

ADVANCED AIR MOBILITY

Conference 2024

Advanced Air Mobility
The real opportunity



MOVEMBER®



Introduction

About EA Maven

Electric Aviation Maven Ltd (EA Maven) is a management consultancy firm focusing on solving the key challenges in the area of AAM infrastructure through the provision of RAM/AAM strategy support, demand modelling, infrastructure design and due diligence services. EA Maven is a leading expert in advanced air mobility demand modelling, system planning and infrastructure design. Our clients' portfolio comprises OEMs, airports, airlines, infrastructure investors, governments and more. Our aim is to help our clients assess the potential that RAM/AAM revolution will bring to their business.



Darrell Swanson - Director / Co-Founder

- Extensive advisory experience to AAM players, supporting clients with go-to-market strategies, infrastructure planning, and regulatory challenges, AAM demand modelling, and market analysis
- Expert in the UK market as board member of British Aviation Group, a representative body for UK companies in the airport and aviation sector
- Former advisor to NASA on electric aviation infrastructure and business model and various leadership roles in aviation consultancy companies

32 years of experience

- MBA, Strategy, Finance, Entrepreneurship, Cass Business School
- MSc, Airport Planning and Management, Loughborough University



Jarek Zych - Director / Co-Founder

- Jarek specializes in demand modelling for AAM, air service development and traffic forecasting for airports, and network, fleet and schedule planning / strategy for airlines
- Significant experience in the UK, US and European markets, advising aviation clients in/out of Europe, US
- Former Sales Engineer EMEA at Cirium and Managing Consultant at Avia Solutions (GE Capital Aviation Services)

19 years of experience

- Postgraduate, Airports Financing, Warsaw School of Economics
- MSc, International Management, University of Warsaw
- BSc, Civil Engineering, Polytechnique

