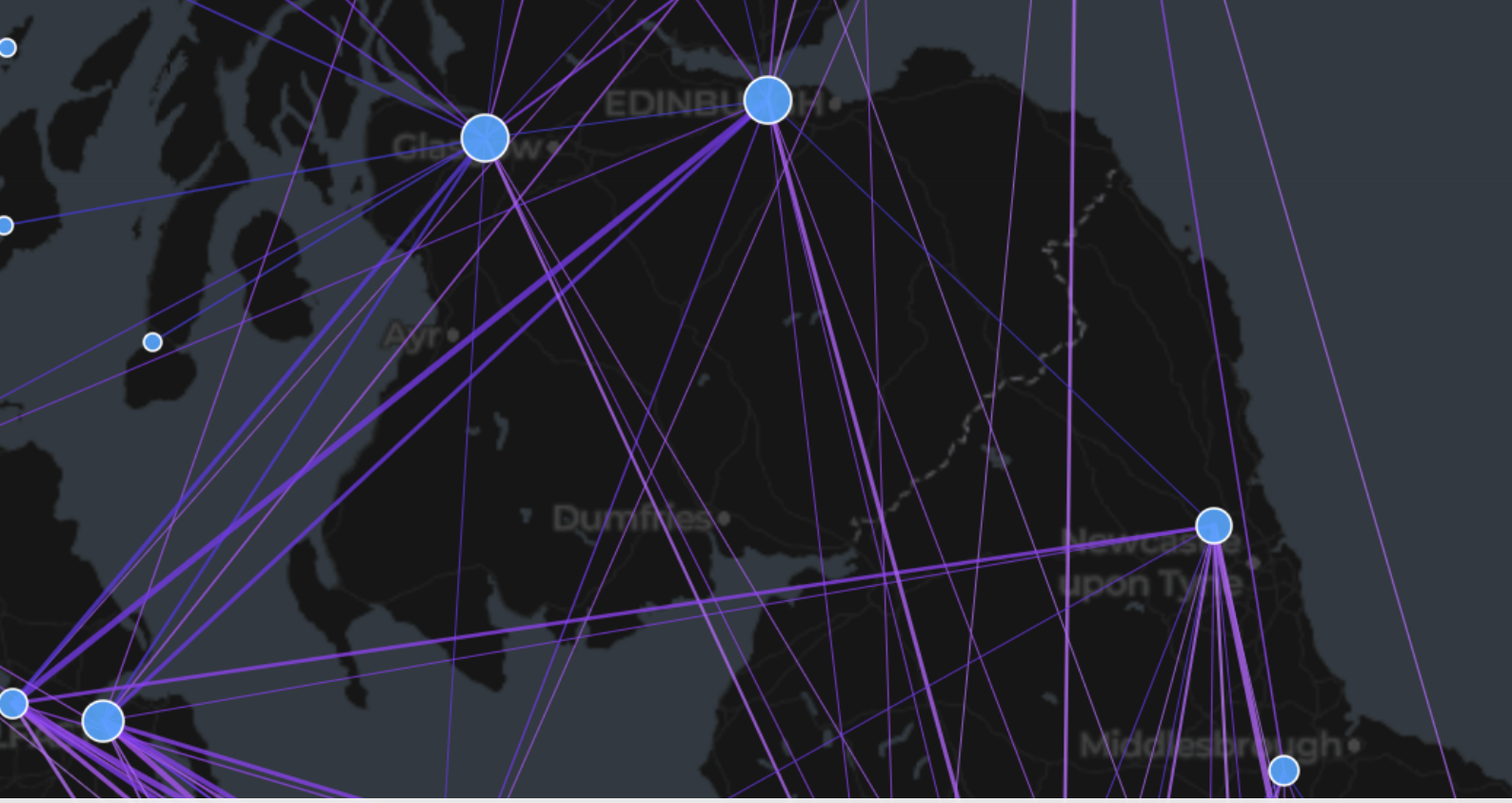
