require a refinery to produce. It requires relatively simple industrial equipment, electricity, and water. This means of production will enable regional and remote Australia to achieve higher levels of fuel security than with fuel distributed from refineries located near capital cities.
9. Stralis Aircraft urges the government to consider supporting the establishment of liquid hydrogen production capacity in remote and regional Australia as a cost effective and reliable fuel supply so that limited and expensive quantities of SAF can be reserved to support long distance flights.

**Design of Production Incentives**

10. As a rule, carbon-based fossil fuels are currently the lowest cost aviation fuels without environmental taxes or market incentives. In the highly competitive aviation market, aircraft operators should not be expected to transition to low-emission fuels for altruistic reasons only.
11. Stralis Aircraft recommends carefully designed market mechanisms to increase the production of green liquid hydrogen steadily in line with net zero targets.
12. The challenge with cost effective production of fuels, including SAF and liquid hydrogen, is to scale up in such a way that might not be commercially viable in the short term but minimise the overall cost in the long term to anyone providing funding.
13. Liquid hydrogen is a good example of a fuel whose cost of production responds to scale. In small quantities (100kg/day), the levelised cost of green liquid hydrogen might be somewhere between $50 and $100 per kg. At industrial scale (10 tonnes per day), the cost might be somewhere between $10 and $20 per kg.
14. To incentivise the production of green liquid hydrogen as a low carbon liquid fuel, Stralis Aircraft proposes that the government underwrites a step change in production so that meaningful economies of scale can be achieved. This will allow customers to plan their operations based on a reliable supply and a predictable price.
15. Hydrogen hubs where liquid hydrogen can be produced and used are beneficial and enable smaller companies who need low volumes to set up and operate, including R&D or pilot projects to help spread costs and risks. Government can also play a key role in connecting production partners with off-takers.

## Considerations Regarding Emissions and Sustainability Criteria

16. SAF encompasses a wide variety of fuel types, with highly variable sustainability credentials. Therefore, the Guarantee of Origin Scheme should apply to SAF. Different SAF can be categorised according to their emissions and sustainability performance so that consumers understand their environmental impact. Each category should be classified for its emissions and sustainability performance. Without it, the only achievement of the low carbon liquid fuel opportunity might be more greenwashing.
17. There is general agreement in the literature that the use of SAF in an existing jet engine means that the engine will operate under the same conditions as for kerosene since equivalent thrust and energy output will be required for the aircraft to operate. The consequence is that even though SAF might reasonably claim to achieve net zero carbon emissions, it will not neutralise the other emissions associated with carbon fuel combustion such as carbon monoxide, volatile organic compounds and NOx.

18. For example, the amount of NOx released by SAF fuelled engines is largely unchanged since emissions are dependent on the temperature of combustion rather than the formulation of the fuel itself.
19. Therefore, if the Australian aviation sector is to properly address climate change, it should adopt **zero greenhouse gas** liquid fuels as a priority, **zero carbon** liquid fuels second and only if there are no other options, **low carbon** liquid fuels.
20. At present, international aviation emissions are not included in Australia's total emissions. This is an international convention, but it distorts emissions figures and conceals Australia's particular dependence on international aviation. As part of the low carbon liquid fuels opportunity, Stralis Aircraft recommends that Australia take account of greenhouse gas emissions on international flights in order to take full responsibility for the environmental impact and allow market mechanisms to eliminate them.

### Design of Demand Side Mechanisms

1. If the aviation industry is to reduce its actual greenhouse gas emissions (as opposed to offsetting them), the relative total cost of high carbon liquid fuels needs to exceed the total cost of low carbon liquid fuels. The total cost is a complicated calculation because it involves the residual value of current aircraft and supporting infrastructure and the cost of new aircraft and supporting infrastructure.
2. Moreover, this transition needs to occur progressively so that the many stakeholders involved have the time to change over efficiently. A transition that exceeds the capacity of the various supply chains to change will only result in disruption and waste. This should not be interpreted as an excuse to go slowly. Supply chains should change as quickly as they can.
3. Stralis Aircraft recommends that market signals are clear and unambiguous. Industry operators should be in no doubt that the change is inevitable.
4. The simplest way to reduce the difference in cost between high carbon and low carbon liquid fuels is to remove all of the subsidies for high carbon liquid fuels. This should be communicated and scheduled so that all stakeholders have reasonable (but not indefinite) time to prepare and adjust. It will be a painful but necessary adjustment. It will be successful if the pain is shared by all players.
5. The orderly removal of subsidies will free up revenue to fund subsidies for underwriting the infrastructure and demand for low carbon liquid fuels such as liquid hydrogen. As already explained, this should be done in line with Australia's net zero obligations and with capacity that achieves meaningful economies of scale.
6. Demand can be stimulated by additionally introducing a carbon price (or ideally a greenhouse gas price) and mandated fractions of low carbon liquid fuels for aircraft operators. Voluntary schemes are unlikely to work because aviation is such a competitive market, and margins are thin. If aircraft operators know that everyone is bearing the same fuel costs, they are more likely to accept their contribution to the achievement of net zero.

### Additional Questions

1. Will liquid hydrogen be officially recognised as a low carbon liquid fuel?
2. If not, where is the financial and policy support for liquid hydrogen in Australia in accordance with guidance from IATA and with Australia's net zero obligations?
3. Will the Hydrogen Production Tax Incentive apply to liquid hydrogen?