Electric and Hybrid Aviation Background

Advanced Air Mobility

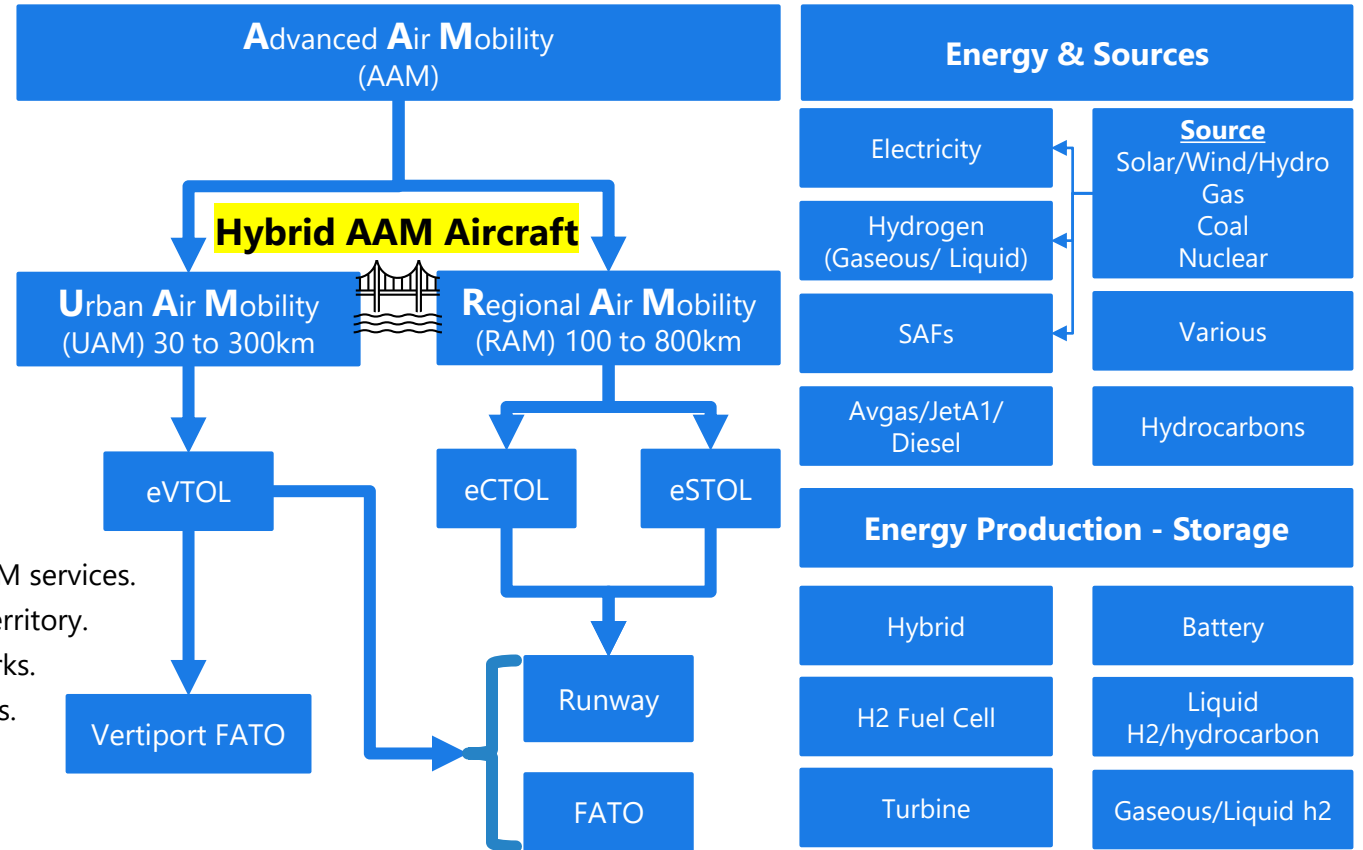
EA Maven's Interpretation

- Urban Air Mobility describes a market which is typified by routes with a range between 30 and 300 km served by eVTOL aircraft at specialised vertiports or existing airports with suitable infrastructure to support operations.
- Regional Air Mobility is a sub section of Regional Aviation which is distinct from the Commuter Aviation market
- Regional Air Mobility is defined by trips that are of high value to the passenger who would otherwise spend significant time on other surface modes of transport.
- This is driven by airline operating economics in that the volume of demand for Sub Regional Aviation is below the threshold for commercially viable services

AAM HORIZON

- H: Hybrid** - A nod to hybrid propulsion systems expanding operational range.
- O: Opportunity** - Capturing the emerging market potential for extended AAM services.
- R: Range** - Overcoming traditional UAM limitations and extending into RAM territory.
- I: Integration** - Seamlessly merging urban and regional air mobility frameworks.
- Z: Zoom** - Focusing on speed within aerodynamic and passenger comfort limits.
- O: Optimisation** - Balancing technology, efficiency, and user needs.
- N: Next** - Representing the next phase in AAM evolution.

HORIZON represents forward-looking innovation and the expanding boundaries of what is possible in air mobility, symbolizing the industry's continuous growth and redefinition.



AAM as enabled by electric propulsion system architectures which is agnostic with regards to energy source and storage system (Battery, Hydrogen (gas/liquid), Hybrid, SAFs, Hydrocarbons)

Electric and Hybrid Aviation Background

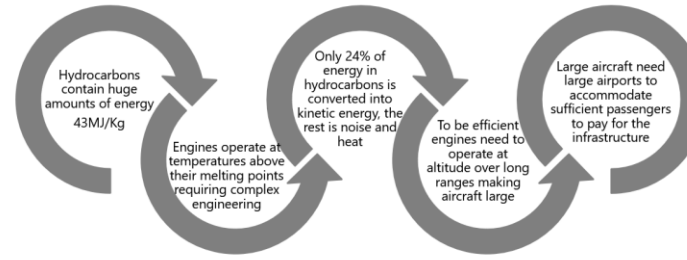
Hydrocarbon vs Electric

Electric Aviation presents us with an unprecedented opportunity in the aviation sector not seen since the very early days of aviation. This innovation has come about through the incremental development of electric propulsion systems which has its roots in electric car manufacturing.

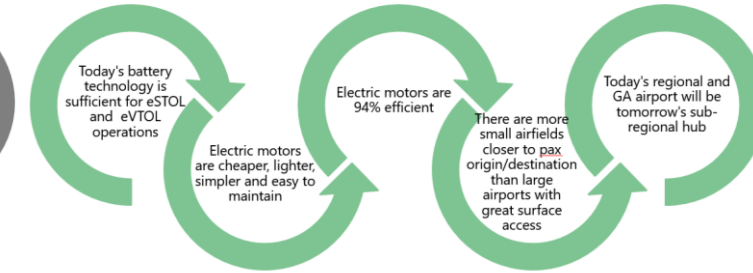
The Economics of Hydrocarbon Aviation v Electric Aviation

- In this new world the economics of aviation are upside down. In this case traditional hydrocarbon powered aviation favoured large aircraft and large airports to pay for effectively the energy density of Jet A1. As engine technology evolved the complexity increased requiring aircraft to be larger, carrying more passengers over longer distances. This in turn required larger airports to be able to pay for the whole system.
- Conversely electric aircraft due to their lower capital, operating and maintenance cost will be able to operate out of smaller airfields at lower costs which may be closer to the passenger's true origins and destinations.
- With reference to regional aviation, a study undertaken by GECAS identifies a trend whereby regional aircraft manufacturers are developing aircraft with more and more range and seat capacity whereas airlines peak average sector length is only 200nm. In this case we have aircraft with a range of up to 2,500nm being operated on sectors of 200nm or only 8% of their range capability. In this case electric aviation has the potential to operate in this 'sweet spot' thus addressing almost 50% of aviation carbon emissions which have been identified by sectors flying less than 500km.

