Transport and Infrastructure Net Zero Consultation Roadmap

Take the survey

Department of Climate Change, Energy, Environment and Water

Response received at:
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3 Published name
A/Prof Jonathan Couldrick

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Yes

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9 Who are you answering on behalf of?

Individual or individuals

10 Organisation name

Not answered

11 What best describes you or your organisation?

Not answered

12 What sector do you represent?

Not answered

13 What state or territory do you live in?

Australian Capital Territory

14 Postcode

2614

15 What area best describes where you live?

City

16 1. Do you support the proposed guiding principles?

Yes

17 1.1 Please add details to your response.

It is a great start but there will need to be concerted effort over the next 25 years to reach net zero by 2025

18 2. Do you support the use of the avoid-shift-improve framework as a tool to identify opportunities for abatement?

Yes

19 2.1 Please add details to your response.

It is a great start but it is unlikely that aviation will get to net zero by 2050 and will require more work.

20 3. Do you agree the development of a national policy framework for active and public transport will support emissions reduction?

Yes

21 3.1 Please add details to your response.

Not answered

22 4. What should be included in a national policy framework for active and public transport and how should it be developed?

The national policy should align with current disclosing requirements and align to international frameworks that Australia will need to interface to. An evidence based approach should be taken to model what the most effective options are.

23 5. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to ensure the movement of people contributes to transport emissions reduction?

See attached Document

24 6.1 What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to ensure that the movement of goods contributes to transport emissions reduction?

Not answered

25 6.2. How would these actions address the identified challenges and opportunities for emissions reduction in the movement of goods?

Not answered

26 7. Do you agree with the proposed net zero pathway for light road vehicles?

Not answered

27 7.1 Please add details to your response.

Not answered

28 8. The Australian Government is currently developing an Australian New Vehicle Efficiency Standard and has already begun to implement actions in the National Electric Vehicle Strategy.8.1 What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce light vehicle emissions?

Not answered

29 8.2 How would these actions address the identified challenges and opportunities to reduce light vehicle emissions?

Not answered

30 9. Do you agree with the proposed net zero pathway for heavy road vehicles?

Not answered

31 9.1 Please add details to your response

Not answered

32 10. The proposed pathway for heavy road vehicles relies on a mix of battery electric, hydrogen fuel-cell and low carbon liquid fuels.Rank from 1 to 3, the order in which these should be prioritised for emissions reduction.

Not answered

33 10.1 Please add details to your response. Why did you rank them in that

order?

Not answered

34 11. What role should low carbon liquid fuels play in the heavy vehicle decarbonisation?

Not answered

35 12. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce heavy vehicle emissions?

Not answered

36 13. Do you agree with the proposed net zero pathway for rail?

Not answered

37 13.1 Please add details to your response.

Not answered

38 14. The proposed pathway for rail relies on a mix of battery electric, hydrogen fuel-cell and low carbon liquid fuels.Rank from 1 to 3, the order in which these should be prioritised for emissions reduction.

Not answered

39 14.1 Please add details to your response. Why did you rank them in that order?

Not answered

40 15. What role should low carbon liquid fuels play in rail decarbonisation?

Not answered

41 16. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to

reduce rail emissions?

Not answered

42 16.1 How would these actions address the identified challenges and opportunities to reduce rail emissions?

Not answered

43 17. Do you agree with the proposed net zero pathway for maritime?

Not answered

44 17.1 Please add details to your response.

Not answered

45 18. The Australian Government is engaging in consultation as part of the development of the Maritime Emissions Reduction National Action Plan and those consultations will also inform the final Roadmap and Action Plan. 18.1 What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce maritime emissions?

Not answered

46 18.2 How would these actions address the identified challenges and opportunities to reduce maritime emissions?

Not answered

47 19. Do you agree with the proposed net zero pathway for aviation?

See attached Document

48 19.1 Please add details to your response.

See attached Document

49 20. The Australian Government has already engaged in consultation on aviation decarbonisation through the development of the Aviation

White Paper and those consultations will also inform final Roadmap and Action Plan.

See attached Document

50 20.1 What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce aviation emissions?

See attached Document

51 21. Do you agree with the proposed net zero pathway for transport infrastructure?

Not answered

52 21.1 Please add details to your response.

See attached Document

53 22. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce transport infrastructure emissions and ensure that transport infrastructure is ready for and enables low-emission transport modes?

See attached Document

54 22.1 How would these actions address the identified challenges and opportunities to reduce transport infrastructure emissions?

See attached Document

55 23. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to ensure the energy mix is ready to support transport emissions reduction?

Not answered

56 24. How should the use of low carbon liquid fuels (LCLFs) be prioritised

across different transport modes over time to achieve maximum abatement?

See attached Document

57 25. What are the best ways for the Australian Government to work collaboratively with industry, business, governments and communities to implement the proposed pathways?

Include universities as an option to undertake the research than will be required over the next 25 years. This will have the added bonus of meeting the needs of the recently released universities accord released by the Department of Education.

58 25.1 What are good domestic or international examples of partnership and collaboration on transport and transport infrastructure emissions reduction that could inform the final Roadmap and Action Plan?

Clean Aviation - www.clean-aviation.eu

59 25.2 What opportunities can Government leverage to show leadership in Australia and internationally?