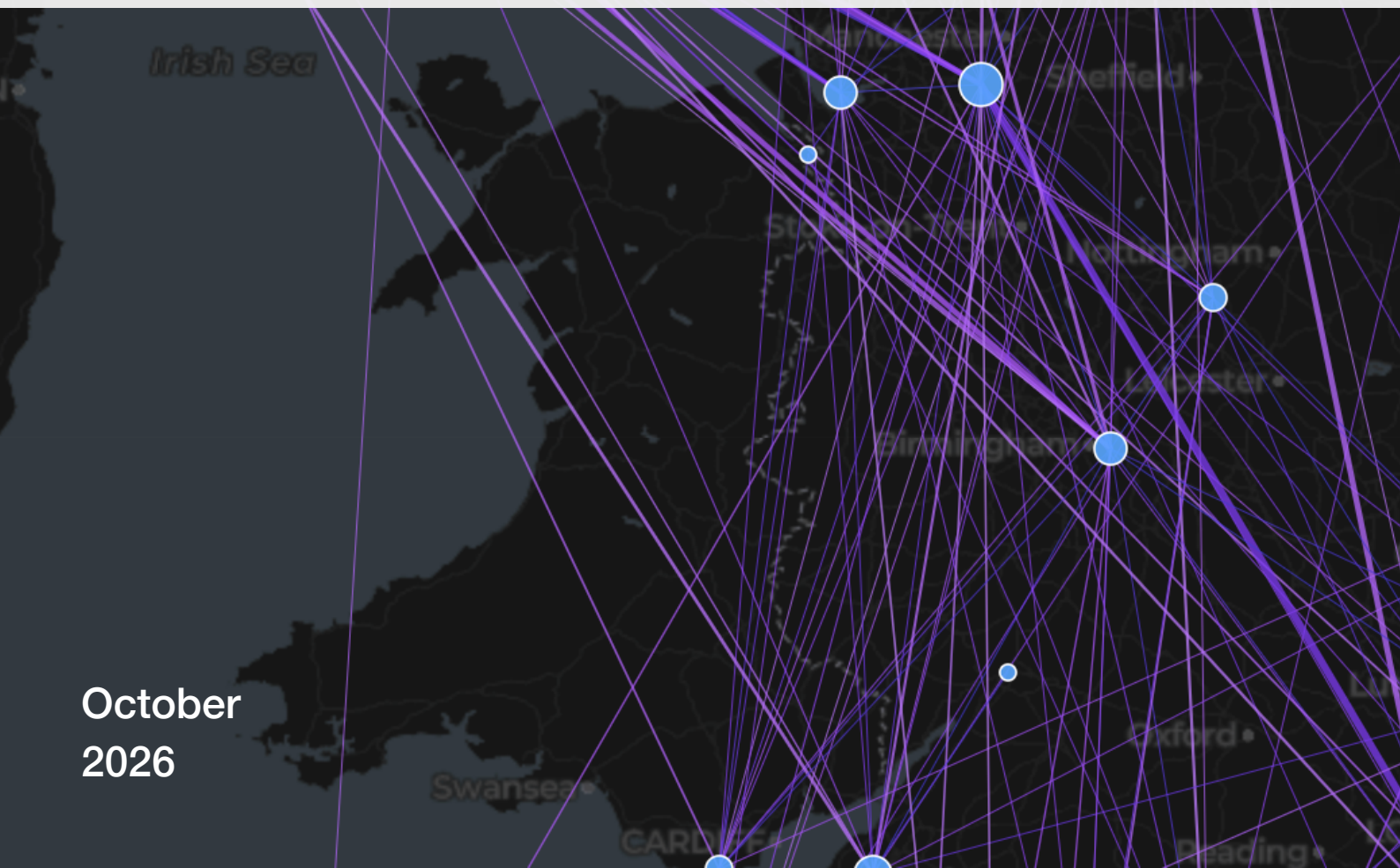