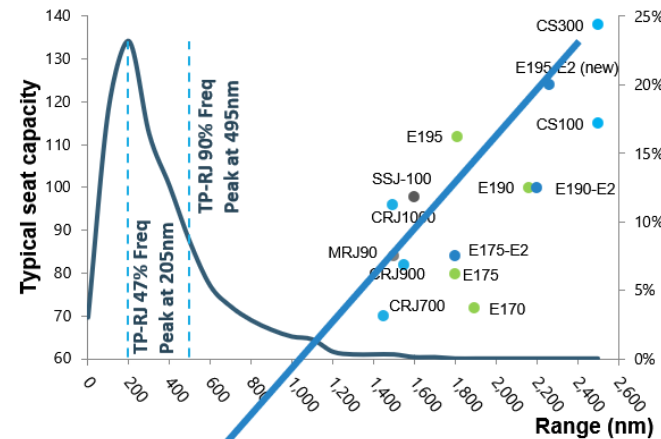
Economics of **Hydrocarbon** v Electric Aviation



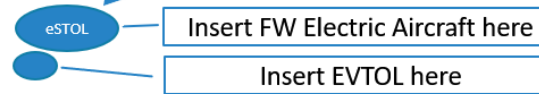
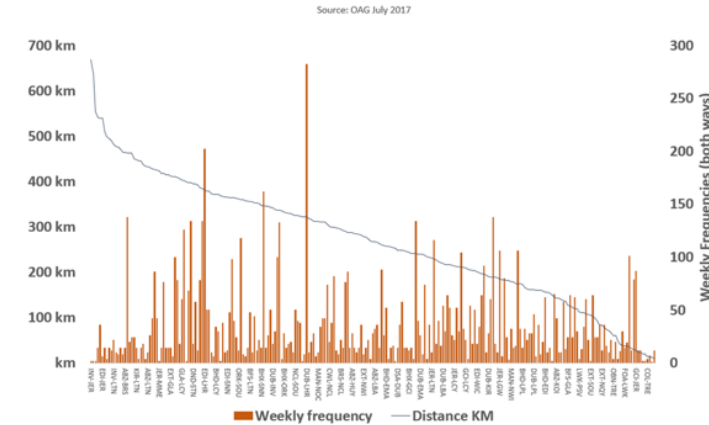
Economics of Hydrocarbon v **Electric** Aviation



The Rise of Distributed Aviation



UK & Ireland Regional Flights - Distance & Frequency



The significance of this chart is that it demonstrates that 90% of flights in Europe using Turbo Prop and Regional Jets are less than 495nm, yet these aircraft have ranges from 1,400nm to 2,400nm

