UNSW SYDNEY | Australia's Global University

Commercial Viability of Sustainable Aviation in Regional Australia:

Cost and Revenue Modelling

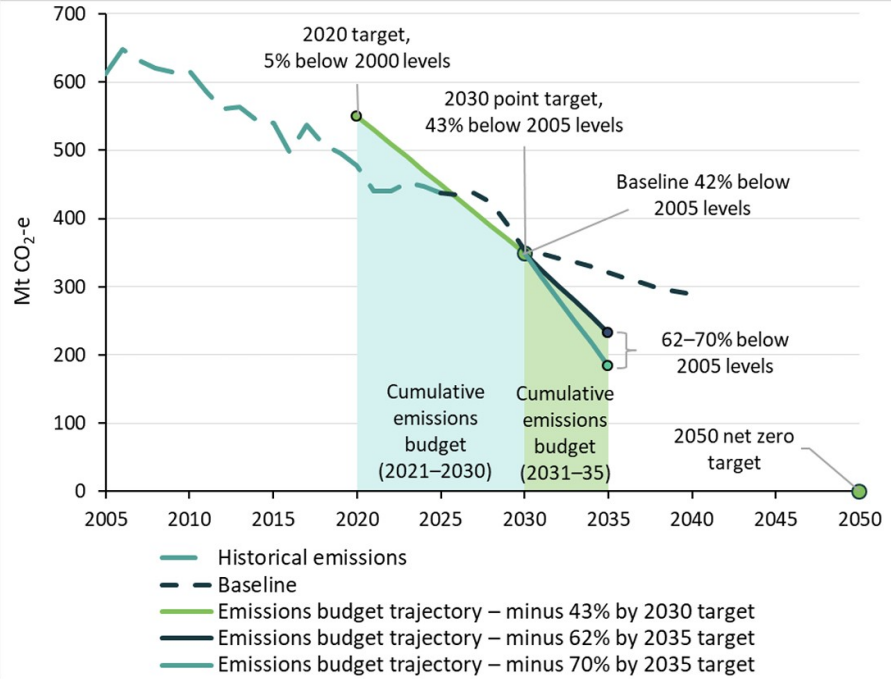
Dr Matteo Malavasi, Dr Mirjam Wiedemann, Dr Stuart Reid

Net Zero Commitment and Regional Airfares

Regional airfares are strongly influenced by aircraft operating costs, fuel costs, and aircraft size relative to demand.

Airlines are already required to reduce emissions annually under the Safeguard Mechanism.

As a results of Net Zero aligned policies, carbon cost will increase jet fuel cost relative to sustainable fuel systems.



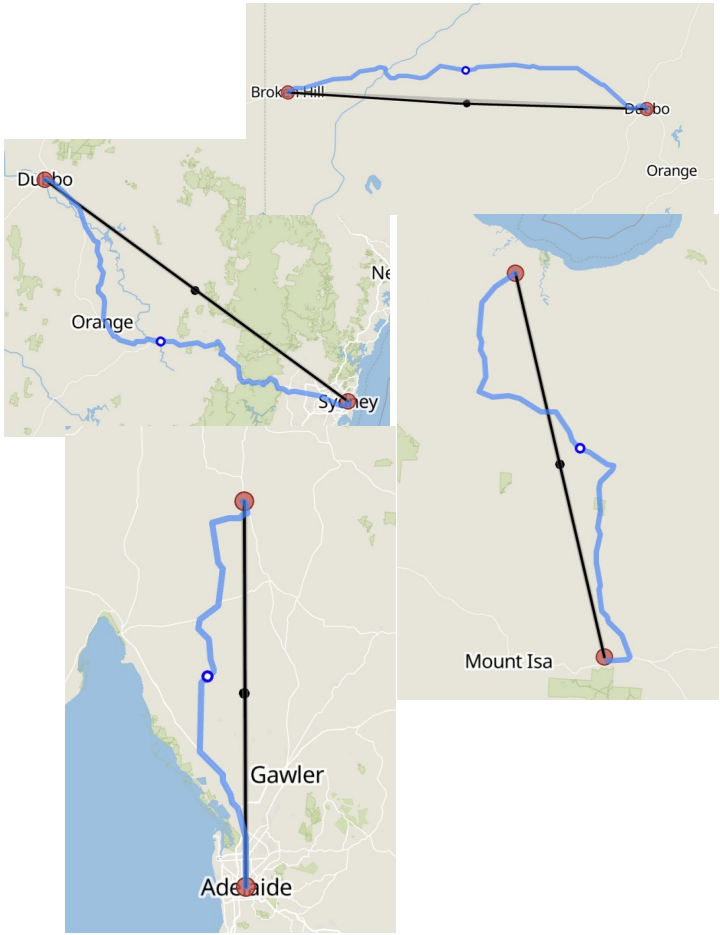
Can Hydrogen and Electric Aircraft help?