Zero emission aviation in the UK: An Early Airport Network



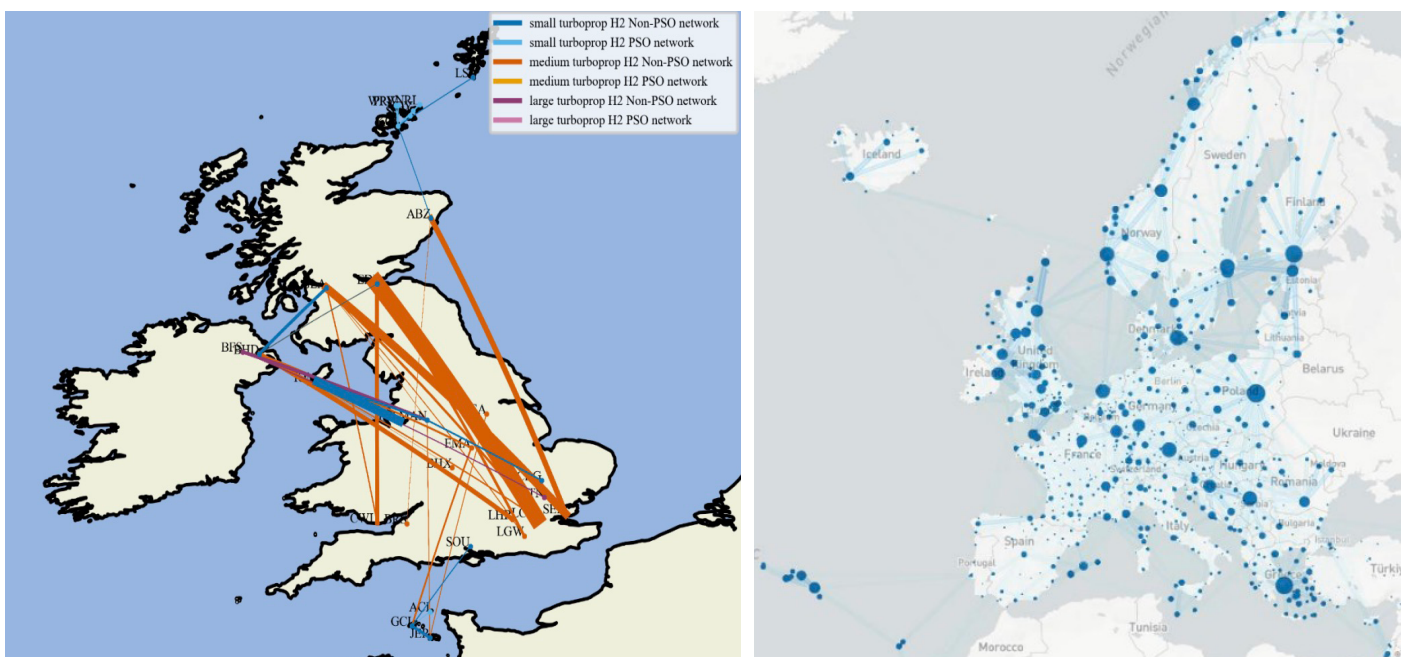
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Introduction

Zero emission aviation ([ZEA](#)) refers to flights that produce zero (or close-to zero) carbon emissions at the ‘tailpipe’, although it is acknowledged that ZEAs can still produce non-CO₂ impacts and the lifecycle assessment of the fuel production requires careful scrutiny if the energy used is not sourced from additional renewables. Electric and hydrogen powered flight are currently the two leading ZEA propulsion technologies. Crucially, as of yet there are no commercial ZEA routes in operation. This analysis and accompanying [interactive tool](#) (route explorer) provide some clear quantification of existing domestic travel patterns by air, and identifies a selection of routes that could offer good starting points for ZEA introduction in the UK – a ZEA early airport network.

The network of domestic connectivity by air has been constructed using data from the Civil Aviation Authority (CAA)¹, with the route explorer displaying commercial domestic flight routes in the UK alongside 5 key route metrics: distance, passengers, flights, CO₂e and passengers per flight². Using this data, this report shows specific ZEA candidate routes through the lens of 5 static maps. The interactive tool can be used to vary any of the criteria used to create these maps.

This analysis builds on the increasing body of research that has been done in planning future aviation systems. Two key recent examples of ZEA mapping come from the Jet Zero Taskforce Hydrogen Task and Finish Group 2025 report ([2026](#)) and the Alliance for Zero-Emission Aviation’s Roadmap for the deployment of hybrid, electric and hydrogen flights in Europe ([2026](#)). The figures below show examples of the outputs from these reports (the Jet Zero graphic is shown on the left, and the AZEA graphic on the right).