eS/CTOL could access +90% of the 249 airport pairs

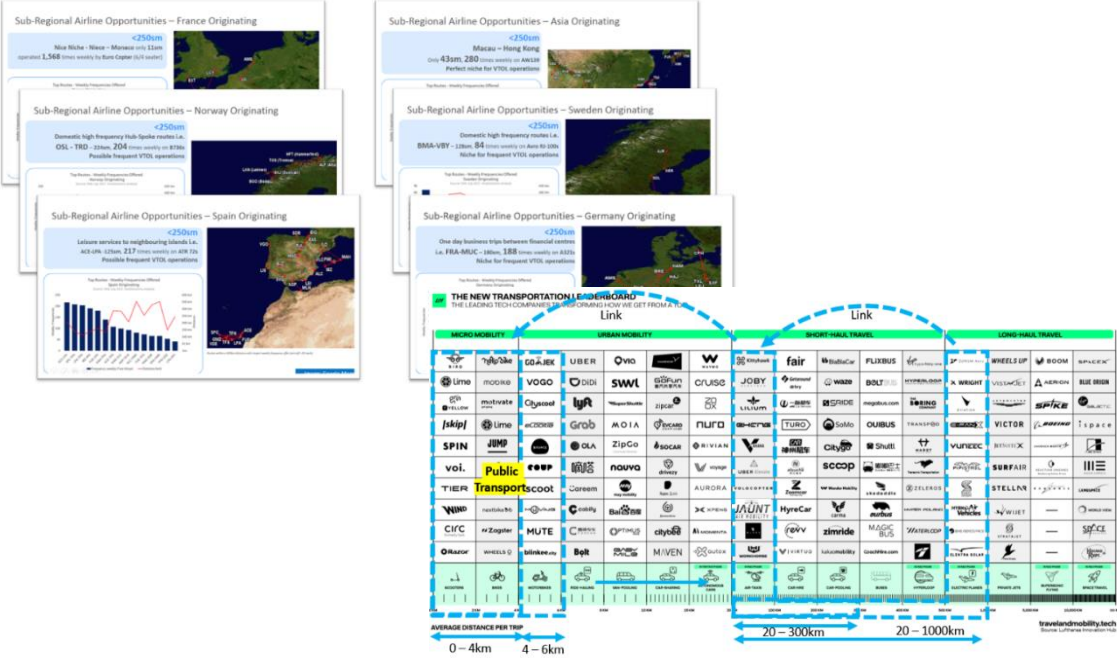
Electric and Hybrid Aviation Background

The Rise of Distributed Aviation

- The opportunity presented via electric propulsion is that we can develop a distributed aviation system that allows us to make the best use of existing aviation infrastructure while still increasing regional connectivity leading to increased economic benefit. The evolution of a distributed aviation system is set out below:
 - Electric propulsion will disrupt the current sub regional aviation system that will lead to a future of distributed aviation.
 - Electric low-cost sub regional airlines (eLCCs) will operate on thinner routes enabled by lower capital, operating and maintenance cost of electric propulsion systems.
 - A quantity of sub-regional traffic will distribute away from the current hub and spoke system of airports (international & regional airports) to secondary and smaller airports.
 - eLCCs will operate out of secondary and general aviation airports due to their lower charges, available capacity, and closer proximity to markets which are viable even though they are uneconomic for hydrocarbon powered airlines.
 - Fixed wing electric aircraft will take passengers over longer distances where passengers will transfer onto either local transportation services or an eVTOL for access into large urban environments. As technology permits direct city center to city center eVTOL operations will be established.
 - A distributed electric aviation system offers lower cost sub-regional flights closer to passengers' origins and destinations while helping reduce the carbon impact of travel.

- Larger international airports may lose some domestic traffic but gain in terms of a reduction in the number of smaller less profitable routes which can be replaced with long haul international flights whilst still maintaining regional connectivity. This has the potential to make the best use of our existing hub airports and their precious runway slots whilst still accommodating growth.
- As electric aviation technologies develop, they will enable larger aircraft, they will be incorporated into our well-established aviation system helping the UK to meet its carbon commitments.

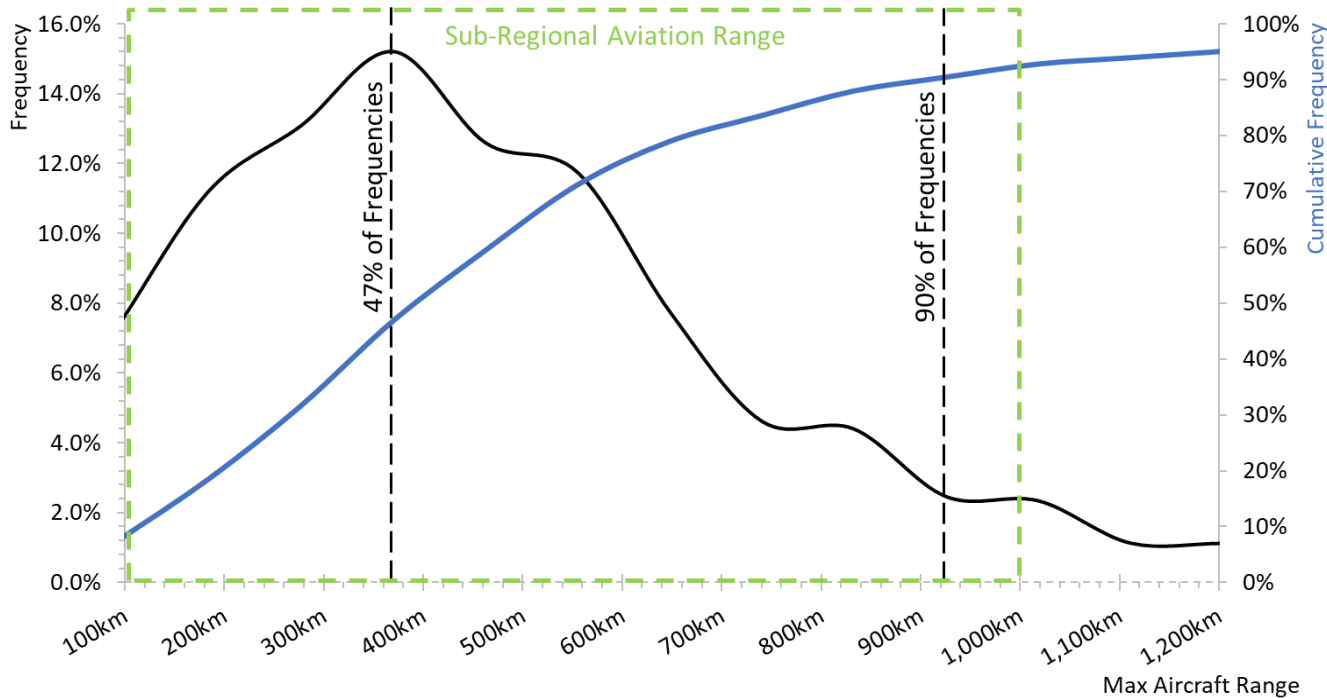
Sub-Regional Airline Opportunities – The World



Electric and Hybrid Aviation Background

The Rise of Distributed Aviation

Regional Jets/Turbo Props
Frequency Distribution vs Cumulative Frequency - Europe
Source: EAMaven analysis



- 47% of frequencies in Europe are offered within 400km, and 90% of frequencies are within 900km.
- There is a clear demand for sub-regional services up to 1000km.