Could aircraft powered by hydrogen and electricity significantly alter cost drivers, and enhance service viability, through:

- lower energy costs and maintenance costs
- and through use of smaller aircraft platforms better suited to small passenger markets?

4 “Representative” Routes

- Sydney - Dubbo: represents a high-traffic regional to capital city; currently serviced
- Dubbo – Broken Hill: represents a longer regional corridor currently; currently serviced
- Cloncurry – Burketown: represents remote Australia; regular commercial aviation is currently absent
- Adelaide – Clare Valley: represents potential connection between capital city and major touristy centre, regular commercial aviation is currently absent



How to Evaluate Commercial Viability

We use a common cost-revenue framework over 25-year horizon, and compare:

- Commercial viability
- Emissions
- Influence of carbon cost

Variable	Value
Nominal interest rate	8%
Inflation rate	3%
Time Horizon	25 years
Load factor	82.5%
Pilot Salary	AUD 120,000
Crew Salary	AUD 75,000
Ticket price	AUD 350

Calculate Revenue and Cost

Revenue is calculated as follows:

$$Revenue = Ticket\ Price \times Load\ Factor$$

Costs per flight are calculated as follows:

$$Cost = Fuel\ Cost + \ Carbon\ Cost + Landing\ Fees + Pilot\ and\ Crew\ Salary$$

The emissions are calculated as follows:

$$tonnes\ CO_2e = \frac{Quantity\ of\ Fuel \times Energy\ Content \times Emission\ Factor}{1000}$$

Carbon Cost:

$$Carbon\ Cost = tonnes\ CO_2e \times Carbon\ Price$$

Fuel Cost Projection

Fuel Cost	Initial AUD/Kg	Final
Jet Fuel Mean	1.8 AUD/Kg	1.8 AUD/Kg
Jet Fuel St.Dev.	1.5 AUD/Kg	2.25 AUD/Kg
Blue Hydrogen Mean	1.8 AUD/Kg	1.8 AUD/Kg
Blue Hydrogen St.Dev.	1.5 AUD/Kg	2.25 AUD/Kg
Green Hydrogen Mean	7.05 AUD/Kg	3.30 AUD/Kg
Green Hydrogen St.Dev.	1.5 AUD/Kg	2.25 AUD/Kg
Average Daily Electricity Price (SA)	0.07737 AUD/kWh	NA

Carbon Cost Scenarios

- **Scope 1:** direct emissions from combustion of fossil fuel
- **Scope 2:** indirect emissions from combustion of fossil fuel/electricity consumption
- **Upstream emissions:** emissions resulting from extraction, transportation, refinery, distribution and combustion, and in the case of hydrogen fugitive emissions, and emissions resulting from distribution, and transportation

Scenario	Carbon Cost in 2025 (AUD per tonne CO2-e)	Carbon Cost in 2050 (AUD per tonne CO2-e)
Low Carbon Cost	44	287
Medium Carbon Cost	56	377
High Carbon Cost	66	469

Sydney - Dubbo

Sydney – Dubbo Context

Currently, the route is serviced by:

- QANTAS: De Havilland-Bombardier Dash-8, and a daily flight frequency that varies from 2 to 4 flights per day
- Rex Airlines: Saab SF 340, and a daily frequency of 1 to 3 flights per day.