1 CAA data supplemented by data from [Flightradar24](#) and the [Inter-Island Air Timetable](#) as needed
 2 Data for passengers, flights, CO₂e and passengers per flight is annual for 2025

The Jet Zero report focuses solely on hydrogen, using a dynamic market based model to predict viable ZEA routes in 2035 and 2050. The AZEA report shows flights eligible for replacement by hydrogen, electric or hybrid routes in 2030, 2040 and 2050 with assumptions around technology capabilities and delivery, and the energy network.

This report offers an alternative, but complimentary, view to these highly detailed forecasts. The tool maintains simplicity by being technology agnostic, with limited assumptions and a sole focus on the potential carbon savings from replacing conventional aircraft on existing domestic routes. The results show the potential for ZEAs to contribute to the UK decarbonisation trajectory for the sector.

The 2026 UK aviation [forecasts](#) published by the DfT project only 3% of the fleet to be made up of ZEAs in 2050. Under the technology development scenario, this figure is 9%, although this has fallen from the prediction in 2022's Jet Zero [strategy](#) that one in every four air transport movements in 2050 would be performed by a ZEA. These diminishing figures for ZEAs potential, attributed largely to later entry into service dates, risk dampening investment and stalling a potential key industrial opportunity for the UK. The outlined suitability of multiple domestic UK routes combined with expertise in aerospace leave the UK well placed to be a leader in ZEA implementation but targeted policy will be required to achieve this.

Table 1: Examples of future ZEA specifications

Source	Seats	Entry into service	Range (km)	Propulsion
Jet Zero Taskforce/ZeroAvia	9	2029	250	Gas hydrogen
	13	2029	220	Gas hydrogen
	48	2033	640	Liquid hydrogen
AURA-AERO	19	2030	1500	Hybrid-electric
Vaeridion	9	2030	400	Electric
Heart Aerospace	36	2031	125 electric 740 hybrid	Hybrid-electric
DfT Aviation forecasts 2026	35	2035/2045	N/A	N/A

Mapping outputs

To illustrate the decarbonisation potential of a ZEA early airport network, domestic routes have been narrowed down using three criteria:

- Operations: removed routes with too many or too few passengers and flights. The rationale for these selections is provided below.
- Technology: specified limits for distance and size of plane/passengers per flight informed by **Table 1**.
- Utility: removed overland routes that are replaceable by rail and only used existing routes.

As the characteristics of future technology remain uncertain and questions over utility are subjective, operational functions are currently a more certain influence on ZEA deployment and markets. Routes in this analysis were therefore removed in a ranked sequence using operations first, followed by technology and then utility. Each removal is additional to the ones that have come previously. The following maps were produced using this process:

Map 1 - All domestic routes in the UK

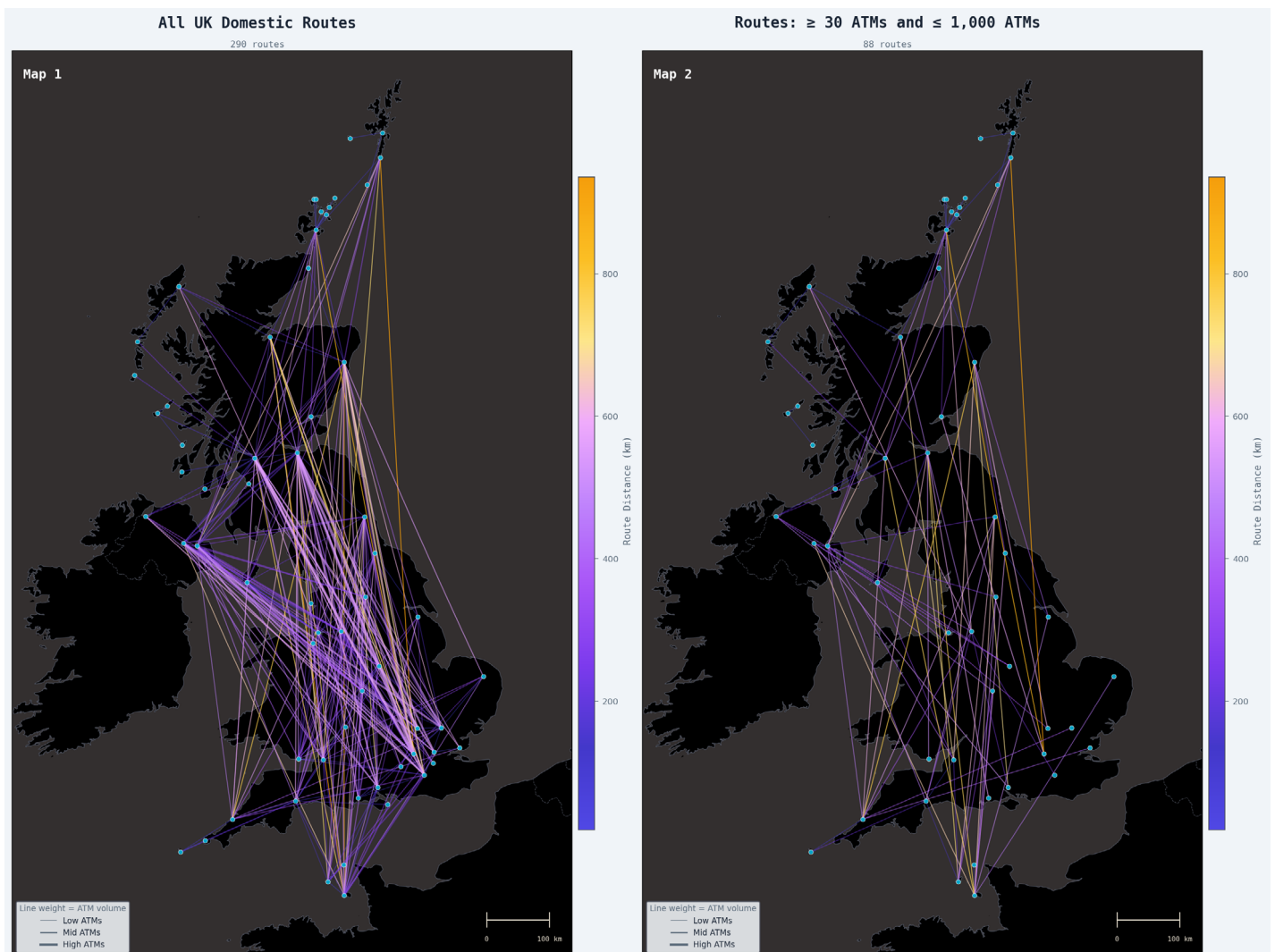
Map 2 - Routes between 30 and 1000 air traffic movements (ATMs) per year