Developing/Supporting research tailored to the Australian ecosystem rather than plain adoption of international research that would have been done (most likely) for European or American conditions.

60 26. What measures and metrics should be used to evaluate the final Transport and Infrastructure Net Zero Roadmap and Action Plan?

A balance scorecard approach - Achieving a net reduction, maintaining/increase volume of cargo/passengers (transitioning where possible), and maintaining the economic benefits of the system

61 26.1 What other data and evidence could governments use and how could this offer further insights on the pace, scale and location of transport emissions reduction pathways?

Not answered

62 27. Do you have any feedback on the proposed review process?

Not answered

63 28. Do you have any further feedback on the Consultation Roadmap and proposed pathways?

Not answered

64 28.1 Is there anything missing? Are the sections appropriately integrated? Is the Roadmap appropriately ambitious?

For aviation it is not ambitious enough and highly unlikely to achieve net zero in aviation without offsets from other sectors

65 29. Is there any further information or documentation that you wish to be considered with your submission?

See attached document "Sustainable Aviation - Transport and Infrastructure Net Zero Consultation Roadmap - Position Paper - 24 Jul 24"

66 Would you like to upload a document?

Yes

67 Have you removed any identifying information from your submission?

Yes

68 Upload a submission

Sustainable_Aviation_Transport_and_Infrastructure_Net_Zero_Consultation_Roadmap_Position_Paper_24_Jul_24.beecf4bc_Redacted.pdf

69 Upload a submission

220224 - Clean-Aviation-infographic-2022.pdf

70 Upload supporting file

Not answered

71 Upload supporting file

Not answered

Director, Transport and Infrastructure Net Zero Roadmap and Action Plan
Transport and Infrastructure Net Zero Consultation Roadmap
Department of Infrastructure, Transport, Regional Development, Communications and the Arts
GPO Box 594
Canberra ACT 2601
Australia

24 July 2024

A Submission to the Transport and Infrastructure Net Zero Consultation Roadmap (May 2024) and how to maximise Aviation's Contribution to Net Zero.

To Whom it May Concern,

The following is the personal position of the author and submitted in response to the Department of Infrastructure, Transport, Regional Development, Communications and the Arts' "*Transport and Infrastructure Net Zero Consultation Roadmap*" (May 2024). It specifically addresses questions19 and 20 – Maximising Aviation's Contribution to Net Zero. However, it may have bearing on other sections, such as q5 (additional actions by governments, community, industry and other stakeholders), q21/22 (infrastructure requirements) and q24 (prioritisation of LCLF).

The body of this letter provides an executive summary in response to the consultation roadmap. Appendix A provides specific responses to the roadmap questions as well as the requested underlying detail.

About the Author
A/Prof Jonathan Couldrick PhD SMAIAA FRAeS FIEAust CPEng NER APEC Engineer IntPE (Aus)

A/Prof Jonathan Coudrick has studied and worked in and around the aviation industry for almost three decades. He is an Honorary Associate Professor of Engineering at the Australian National University, a Senior Member of the American Institute for Aeronautics and Astronautics, a Fellow of the Royal Aerospace Society, and is registered to practice in Mechanical and Aerospace Engineering.

A/Prof Jonathan Coudrick is the Senior Engineering Manager for Nova Systems an Australian owned and operated company and one of four Major Service Providers to the Australian Defence Capability Acquisition and Sustainment Group. He is the previous AIR MSP Portfolio Manager for Nova Systems, where he managed a team providing services that cover eight aircraft types as well as aeronautical ground support equipment and commons for the Australian Defence Force. He is a past Chair of the Mechanical College Board, is a corresponding member of the National Committee for Space Engineering and sits on the Joint Board for Aerospace Engineering (responsible for managing the collaborative strategy between Engineers Australia and the Royal Aeronautical Society Australian Division).

This submission and the underlying research is not funded by any fuel companies, aircraft designers, manufacturers and operators. Nor are any of these funding any of A/Prof Jonathan Couldrick's other work or positions.

Executive Summary

Appendix A provides specific responses to the roadmap questions as well as the requested underlying detail.

Overall, the government's roadmap is commendable. However, it will **not achieve net zero across aviation by 2050 alone due to only considering hydrogen and Low Carbon Liquid Fuels.** More work will be required to decarbonise the aviation sector or the sector will need the ability to offset aviation with other negative emission sectors.

Level of Implementation of the Consultation Roadmap	Aviation Carbon Footprint compared to 2023 levels		
	2023	2035	2050
Highly Successful Implementation	100%	84.2%	26.0%
Successful Implementation	100%	99.5%	80.6%
Unsuccessful Implementation	100%	115%	135%

Potential Australian aviation carbon footprint from domestic and international flying activities of the VH-fleet compared to 2023 levels

Based on research conducted at the Australian National University (ANU) modelling Australia's aviation sector, it is expected (under the most likely "Successful implementation" scenario) that the carbon footprint of Australian aviation flight activities in 2035 and 2050 is expected to decrease by 0.5% and 19% respectively compared to 2023 levels (See above table). However, this is **highly dependent on the success of all the elements of the roadmap coming together, which will require ongoing effort over the next 25 years**. If a concerted effort is made across the numerous stakeholders involved, then greater reductions are possible, which will require:

- Australian government bodies (including AirServices and CASA), infrastructure owners (primarily airports) and operators to be **ready to accept new/novel technologies that will change how we operate and accept/manage risk.** These will primarily see evolution of current technologies but will still create a level of disruption.