- Regional Jet/Turbo Prop Frequency Distribution & Cumulative Frequency in Europe (2017) outlining key aspect of Sub Regional Aviation aka Regional Air Mobility
- This sets out range consideration for RAM aircraft against a backdrop of Regional Aviation.
- With reference to the US and the commuter market, this should be considered separately and with great care as the market dynamics are very different from RAM.
- **Transitioning to regional point-to-point travel using economically viable eSTOL and eVTOL air vehicles will benefit the UK, Europe, and globally by fostering high-skilled job creation in infrastructure development and supporting services. This shift will also spur economic activity around new and existing vertiports and airports, enhancing regional connectivity.**
- **The anticipated increase in international travel allows smaller airports to handle more regional traffic, thus enabling major airports to expand long-haul operations without sacrificing regional links. Integrating sub-regional fixed-wing and vertical aviation with existing and new mass transit systems will improve regional connectivity and social inclusion.**
- **Furthermore, the adoption of electric and hybrid aviation promises a lower environmental footprint compared to traditional air and ground travel, supporting increased travel volumes without proportionate environmental impacts. While eVTOL and eSTOL journeys supplement sustainable surface travel, they also shorten the distance from origin to destination, making more locations accessible within the sustainable public and private transportation network.**

The UK Advanced Air Mobility Opportunity

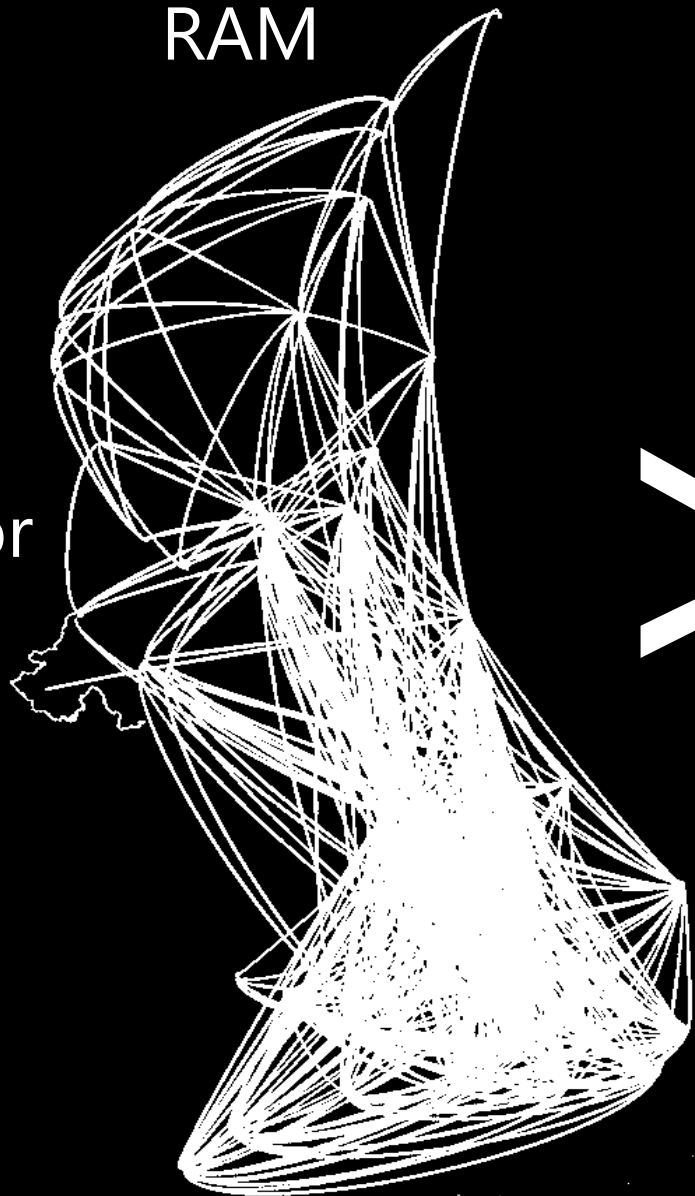
RAM > UAM

Why?