Map 3 - Routes with <30 passengers per flight on average

Map 4 - Routes under 300km in distance

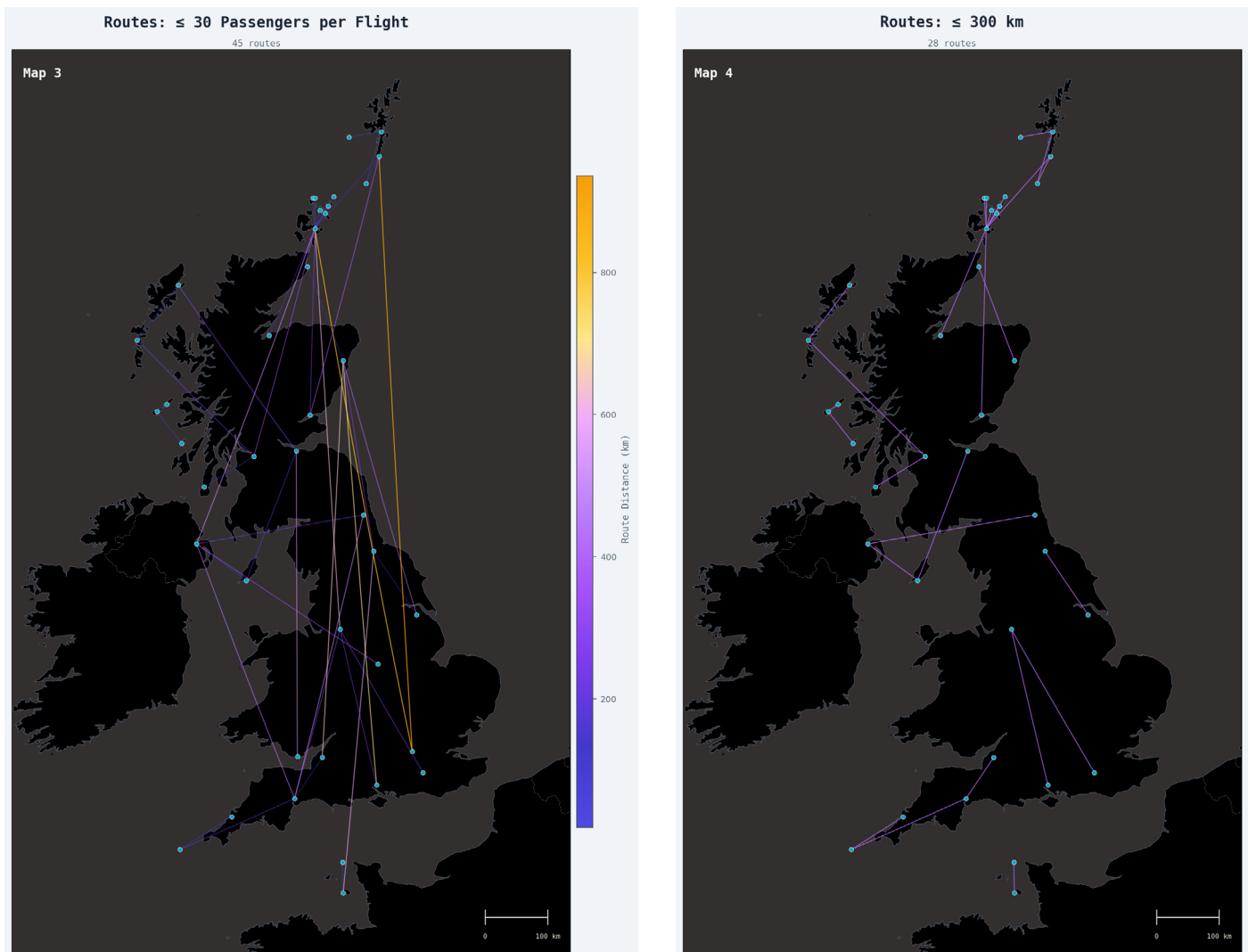
Map 5 - Removal of overland routes that are replaceable by rail

In **Map 2** routes with less than 30 ATMs/year were removed to exclude routes that are likely to not be consistently commercially viable. Any early ZEA route will need a consistent level of demand to ensure stability. 30 was used as a cutoff to focus on routes with at least one flight a week, without ruling out those that operate seasonally. Routes with over 1,000 ATMs/year offer a different issue of complexity, with it likely to be harder to integrate initial ZEA routes into a dense network and potentially requiring airports, at this scale, to have permanent energy storage infrastructure to handle ZEAs. ATMs have been used to assess the suitability of airspace and airports from an operations density perspective, however in areas of quieter operations, routes with higher ATMs could potentially remain feasible for ZEA (see 'other considerations' below). Between **Maps 1 and 2**, a lot of density is taken out of the network, especially between London and the north of England and Northern Ireland.



Maps 3 and 4 have been filtered via estimated technology limitations. ZEA aircraft will be small initially so routes that typically use larger planes are removed to avoid having to substitute in a significantly larger number of ZEA movements. Average passengers per flight has been used as a proxy for plane size, with the limit set at 30. This is likely to be above the initial size of ZEA aircraft but it is expected that any route averaging less than 30 passengers per flight will be serviced by a range of small regional aircraft types.

Map 4 rules out any route over 300km. The exact range of initial ZEA aircraft is unclear but initial routes will be very short range. It is possible that some ZEA propulsion will be implemented using hybrid systems, which combine with traditional kerosene engines, to boost ranges. Aircraft are likely to be required to operate well within their maximum range due to safety regulations.



Map 5 shows the result of adding the utility based removals. Overland routes have been removed on the basis that where possible, using low carbon overland travel is preferable. Two overland public service obligation (PSO) routes in Scotland were retained on the assumption that the PSO status indicates significant local value, and PSO could be a mechanism to require operators to invest in ZEAs. No London routes were left at this point, reinforcing the point that smaller regional airports will likely be more suitable for the first ZEAs.