- Low Carbon Liquid Fuels (LCLF) with low (~10-15%) carbon intensity to be sufficiently available to aviation, which will require significant work in the face of global competition for the associated feedstock and supply. Modelling identifies that **6GL and 11GL of LCLF are required to be available in Australia by 2035 and 2050 respectively.**

  There is going to be significant competition for LCLF feedstock for domestic production; however, if Australian LCLF is going to be recognised by Australian and international operators (flying to, from and within Australia), **any Australia framework needs to consider international initiatives/concerns as there can be unintended consequences to prioritising LSLFs over all other things.** Furthermore, not all LCLFs may be recognised by international bodies, for example Europe does not recognise LCLFs made from food and feed crops.

  Internationally, Australia's framework will need to interface with other government frameworks as well as considering the entire fuel lifecycle, from production through to end use, to understand a fuels carbon intensity.

- **Significant new Australian infrastructure to be in place by 2035 for the incorporation of hydrogen into the supply chain.** It is highly recommended that that Australia does not wait for hydrogen aircraft to arrive before high level planning is undertaken to prepare other stakeholders (e.g. neighbouring landowners to airports) to understand how they will be impacted. **Modelling can easily be undertaken to determine the volume levels of hydrogen required and in what timeframes, which will drive long term designs and plans.**

  To implement the Net Zero Roadmap for hydrogen and achieve superior carbon reductions, will **require the next level of planning to better understand future requirements and the policies required to realise the full outcomes.** For example, it is estimated that airports will only start considering implementation of hydrogen infrastructure in the 2030 timeframes for infrastructure to be in place by 2035. However, **high-level planning, research and policy could be undertaken in the short term to safeguard access to the land that will be required and estimate the scale of infrastructure required over the various timeframes.** Understanding this will be required prior to any detailed designs that will be kicked off in 2030, requiring modelling to be conducted over the next five years.

- Market Based Measures are the economic levers required to offset and manage any remaining $C0_2$ emissions after implementation of the roadmap. **No modelled scenarios existed, under the current roadmap approach, where aviation had net zero emissions without the existence of non-aviation offsets. As Market Based Measures are expected regardless, clarity around what needs to be offset is vital.** Modelling and options to further reduce aviation's footprint (beyond the roadmap actions) are very different if only Australian domestic flights need to be accounted for compared to Australian international flights; however, this would be a completely different position if all internationals flights (Australian and no-Australian) within/to/from Australia need to be accounted for.

  Further options (i.e. additional roadmap actions) are available to reduce aviation's carbon footprint. A high level consideration of what these could include is included in Appendix A and range from examining "bottlenecks" in the system through to economic modelling to ensure costs are not significantly affected. **Australian universities and industry are well placed to undertake holistic modelling in the short term, to be ready in the medium term, to have a long term impact.**

It is highly recommended that an evidence based approach is taken in setting policies. ANU research has shown the scale of various high level elements that need addressing. For Australia to get its "biggest bang for buck," it needs to understand the scale of additional options in the long term rather than undertaking what is easiest in the short term. For example, complete electrification of Advanced Air Mobility (AAM) will only have a marginal impact (3-4% at best) on the aviation flying footprint due to the volume/scale of short-, medium- and long-haul aircraft in operation compared to commuter and regional aircraft. Whilst AAM will be importantly economically to Australia, this needs to be separated from their marginal impact to the carbon footprint.

An evidence based approach is easily achieved and does not require significant additional investment in the university sector. For example, the current ANU modelling was undertaken as a secondary activity. Whilst it is acknowledged that there are limitations to this research due to the minimal resources applied, these limitations could easily be addressed; however, **the fundamental question that needs to be asked first is, over what timeframes are research outcomes required, regardless of who does it?** Shorter timeframes would dictate that research would need to be prioritised higher.

If you have any questions regarding any of the above, or would like clarification, then please do not hesitate to contact me.

Regards

A/Prof Jonathan Couldrick

Appendices

A. **Detailed Response to the Transport and Infrastructure Net Zero Consultation Roadmap (May 2024) and how to maximise Aviation's Contribution to Net Zero**

Appendix A – Detailed Response to the Transport and Infrastructure Net Zero Consultation Roadmap (May 2024) and how to maximise Aviation's Contribution to Net Zero

Q19. Do you agree with the proposed net zero pathway for aviation?

SUMMARY POSITION

Overall, the government's roadmap is commendable. However, it will not achieve net zero across aviation by 2050 alone due to only considering hydrogen and Low Carbon Liquid Fuels. More work will be required to decarbonise the aviation sector or the ability to offset aviation with other negative emission sectors. Aviation is a hard to abate sector and a complex ecosystem that is important to Australia's economy.

The following sections identify key things that also need to occur and identifies the scale of their impact to decarbonising aviation. This is based on research conducted at the Australian National University (ANU) that modelled Australia's aviation sector.