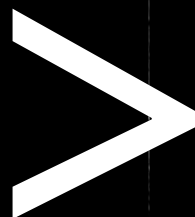
Total UK AAM Potential Summary

Routes Network

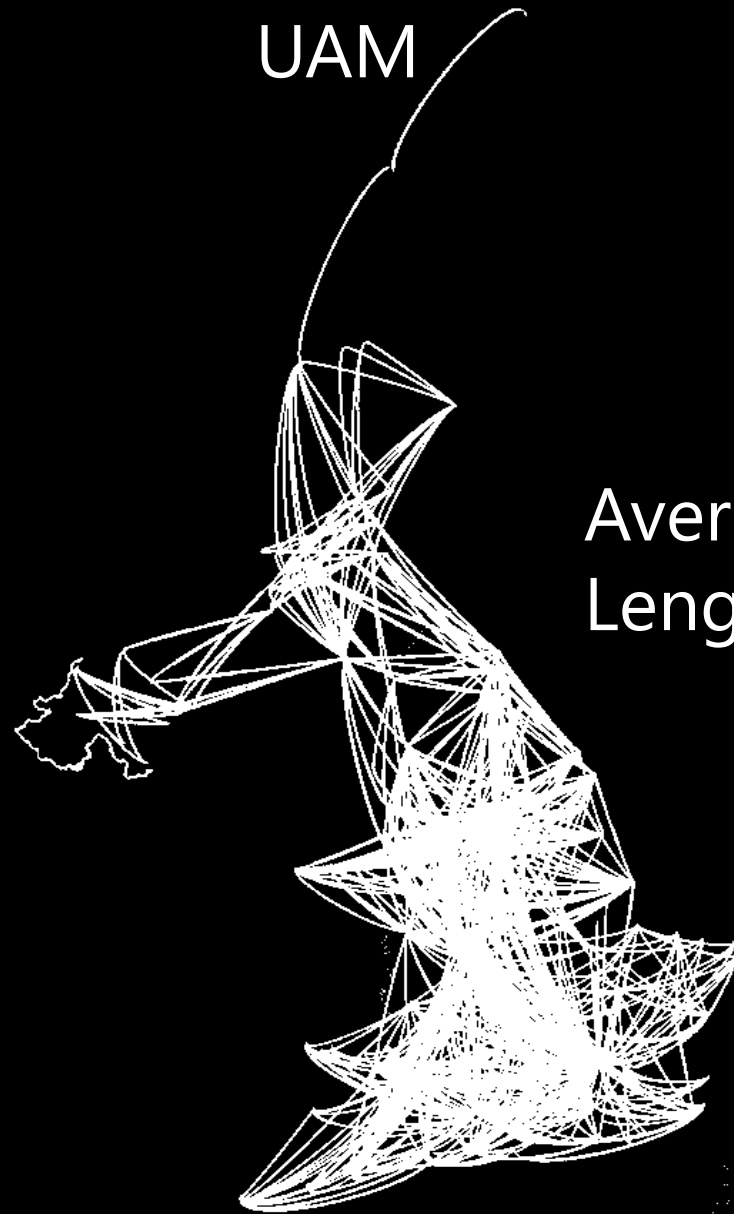
RAM



Average Sector
Length 143mi



UAM



Average Sector
Length 71mi

Total UK AAM Potential Summary

RAM



63/684 airports*/routes**



TM – 430.7m travellers annually***



82.5% of journeys by car producing significant carbon emissions



21.9% business, 78.1% leisure/VFR travellers



47.2m hours saved weekly/annually if switched to RAM**** 5.4k years annually!



UAM



264/994 cities/routes identified with at least 96k travellers per year with 49 routes having over 1m travellers per year



TM – 316.8m travellers annually***



75% of journeys by car producing significant carbon emissions



33.3% business vs 66.4% leisure/VFR travellers



27.8m hours saved weekly/annually if switched to UAM**** 3.2k years annually!

* Based on LAU1 UK spatial division of 400 shapes. Each airport and its respective catchment based on the shape where each airport is located plus the adjacent shapes.
** Total possible routings between all airports and their respective catchment areas with a minimum distance of 70 statute miles. Excluding routes touching London.
*** Sum of all travellers on 1,706 routes analysed. Demand numbers based on airports' catchment areas.

* Cities selected based certain sifting criteria.
** Total possible routings between all cities based on 3 main selection criteria: distance (50-120 statute miles), population (min 20k inhabitants per city), min travellers
*** Sum of all travellers on 994 routes analysed. Demand scaled down based on population distribution (city-city demand adjustment).
**** Based on mixed capture rates of top 994 routes. Time savings based on flight vs car/rail travel time ratios for biz and leisure. Economic stimulation based on the DfT WebTag data.

Total UK AAM Potential Summary

Economic Boost by Top Regions (annually)

RAM



UAM



£1.1bn per year****

Economic stimulation through increased productivity



615.9m per year****

Economic stimulation through increased productivity

Total UK AAM Potential Summary

Aircraft, Stands, Energy, Hydrogen & Carbon Emissions

RAM



Up to 1,5k aircraft required*



448.3k/214.7k tonnes

Carbon emission savings (on people switching from cars and rail) annually assuming using 100% of SAF/JET A fuel**



120.9k tonnes – H2 Aircraft

Carbon emission savings (on people switching from cars and rail) **annual** assuming using Hydrogen (22% of blue and 78% grey hydrogen)***

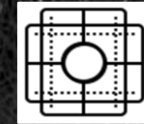


2,730 GWh to create the 52m kg of hydrogen for an all-hydrogen system

UAM



Up to 2.2k aircraft required*



905/314 stands/vertiports required**



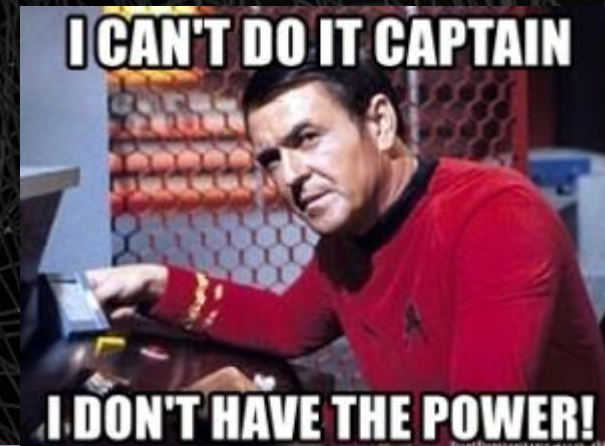
178k tonnes

Carbon emission savings annually**



849.1 GWh

cumulative energy required annually**



* Assuming all routes are operated. Calculations based on a 9-seater aircraft; performance based on various OEMs. Annual aircraft utilisation at max 2000hrs.
 ** Across all routes
 *** CO2 emission of 9kg per 1kg of grey hydrogen and 2kg of CO2 per 1kg of blue hydrogen.