The adjustments result in **a proposed network of 24 routes, covering 31 airports**. These networks can be categorised into four distinct area groups:

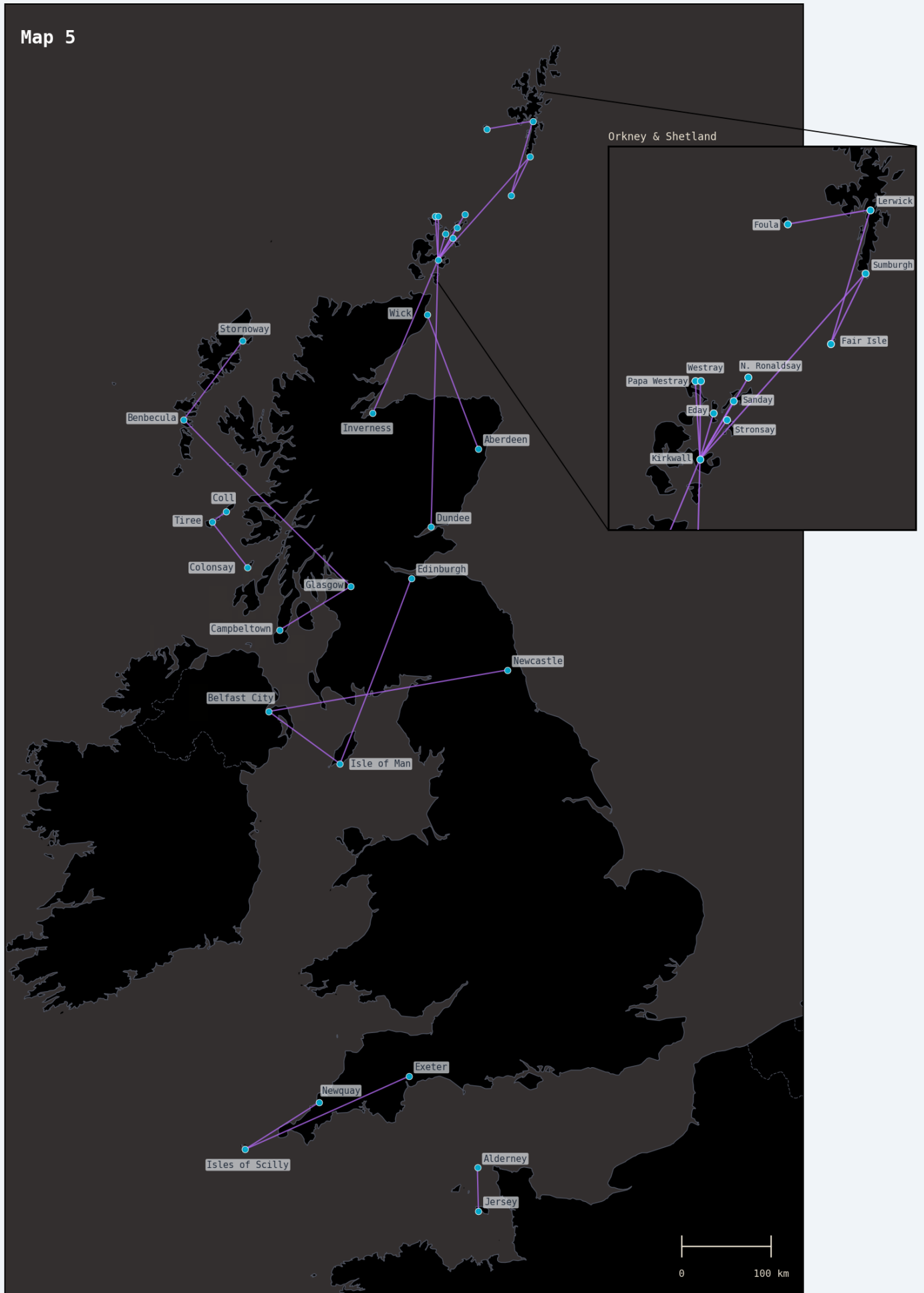
- The Shetland and Orkney Islands
- The Hebrides
- The Irish Sea
- Southern islands

The Highlands and Islands region is especially promising from a route perspective, with 19 of the airports in **Map 5** in this region.