The Alterative considered is the:

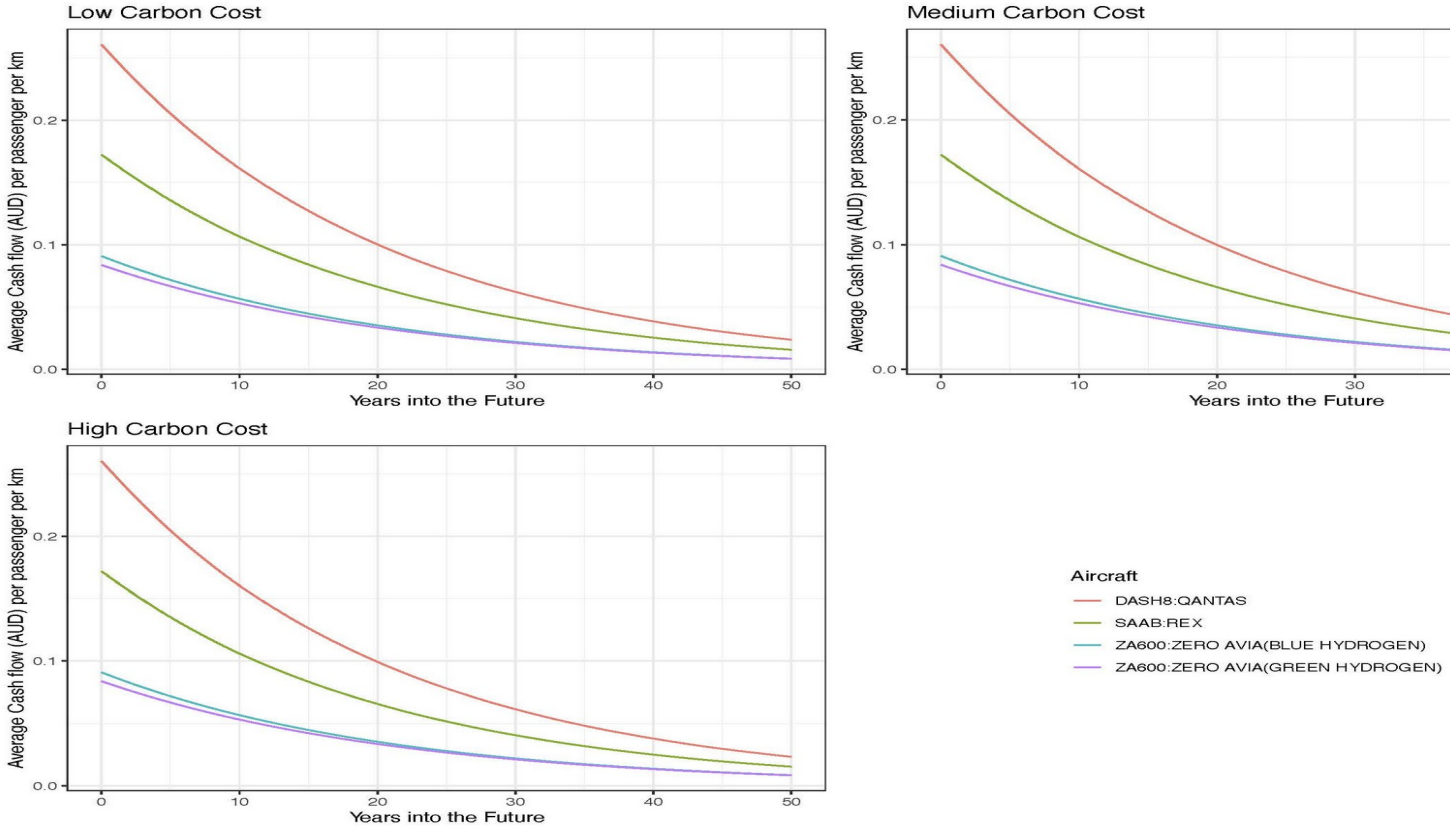
- Zero Avia ZA600 propulsion system for a retrofit of the Cessna Caravan with a configuration of 19 seats.

To ensure comparability we assume an average load factor of 82.5%, and we set the total number of daily passengers to 164 (corresponding to 4 QANTAS DASH8 flights at 82.5%).