Level of Implementation of the Consultation Roadmap	Aviation Carbon Footprint compared to 2023 levels		
	2023	**2035**	**2050**
Highly Successful Implementation	100%	84.2%	26.0%
Successful Implementation	100%	99.5%	80.6%
Unsuccessful Implementation	100%	115%	135%

Potential Australian aviation carbon footprint from domestic and international flying activities of the VH-fleet compared to 2023 levels

It is expected (under the most likely "Successful Implementation" case) that the carbon footprint of Australian aviation flight activities in 2035 and 2050 is expected to decrease by 0.5% and 19% respectively compared to 2023 levels (See above table). However, this is highly dependent on the success of all the elements of the roadmap coming together, which will require significant effort over the next 25 years. If a concerted effort is made then greater reductions are possible, which will require:

- Australian government bodies (including AirServices and CASA), infrastructure owners (primarily airports) and operators to be ready to accept new technologies that will change how we operate and accept/manage risk.

- Low Carbon Liquid Fuels (LCLF) also known as Sustainable Aviation Fuel (SAF) or biofuels with low (~10-15%) carbon intensity to be sufficiently available to aviation, which will require significant work in the face of the global competition for the associated feedstock and supply. Modelling identifies that 6GL and 11GL of SAF are required to be available by 2035 and 2050 respectively.

- Significant Australian infrastructure to be in place by 2035 for the incorporation of hydrogen into the supply chain. It is highly recommended that Australia does not wait for hydrogen aircraft to arrive before high level planning is undertaken to prepare other stakeholders (e.g. neighbouring landowners to airports) to understand how they will be impacted. Modelling

can easily be undertaken to determine the volume levels of hydrogen required and in what timeframes, which will drive long term designs and plans.

- Different modes of operations are considered to drive sustainability into current operations. This could include anything from examining "bottlenecks" in the system through to economic modelling to ensure costs are not significantly affected. Australian universities and industry are well placed to undertake holistic modelling in the short term, to be ready in the medium term, to have a long term impact.

As it is expected that Market Based Measures will be required regardless, i.e. aviation will be a net positive producer of $C0_2$ out to 2050, clarity around what needs to be offset is vital. Modelling and options to further reduce aviation's footprint are very different if only Australian domestic flights need to be accounted for compared to Australian international flights; however, this would be completely different if all internationals flight within/to/from Australia need to be accounted for.

DETAILS - MODELLING OF AUSTRALIAN FLIGHTS AND THE POTENTIAL FOR CO_2 REDUCTIONS

"Although the aviation industry currently has limited cost-effective abatement options, by 2035 they are projected to reduce emissions by incorporating sustainable aviation fuels"[1]

The Australian National University (ANU) undertook a research project in 2023 to model the aviation CO_2 footprint from all Australian flying activities. It sampled actual flight data across 2023 from the entire Australian fleet[2] both international and domestically. Based on a compound growth in Australian aviation activities of 3.6%[3], **it is expected that if nothing changes Australia's aviation $C0_2$ footprint is expected to grow by 53% and 160% by 2035 and 2050 respectively.**

It is noted that CSIRO estimated a 2.2% annual growth in aviation fuel usage after accounting for expected technical and operational efficiencies.[4] ANU's modelling separated the effects of technical and operational efficiencies as they are not guaranteed (as discussed later); however, an equivalent growth rate would be 1.6% under ANU's model (compared to CSIRO's 2.2%).

	Potential CO_2 savings	
	2035	**2050**
Technical & Operational Efficiencies	-22%	-42%
Sustainable Aviation Fuel	-13% ±10%	-23% ±20%
Electrical and Hydrogen Transition	-1% ±1%	-9% ±8%
Market Based Measure	-65% ±10%	-31% ±21%

Table 1 Potential CO_2 savings for the Australian aircraft fleet from different sources out to 2050 based on modelling of 2023 ADS-B flight data of the (combined domestic and international) VH-fleet[5]

[1] Australian Government, Department of Climate Change, Energy, the Environment and Water, "Australia's emissions projections 2023" November 2023, p56 < =https://www.dcceew.gov.au/climate-change/publications/australias-emissions-projections-2023>.
[2] "VH" aircraft only and so excludes military aircraft and foreign aircraft flying into and out of Australia.
[3] 3.6% is derived from the increase in Aviation fuel use between 2010-2019.
[4] CSIRO, "Sustainable Avia□on Fuel Roadmap", August 2023, p8 <https://www.csiro.au/en/news/all/ar□cles/2023/august/sustainable-avia□on-industry-Australia>.
[5] The way to read this data is to multiple the growth in aviation with the potential saving. For example, by 2035 the Australian aviation footprint is expected to grow by 53% compared to 2023 level with technical and operational efficiencies reducing the carbon footprint by 22% and SAF having an impact of -3 to -23%. As such

Using aviation industry projections for potential transition to new fuel types, the ANU research identified the magnitude of CO_2 savings that could be achieved out to 2050, see Table 1. The categories of saving are divided into four categories:

- **Technical & Operational Efficiencies** – The aviation industry has typically enjoyed an annual 2% efficiency dividend as conventional flight has evolved over the last 25 years. Projecting forward this will come from areas such as:
    - More dynamic modelling of routes to reduce distance travelled and holding patterns.
    - Lighter and more efficient aircraft structures and systems for existing designs.
    - More efficient operations to reduce turnaround times or direct routes, e.g. Qantas' project sunrise creating a direct route from Sydney to London.
    - New aircraft designs such as Airbus' Blended Wing Body (BWB) or Boeing's Transonic Truss Braced Wing (TTBW)

  Technical and operational efficiencies will be the "easiest" to incorporate and will likely have the biggest impact to aviation's footprint. However, none of the above are guaranteed to be incorporated early into our ecosystem if Australia is not planning for them now. As Australia is mainly an adopter/receiver of these types of technologies, this will require key players such as CASA, AirServices and Airports to be ready to incorporate them as they become available.[6]

- **Sustainable Aviation Fuel (SAF)** – Also referred to as biofuels and Low Carbon Liquid Fuels (LCLF), SAF is a very promising technology for Australia with the potential to have a large impact on aviation's carbon footprint but only if available in sufficient quantity at the right locations. **Modelling identifies that Australia will need approximately 6GL and 11GL of SAF to be available by 2035 and 2050 respectively to achieve the higher end of the potential $C0_2$ savings identified in Table 1.** This is slightly below CSIRO's projected total Australian SAF production capacity from all feedstock types; however, it is expected that there will be significant competition for this (discussed further below).

- **Electrical and Hydrogen Transition** – Whilst SAF has the potential to have a bigger impact, transition to electrical- and hydrogen-fuelled aircraft will still have a significant effect on Australia's CO_2 emissions. However, its impact will be limited in the short term by the fact that Long- and Medium-Haul aircraft are currently Australia's largest CO_2 emitters and the hardest to transition before 2050. Again, **as Australia will likely be a net consumer of electrical and hydrogen aircraft technology, we need to plan for their incorporation in the 2035 time frame to maximise their adoption.** This planning is more about infrastructure, as such planning needs to happen now so that Australia is ready to incorporate them into the fleet as soon as possible, see below for further discussion.

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the expected carbon footprint of Australian aviation in 2035 is expected to change between decreasing 16% (100% * (1+0.53) * (1-0.22-0.23)) through to increasing 15% (100% * (1+0.53) * (1-0.22-0.03)) compared to 2023 levels. Note the impact of hydrogen has not been included in this calculation/

[6] For example, the A380 was a conventional designed aircraft but the volume of passengers saw a significant change to airports that impacted from bridge design through to immigration remodelling to deal with the mass arrivals occurring at one time rather than spread out over 2-3 flights

- **Market Based Measures** – These are fundamentally the economic levers that the Australian government can implement/recognise to allow carbon offsets to be recognised between entities as **there were no scenarios out to 2050 for aviation to reach net zero in isolation. This means that Market Base Measures will be required with the only question being their magnitude.** Depending on the success of the above technical/operational efficiencies, implementation of SAF and transition to new power sources, market based measures may need to offset up to half of aviation's carbon footprint from flying.

A corollary of the Market Based Measures (MBM) is that they can be used to predict the expected change in CO_2 emissions by Australia's aviation sectors flight activities. As such based on mid-point MBMs of 65% and 31% in 2035 and 2050 respectively (see Table 1), **it is expected that the carbon footprint of Australian aviation flight activity in 2035 and 2050 is expected to decrease by 0.5% and 19% respectively compared to 2023 levels.[7] As shown in Table 2, this is highly dependent on the success of all the elements of the roadmap coming together, which will require concerted effort of the next 25 years.**

Level of Implementation of the Consultation Roadmap	Aviation Carbon Footprint compared to 2023 levels		
	2023	**2035**	**2050**
Highly Successful Implementation[8]	100%	84.2%	26.0%
Successful Implementation	100%	99.5%	80.6%
Unsuccessful Implementation[9]	100%	115%	135%

Table 2 Potential Australian aviation carbon footprint from domestic and international flying activities of the VH-fleet compared to 2023 levels

Another key question for the Australian government is **what will the Australian aviation system need to offset, i.e. does just the VH-fleet flying globally needs to reach net-zero or does Australia need to also consider international operators within Australia? Modelling and options are very different if only Australian domestic flights need to be accounted for compared to Australian international flights; however, this would be completely different if all internationals flight to/from Australia then had to be accounted for.** It is noted that mother nature will take all CO_2 emissions from flight activities, but it is acknowledged that Australia's international obligations may constrain what is considered or how Australia engages internationally. Depending on the answer to this, options to reduce aviation's footprint could include things such as:

- Flying greener with existing aircraft – There will need to be significant modelling to understand what is possible but slowing aircraft down, changing flight times and flying at different altitudes are expected to have a marked effect.

[7] As such the expected carbon footprint of Australian aviation in 2035 is expected to change by decreasing 0.5% (100% * (1+0.53) * (0.65)) in 2035 and 20% (100% * (1+1.6) * (0.31)) in 2050 compared to 2023 levels.
[8] With significant co-ordinate effort this could see the Australian aviation's footprint decreasing 16% (100% * (1+0.53) * (0.55)) in 2035 and 74% (100% * (1+1.6) * (0.10)) in 2050 compared to 2023 levels.
[9] If the government's roadmap is not successful it is possible that Australia's carbon footprint could increase by 15% (100% * (1+0.53) * (0.75)) in 2035 and 35% (100% * (1+1.6) * (0.52)) in 2050 compared to 2023 levels.