* Assuming all routes are operated. Calculations based on a 4-seater aircraft; performance based on various OEMs. Annual aircraft utilisation at max 2800hrs.
 ** Across all routes

Total UK AAM Potential Summary

Airline/Operator Revenues



RAM

£2.8bn Annual operator ticket revenue

£621m
Annual airport operator revenue from landing and ground handling charges

£203m
Annual airport operator revenue from passenger charges



UAM

£2.27bn Annual operator ticket revenue

£495.3m
Annual vertiport operator revenues from landing and ground handling charges

£100.9m
Annual revenues for vertiport operators from energy

£953m
Capital cost of infrastructure excluding planning application and design costs

UAM or RAM

Which is potentially more economically significant?

Measure	RAM	<>	UAM	Total/Note
Cities/Airports	63	<	264	327
Average Sector Length (mi)	143	>	76	
Potential Routes	684	<	994	1,678
Target market	430	>	316	
Hours Saved (m hours)	47.2	>	27	74.2
Economic Impact (£bn) increased productivity	1.1	>	0.61	£1.71bn
Operator revenues (£bn) tickets sales	2.8	>	2.27	£5.07bn
Routes/Airport or City/Population centre	10.9	>	3.8	RAM is 3 x bigger than UAM
Economic Impact/City or Airport £m	15.9	>	3.8	RAM is 8 x bigger than UAM

- In terms of potential economic impact, RAM is 8.16x bigger than UAM
- This is because RAM offers more utility to travellers in terms of potential time savings and hence the ability for them to be more economically productive.
- An additional contributory factor is that the catchment area for airports in this study are larger than cities given the longer range of fixed wing aircraft attributing to increased utility of RAM flights. This approach is consistent with airport catchment area analysis.



Total UK AAM Potential Summary

Assuming 10% of routes operated in 2035

Total UK AAM Potential Summary

10% routes operated in 2035



RAM



UAM



23/70 airports*/routes**



82/105 cities/routes



78.9% of travellers by car producing significant carbon emissions



70.3% of travellers by car producing significant carbon emissions



27.4% business vs 72.6% leisure/VFR travellers



33.4% business vs 66.6% leisure/VFR travellers



5.5m hours saved annually if switched to RAM****
633 years annually!



4.9m hours saved annually if switched to UAM****
568 years annually!



£143.9m per year****
Economic stimulation through increased productivity



£130.8m per year****
Economic stimulation through increased productivity

* Based on LAU1 UK spatial division of 400 shapes. Each airport and its respective catchment based on the shape where each airport is located plus the adjacent shapes.
** Total possible routings between 23 airports and their respective catchment areas with a minimum distance of 70 statute miles. Excluding routes touching London.
*** Sum of all travellers on 1,706 routes analysed. Demand numbers based on airports' catchment areas.

* Cities selected based certain sifting criteria.
** Total possible routings between all cities based on 3 main selection criteria: distance (50-120 statute miles), population (min 20k inhabitants per city), min travellers
*** Sum of all travellers on 994 routes analysed. Demand scaled down based on population distribution (city-city demand adjustment).
**** Based on mixed capture rates of top 994 routes. Time savings based on flight vs car/rail travel time ratios for biz and leisure. Economic stimulation based on the DfT WebTag data.

Total UK AAM Potential Summary

10% routes operated in 2035 - Aircraft, Stands, Energy, Carbon Emissions



RAM



Up to 193 aircraft required*

Assuming 7 operators operating on 70 routes from 15 hubs



55.3k/24.7k tonnes

Carbon emission savings (on people switching from cars and rail)
annual assuming using 100% of SAF/JET A1 **



32.4%

% share of SAF fuel required to nullify carbon emissions from people switching from rail for Jet A1 Operations.



11.6k tonnes

Carbon emission savings (on people switching from cars and rail)
annual assuming using Hydrogen (22% of blue and 78% grey hydrogen)***



361 GWh to create the 6.87m kg of hydrogen for an all-hydrogen system

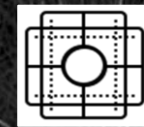


UAM



Up to 356 aircraft required*

Assuming 7 operators operating on 105 routes from 15 hubs*



88/219+137 vertiports/stands+remote parking stands required**



£329m est. capital cost of vertiports



36.4k tonnes

Carbon emission savings annually**



177.6 GWh cumulative energy required annually**

* Assuming 70 routes are operated. Calculations based on a 9-seater aircraft; performance based on various OEMs. Annual aircraft utilisation at max 1500hrs.