Sydney – Dubbo Input data

Airline	Aircraft	Weight	Daily Flights	Seats	Fuel Consump-tion	PAX (per flight);	Crew (per flight)
QANTAS	Dash-8	28,998 kg	4	50	1.35 kg/km	41	2
Rex Airlines	Saab SF 340	13,154 kg	6	36	0.94 kg/km	29	1
Zero Avia	ZA600	6,575 kg	11	19	0.2 kg/km	15	1

Average Cash Flow (Revenue – Cost) per Passenger per km



Present value of cash flows considering emissions (scope 1 + scope 2 + upstream)

Aircraft	NPV (Low Carbon Cost) - million AUD	NPV (Medium Carbon Cost) -million AUD	NPV (High Carbon Cost) - million AUD
DASH-8	196.00	194.90	193.80
Saab SF 340	194.46	193.31	192.17
ZA600 (Blue)	189.75	189.31	188.88
ZA600 (Green)	181.66	181.44	181.22

Overall this case study shows that:

- Hydrogen aircraft could operate in the regional market (PV are positive)
- Hydrogen aircraft has the added benefit of more frequent services

Dubbo – Broken Hill

Dubbo – Broken Hill Context

Currently, the route is serviced by:

•Rex Airlines: Saab SF 340, 1 flight per day

The Alterative considered is the:

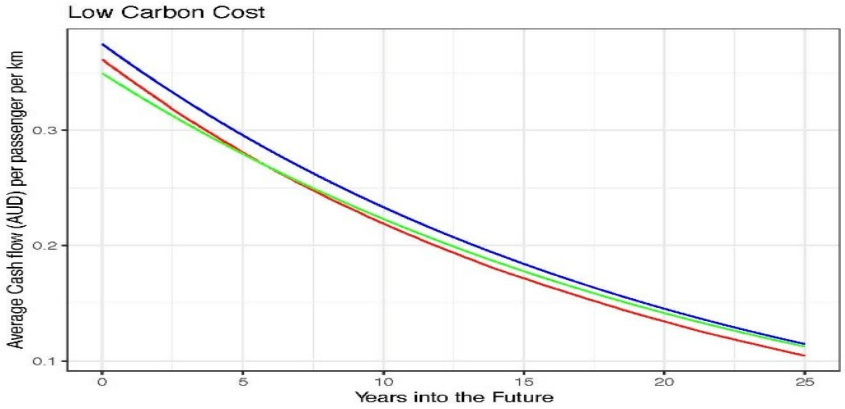
• Zero Avia ZA2000 with a range of over 1,300km and more than 40 seats .

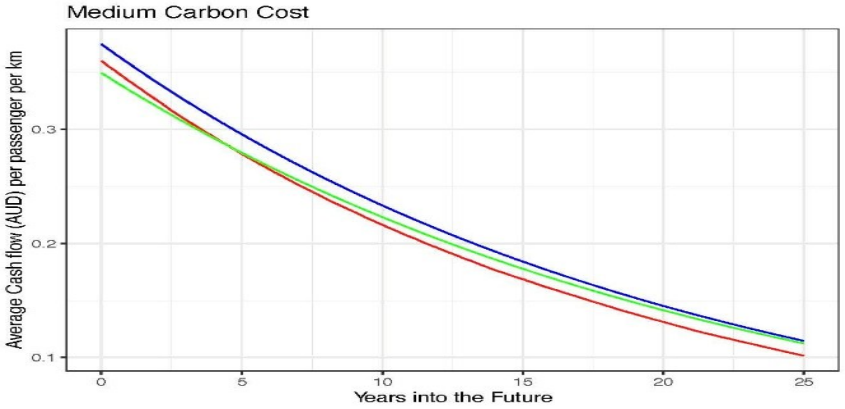
Given the limited number of flights between Dubbo and Broken Hill and the similar aircraft configuration, in this case only one flight per day with 29 PAX