- Changing the Australian Fleet mix – Moving away from Medium- and Long-Haul aircraft will increase the potential for electrical and hydrogen transition; however, this will create other bottlenecks, for example gates at aircraft and take-off/landings slots.

Q20.1. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce aviation emissions?

Q24. How should the use of low carbon liquid fuels be prioritised across different transport modes over time to achieve maximum abatement?

SUMMARY POSITION

Fundamentally, the consultation roadmap is optimistic but achievable. However, achieving net zero within aviation will require ongoing concerted effort over the next 20+ years.

To make any net reduction in Australia's Aviation CO_2 footprint from 2023 levels would require at least 5GL of Low Carbon Liquid Fuels (also referred to as Sustainable Aviation Fuel or biofuels) with a carbon intensity of 10-30% to be available by 2035.

To realise significant reductions in Australia's Aviation CO_2 footprint would require 6GL and 11GL of LCLF to be available by 2035 and 2050 respectively at a Carbon Intensity around 10-15%. Noting that this is considered a stretch target when considering competition of the underlying supplies internationally and the association feedstock domestically.

There is going to be significant competition for LCLF feedstock for domestic production. Moreover, if Australian SAF is to be recognised by Australian and international operators flying to, from and within Australia, Australia needs to learn from international initiatives/concerns as there can be unintended consequences to prioritising LSLFs over all other things. Furthermore, not all LCLFs will be recognised by international bodies, for example Europe does not recognise LCLFs made from food and feed crops.

DETAILS - COMPETITION FOR LCLFS AND THE PRIORITISATION OF FEEDSTOCK

"Emissions are projected to peak in 2027, after which they are expected to decline to 8 Mt CO_2-e in 2035. Emissions from domestic aviation are from flying only and do not include emissions from airports and ancillary services."[10]

Modelling of Australian flying activities and projections out to 2035 identifies that **Australia would need to have access to at least 5GL of LCLF with a carbon intensity between 10-30% for this statement to be realised if emissions from both international and domestic flights applied.** Whilst the above quote may only be for domestic aviation, it is expected that Australia will need to factor in its international commitments. For example, international flights originating from Australia will need to have a minimum proportion of SAF incorporated,[11] which is expected to significantly increase competition for access to LCLF imports, resulting in a price increase if Australia cannot produce enough domestically.

[10] Australian Government, Department of Infrastructure, Transport, Regional Development, Communications and the Arts, "Transport and Infrastructure Net Zero Consultation Roadmap" p60.
[11] For example, ReFuelEU will be mandating that European Union airports to have 20% SAF by 2035 and 70% by 2050 and the proportion of SAF is expected to continue to grow out to 2035. Source <https://www.consilium.europa.eu/en/press/press-releases/2023/10/09/refueleu-aviation-initiative-council-adopts-new-law-to-decarbonise-the-aviation-sector>.

Modelling identifies that Australia will need approximately 6GL and 11GL SAF to be available by 2035 and 2050 respectively to achieve the higher end of the potential $C0_2$ savings identified in Table 1. Whilst this only represents around 80% of the maximum possible LCLF production capacity for Australia in 2050 predicted by CSIRO, the CSIRO projections are reliant on very novel technology being implemented. Moreover, it is expected that **competition for LCLFs from the maritime sector as well as access to the feedstock for agriculture are expected to mean that 11GL will be a stretch target for Australia by 2050, whilst keeping prices low.**

Recognising that different feedstock and longer distance imports will have differing carbon intensities means that Australi will need to prioritise feedstock for LCLFs if Australia is to have a low Carbon Intensity LCLF. However, **prioritisation of feedstock needs to be balanced across all sectors as use all feedstocks may have unintended consequences.** For example, the ReFuelEU mandate specifically excludes LCLFs made from food and feed crops, as EU regulators are concerned that demand could lead to land use being switched from food to fuel. Within Oceana, the analogy of deforestation for palm oil can be made having deleterious effects to other ecosystems.

Q20.1. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce aviation emissions?

Q 5. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to ensure the movement of people contributes to transport emissions reduction?

SUMMARY POSITION

For Australian produced LCLFs to be recognised by international operators and for Australian operators to be able to rely on international LCLF supplies, the Australia framework for achieving net-zero fundamentally needs to consider the overall supply chain and how to capture carbon credits/debits at the various stages of production, transport and supply.

Internationally, Australia's framework will need to interface with other government frameworks as well as considering the entire fuel lifecycle, from production through to end use, to understand a fuels true carbon intensity. For example, it is nugatory if more carbon is released in the production and supply of LCLFs to the aircraft than conventional fossil fuel based aviation fuel.

From an engineering perspective this is a control volume problem and is a standard technique for how the problem might be addressed. Importantly, this can be managed through certification of fuel under a regulation framework; however, it is unknown how current Australian government mandatory climate-related disclosures will align to simplify these assessments. Importantly, aligning these assessments and domestic disclosures with international bodies will mean Australian operators may better compete for overseas supplies. Of note is it is not yet known what affect recognising/aligning to international frameworks will have on competition for Australian supplies, for example a 'book and claim' system may hurt Australia in the short term but in the long-term Australia will be a quasi-closed market for LCLF, as international aircraft flying out of Australia don't really have much option other than to refuel in Australia.