Zero Emission Candidates

24 routes

Map 5



Other considerations

1. Supporting routes

This list of routes is not definitive and the interactive route explorer can be used to widen the net to routes that were close to meeting the criteria above and could play a supporting role in ZEA adoption. Two key criteria alterations that open up realistic additional routes are increasing the ATMs per year and increasing the range.

The southern island networks offer good examples of this, with the following routes included if the ATM cap is removed, Alderney to Guernsey and Southampton; Jersey to Exeter, Bristol and Southampton; and the Isles of Scilly to Land's End. Similar examples appear across the network: Glasgow to Barra, Islay and Tiree; Aberdeen to Kirkwall; Isle of Man to Birmingham; and Belfast City to Edinburgh and Leeds Bradford. Similarly, increasing the range from 300 to 400km adds 4 routes: Belfast City to East Midlands; Edinburgh to Stornoway; Dundee to Sumburgh and Glasgow to Kirkwall.

This analysis only includes existing routes, largely as the uptake of ZEA will require routes with stable, established demand, but also in part as a response to suggestions that ZEA could be used to unlock new demand for regional aviation. The AZEA study suggests that although regional air mobility has been decreasing over the last 30 years, this section of the market has 'a strong potential for growth enabled by green propulsion technologies'. Using ZEA for regional expansion could raise noise concerns for areas under potential new flightpaths. The noise impact of ZEA uptake is still uncertain but improvements are [expected](#) when compared to conventional aircraft. This analysis supports focusing on routes where both utility and carbon savings are highest, i.e. replacing rather than adding to current flights. We have similar concerns over any shift to 'advanced air mobility'.

And of course, the limitation to domestic routes is an arbitrary decision, although arguably, it eliminates the need for ZEA regulation in other countries to be compatible and at a similar level of maturity. As previously identified by the government, 'domestic aviation offers a key stepping-stone to enabling net zero aviation by 2050' with 'more levers for government intervention' (Ricardo/DfT, [2023](#)). The tool is easily adapted to international networks too, and AEF is considering this as a next step.

2. Government policy

The surrounding policy context around these network areas is important. Of the eight successful projects from round one of the zero emission flight demonstrator [competition](#), four are based in the South West, 2 in the Highlands and Islands, one UK wide and one in London. Additionally, the Scottish Government has set a [target](#) for the Highlands and Islands to be the world's first net-zero aviation region by 2040.

PSO routes have been flagged as potential entry points for ZEA. These are routes with key social or economic value that lack commercial viability so receive subsidies to continue operations. The 2026 Jet Zero hydrogen report outlines the potential of PSOs in detail, indicating ZEA potential as these routes 'align well with the early operational capabilities of hydrogen aircraft' and they offer a point of government intervention that could reduce financial risk of early operations.

AEF, working with the World Economic Forum, has previously produced a [report](#) on the role of governments and policy in creating a market for ZEAs.

3. Aircraft

Further work beyond the scope of this study could assess the specific types of aircraft currently operating across each route in the network. The measure of average number of passengers per flight provides a useful proxy for plane size and type, however the actual make up of the fleet could include significantly larger and smaller aircraft with different suitability for ZEA replacement. The age and context of the fleet is also important. For example, operators with a small and new fleet of aircraft may be less inclined to replace these with compared to an operator with a larger fleet where aircraft can be more easily shuffled around to accommodate new ZEA aircraft.

The location of airports in the network could impact the suitability of different ZEA aircraft. There may be benefits to some airports in being closer to the manufacturing or testing areas of ZEA developers. Similarly, airports may see logistical benefits in being closer to suppliers of green hydrogen.

Conclusion

Initial emissions savings are small (implementing this network would reduce total today's UK aviation emissions by 2 ktCO₂e annually), but it is stressed that these routes, and the associated ground infrastructure needed for refuelling, charging and storage, are a necessary first step with the potential to unlock wider deployment of ZEA operations in the UK.

Acknowledgements

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