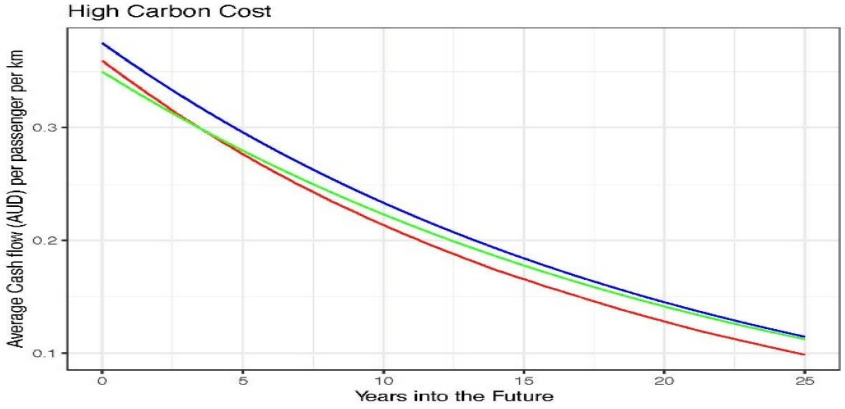
Dubbo – Broken Hill Input data

Airline	Aircraft	Weight	Daily flights	Seats	Fuel Consumption	Passengers (per flight)	Crew (per flight)
Rex Airlines	Saab SF 340	13154	1	36	0.94 kg/km	29	1
Zero Avia	ZA2000	28998	1	40	0.14 kg/km	29	1

Average Cash Flow (Revenue – Cost) per Passenger per km







Present value of cash flows considering emissions (scope 1 + scope 2 + upstream)

Aircraft	PV (Low Carbon Cost) - million AUD	PV (Medium Carbon Cost) - million AUD	PV (High Carbon Cost) - million AUD
Saab SF 340	25.00	24.58	24.17
ZA2000 (Blue)	26.68	26.62	26.56
ZA2000 (Green)	25.57	25.54	25.51

Overall this case study shows that:

- Hydrogen aircraft could match the financial performance of existing aircraft
- Carbon cost policies can make economic transition the regional aviation sector achievable within 5 years.

Cloncurry – Burketown

Cloncurry – Burketown Context

Regular commercial aviation is currently absent.

Sustainable aircraft could potentially open up new routes, especially between remote location where traffic is not that heavy

Here we calculate the minimum viable passenger numbers for profitable operation in smaller aircraft and under carbon cost consideration.

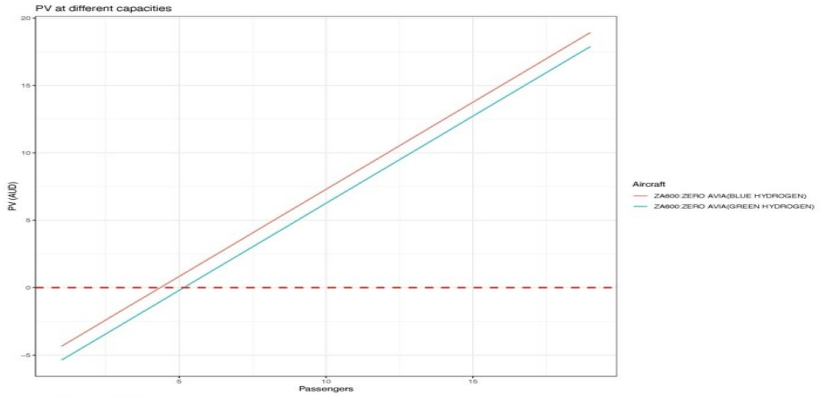
We consider:

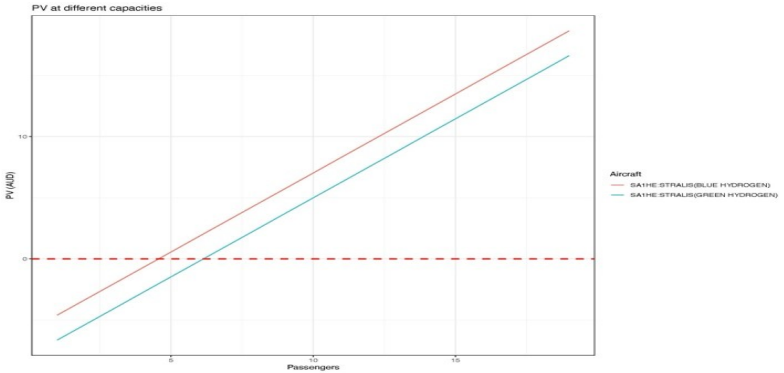
- Stralis SA1HE
- Zero Avia ZA600
- Saab SF340 as a benchmark