DETAILS - NOT ALL LCLFS ARE CREATED EQUALLY - IMPORT VERSUS LOCAL REFINEMENT

"*Reducing the carbon intensity of liquid fuels with certification that verifies emissions abatement would ensure genuine emissions reduction in the aviation sector.*"[12]

This is a very important statement as certification of LCLFs needs to factor in everything from production through to final use to understand the true carbon intensity of a fuel. As such there needs to be a standard framework to drive sustainability into the supply chain. Considerations to implement such a system needs to include:

- **Alignment to current government disclosing requirements** - **The aviation fuel supply chain should align to the Australian government mandatory climate-related disclosures** for entities required to lodge financial reports under the Corporations Act 2001 (Cth). This will likely cover all large operators and infrastructure owners; however, should a framework also consider small commercial and private operators who will also be emitting CO_2. Importantly,

[12] Australian Government, Department of Infrastructure, Transport, Regional Development, Communications and the Arts, "Transport and Infrastructure Net Zero Consultation Roadmap" p5.

aligning the certification framework to the disclosing statements would create efficiencies and reduce barriers to compliance. Such a framework could then be applied to smaller non-disclosing entities to allow an overall picture to be developed and or reported against by the larger entities.

- **Domestic Supply Chains** – Domestically, it is expected that certification requirements will be easier to implement and enforce to factor in Australia's obligations by (Australian and international) companies' operating within Australia. **Certification of supplies from producers (who manufacture the LCLF) through to distributors, airports and finally to operators (who consume the LCLF) requires the ability to understand the carbon footprint of each part of the supply chain, which will drive the carbon intensity lower and in doing so reduce the actual footprint.** Understanding inefficient parts of the supply chain will allow these to be addressed in priority order and will likely take decades to achieve.

- **International Supply Chains** – Similar to the above, it would be beneficial for Australia to align to international frameworks to allow the carbon intensity of the entire supply chain to be understood from producer to operator. Moreover, **recognising international frameworks would allow Australia to better compete for imports if Australian entities are able to recognise international LCLFs supplies**. However, it is acknowledged that this is currently in a state of flux, e.g. the EU is currently considering whether/how to recognise the United States preferred approach to "book and claim".[13] The key benefits of such an approach are:
    - It will not impede domestic reduction of Australia's CO_2 footprint from an accounting perspective in the short term if an operator can offset from an international source;
    - It will not further increase costs/competition on imported fuel making Australia more competitive on the international stage by restricting recognition of certain classes of fuel types;
    - **It may reduce the carbon intensity of the LCLFs domestically, although this will depend on the supply chain in its entirety as having to ship LCLFs one way in the first place to only use it on the flights out is likely to be more carbon intensive. However, it is noted that this may increase competition for locally sources LCLFs, which may need incentives**.

[13] A feasibility study is expected this month. Source <https://www.trade.gov/market-intelligence/european-union-aerospace-and-defense-sustainable-aviation-fuel-regulation>.

Q 20.1. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce aviation emissions?

Q20.2. How would these actions address the identified challenges and opportunities to reduce aviation emissions?

SUMMARY POSITION

It is highly recommended that an evidence based approach is taken in setting policies. ANU research has shown the scale of various high level elements that need addressing. For Australia to get its "biggest bang for buck," it needs to understand the scale of changes in emissions for the various options in the long term rather what is easiest in the short term. For example, Advanced Air Mobility (commonly referred to as "Air Taxis") will expand significantly; however, complete electrification of AAM will only have a marginal impact (3-4% at best) on the aviation flying footprint due to the volume/scale of short-, medium- and long-haul aircraft in operation compared to commuter and regional aircraft. Whilst AAM will be importantly economically to Australia, this needs to be separated from their marginal impact to their carbon impact.

An evidence based approach is easily achieved and does not require significant additional investment in the university sector.[14] For example, the current ANU modelling was undertaken as a secondary activity. Whilst it acknowledged that there are limitations in this research due the minimal resources available, these could be easily addressed with time or additional resources. However, the fundamental question that needs to be asked first is, **over what timeframes are research outcomes required, regardless of who does it?** Shorter timeframes would dictate that research and resources would need to be prioritised higher.

DETAILS - DIFFERENT POLICIES AND MARKET BASED MEASURES SET OF INFRASTRUCTURE FOR SMALL AIRCRAFT

It is expected that different aircraft will require different policy settings to achieve net-zero. For example; where different non-aviation modes of transport cannot be used, large long-haul aircraft will likely need to have LCLFs prioritised in the 2040 timeframe as they are unlikely to transition to any other fuel source; whereas new small aircraft could be prioritised/incentivised for electrification.

Modelling of the small aircraft sector identifies that **full transition of the small aircraft/commuter segment to electrical or hydrogen fuel sources, will only reduce aviation's carbon footprint by 3-4% at best.** The driving factor behind this is that the larger aircraft, whilst less in number, outfly the smaller aircraft in both passengers/cargo and kms flown.

There was a large level of uncertainty in the small aircraft data of the ANU model and their electrification may only reduce CO_2 emission by as little as 1% as the scale of growth in Advanced Air Mobility (AAM - colloquially referred to as "Air Taxis") is unknown. As such, the ANU model took a much higher level of growth in this sector compared to the larger sector to compensate for reduced data. Importantly, it is noted that the AAM sector is primed for electrification with the current

[14] Recommendation 25 of the Australian Government (Department of Education) "Australian Universities Accord" highlighted the need for "Australian businesses and governments drawing more heavily on the research and consultancy capacity of Australian universities." Source <https://www.education.gov.au/australian-universities-accord/resources/final-report>.

developments in Electric Vertical Take-Off and Landing (EVTOL) occurring. It is acknowledged that this means the confidence level in the ANU model for small aircraft and private operators is significantly reduced compared to the larger aircraft and commercial operators. This was a limitation of the data available. To increase the confidence level of the modelling the following would be beneficial:

- Any official projections of the growth in AAM could be specifically incorporated;
- Private flight plans (held by Airservices) be provided so that theoretical models could be incorporated into the model as not all aircraft have ADS-B transponders; or
- All aircraft could be regulated to have ADS-B transponders turned or fuel usage directly monitored so that real flight data could be automatically captured to understand actual flight data and footprints to be calculated. Noting that this would benefit mandatory disclosures and reporting.

Q21. Do you agree with the proposed net zero pathway for transport infrastructure?

Q22. What additional actions by governments, communities, industry and other stakeholders need to be taken now and in the future to reduce transport infrastructure emissions and ensure that transport infrastructure is ready for and enables low-emission transport modes?

SUMMARY POSITION

Whilst the Net Zero Consultation Roadmap approach is commendable, it underplays the logistics required to make it a reality. Key thing that do not appear to be fully consider are the timelines and policy settings that will be required to implement any solutions. Analogous to a high speed train network in Australia, half of implementing such a project now is gaining access to the land to make it a reality and the other half being the economics.

To implement the Net Zero Roadmap and achieve superior carbon reductions, will require time/work to understand the details of what is required moving forward and the policies required to realise the full outcomes. For example, it is estimated that airports will only start considering implementation of hydrogen infrastructure in the 2030 timeframes for it to be in place by 2035. However, high-level planning, research and policy could be undertaken in the short term to safeguard access to the land that will be required and estimate the scale of infrastructure required over the various timeframes. Understanding this will be required prior to any detailed designs that will be kicked off in 2030, requiring modelling to be conducted over the next five years.

DETAILS - A DIFFERENT SET OF INFRASTRUCTURE IS REQUIRED FOR HYDROGEN

Whilst hydrogen appears to be a long way off, with regional aircraft likely to only be entering service around 2030 and the main ramp up coming in 2035 as short-haul aircraft begin transition, **decisions and planning need to occur within the next few years so that future design options are not artificially impeded and the long term benefits/reduction in CO_2 reduced**. As such, the Australian government is in an excellent position to implement policies and plans for infrastructure owners. For example, airports will need to start designing and building new infrastructure from around 2030 so that it is in place by 2035. This provides time for the government in the preceding years to:

- **Model and plan how much hydrogen will be required and where to allow the infrastructure owners to start long term planning.** For example, liquid hydrogen (the expected preferred hydrogen state for short-haul aircraft) would likely need to be isolated due to the explosive nature. Knowing the volumes required, over what timeframes and in what locations, would drive infrastructure standards and potentially the need to acquire land neighbouring airports and fuel depots.

- Identify Land and infrastructure that will be required and potentially quarantined for its use. For example, **a policy that recommended leasing land for alternate use over the next five to ten years would facilitate it being transitioned for hydrogen infrastructure at a later date rather than selling it now and dealing with forced acquisitions later.** Alternatively, limiting land use/zoning to account for the expanded/nature of fuel sources.

CLEAN AVIATION'S JOURNEY TO CLIMATE NEUTRALITY BY 2050

TODAY, THE AVIATION INDUSTRY GENERATES

87.7M JOBS

2.8% OF GLOBAL CO_2

BY 2050:
DEMAND FOR FLIGHTS **x3**

IF NO ACTION IS TAKEN:
EMISSIONS **x2**

CONTEXT

TARGETS

INVESTMENT

SOLUTIONS

OPPORTUNITY

30-50% IMPROVED ENERGY EFFICIENCY THROUGH TECHNOLOGY

100% NET GREENHOUSE GAS EMISSION REDUCTION THROUGH TECHNOLOGY, H2, SAF & OPERATIONAL MEASURES

KEY IMPACTFUL TECHNOLOGIES

FOR FLIGHTS OF LESS THAN 4000 KM

1. (HYBRID) ELECTRIC REGIONAL AIRCRAFT
2. ULTRA EFFICIENT SHORT/MEDIUM RANGE AIRCRAFT
3. HYDROGEN-POWERED AIRCRAFT

€1.7B PLEDGED THROUGH HORIZON EUROPE

€2.4B VIA EUROPE'S AERO INDUSTRY

= **€4.1B** TOTAL INVESTMENT

REPLACING OVER **40,000** AEROPLANES BETWEEN 2035-2050

= **€5 TRILLION** IN ECONOMIC VALUE

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