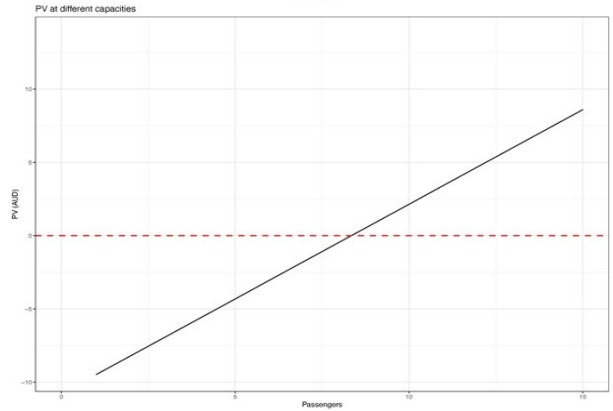
Cloncurry – Burketown Input data

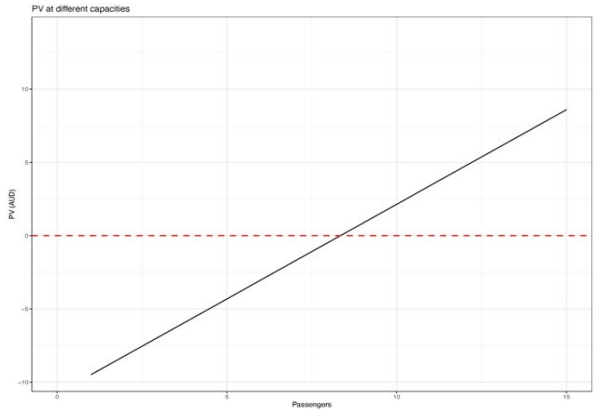
Airline	Aircraft	Weight	Daily Flights	Seats	Fuel Consumption	Crew (per flight)
Stralis	SA1HE	13154	1	15	0.1 kg/km	1
Zero Avia	ZA600	6575	1	19	0.2 kg/km	1
Saab	SF340	13154	1	36	0.94 kg/km	1

Minimum Viable Number of Passengers









Adelaide – Clare Valley

Adelaide – Clare Valley Context

Transport relies on private mode of transport, typically on road. This case allows to investigate whether clean, small-scale aircraft could open new routes and offer socio-economic benefits for regional communities and tourist sector

In this case study we compare:

- Average Diesel Car
- Average Petrol Car
- Average Electric Car

With:

- Joby S4 eVTOL

Adelaide – Clare Valley Input data

Input Variable	Values
Distance	150km
Travelled time by car	2 hours
Travelled time by Electric drone	28 minutes
Cost of travelled time	15 AUD/h
Fuel consumption Joby S4	1.2 kWh
Fuel consumption average petrol car	11.1 l/100km
Fuel consumption average diesel car	10.11 l/100km
Fuel consumption average electric car	0.2 kWh/km
Electricity price (South Australia)	0.07737 AUD/kWh
Petrol price (South Australia)	1.44 AUD/l
Diesel price (South Australia)	1.47 AUD/l
Pilot salary (annual)	AUD120,000
Effective Salary per flight	AUD 27.90

Adelaide – Clare Valley Results

Aircraft/Car	Fuel Cost (AUD)	Pilot Cost (AUD)	Time Cost (AUD)	Carbon Cost (AUD)	Total Cost (AUD)
Joby S4	12.99	27.90	7.03	1.62 to 2.43	49.54 to 50.35
Petrol Car	23.97	0	30	2.12 to 3.19	56.09 to 57.16
Diesel Car	22.27	0	30	2.25 to 3.38	54.52 to 55.65
Electric Car	2.32	0	30	0.29 to 0.43	32.61 to 32.75

Conclusion

Hydrogen aircraft are economically viable in many regional markets:

- Viable in all the case studies considered
- In the regions it’s where they shine: better cashflow performance, almost 40% reduction in the minimum number of passengers required, potential for great tourist/capital region connections

Large emission reduction are achievable in the aviation sector and carbon cost policy can boost transition.

Note of caution: a lot of uncertainty coupled with high infrastructure cost!

Thank you!

m.malavasi@unsw.edu.au