** Across all 70 routes

*** CO2 emission of 9kg per 1kg of grey hydrogen and 2kg of CO2 per 1kg of blue hydrogen.

* Assuming 105 routes are operated. Calculations based on a 4-seater aircraft; performance based on various OEMs. Annual aircraft utilisation at max 2800hrs

** Across 105 routes

Total UK AAM Potential Summary

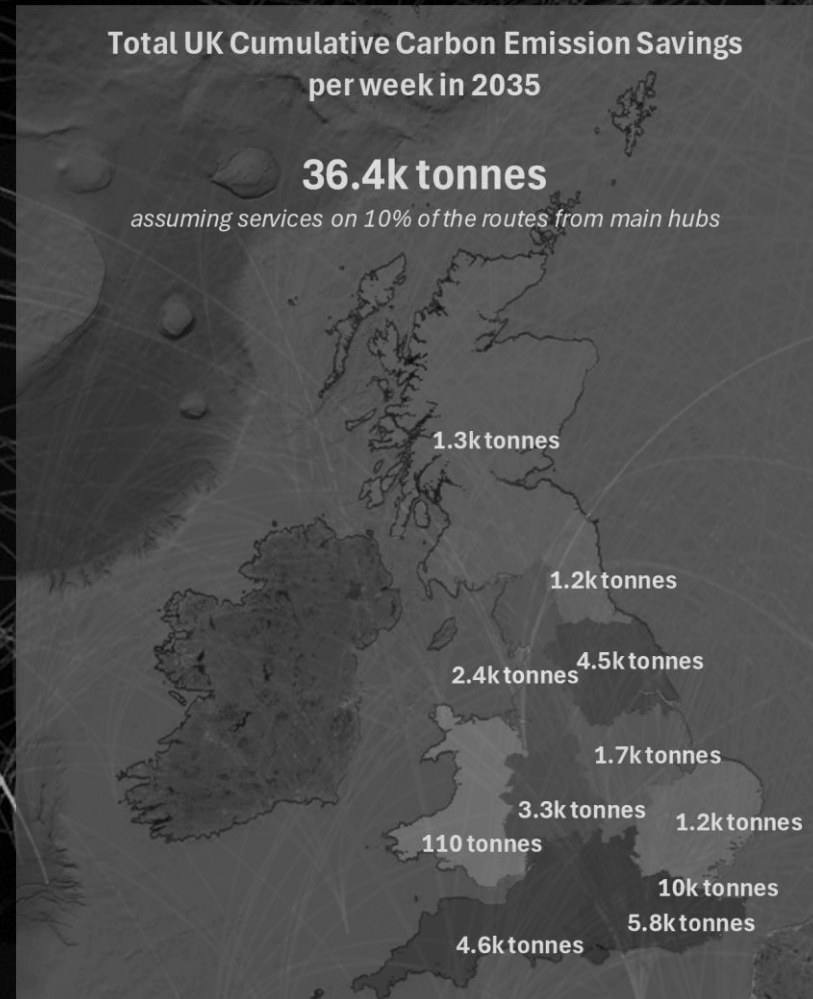
10% routes operated in 2035 – Carbon Emission Savings and Energy Required by Region



Total UK Cumulative Carbon Emission Savings
per week in 2035

36.4k tonnes

assuming services on 10% of the routes from main hubs



Total UK Cumulative Energy Required per week in 2035

3.7k mWh

assuming services on 10% of the routes from main hubs



Total UK AAM Potential Summary

10% routes operated in 2035 - Airline/Operator Revenues



RAM

£307.8m

Annual revenues from selling tickets

£76.6m

Annual revenues for an airport operator from landing and ground handling/passenger charges



UAM

£503.3m

Annual revenues from selling tickets

£180.5m

Annual revenues for an airport operator from landing and ground handling charges and passenger charges










£43.3m

Annual cumulative revenues for an airport operator from energy charges

Total UK RAM Potential Summary

10% routes operated in 2035 – **RAM** Operators Analysis












 Operator	 Hubs	 Routes	 Aircraft	 Pilots	 Maintenance	 Landings (k)	 Pax (k)	 Revenue (£m)
1	6	45	30	180	6.0	62.9k	533.3	48.2
2	4	38	29	171	5.0	68.5k	582.1	45.0
3	4	30	18	106	3.0	43.2k	365.9	27.6
4	7	50	42	254	8.0	93.4k	794.4	67.5
5	4	36	26	158	6.0	55.3k	469.0	42.4
6	5	38	23	139	4.0	53.7k	454.6	36.6
7	5	39	25	150	5.0	50.3k	428.6	40.4
Total	15	105	193	1,158	37	427.4k	3.6m	£307.7

* Assuming 7 operators operating on a 9-seater aircraft from different hubs. Cumulative on 105 UAM and 70 RAM routes. Revenues assuming LF of 80% and annual utilisation of 1500hr for RAM and 2800hrs for UAM. Cost structure based on EA Maven analysis derived from various OEM data.

Total UK UAM Potential Summary

10% routes operated in 2035 – **UAM** Operators Analysis

 Operator	 Hubs	 Routes	 Aircraft	 Pilots	 Maintenance	 Landings (k)	 Pax (k)	 Revenue (£m)
1	6	64	51	203	6	196.5	776.1	71.5
2	6	54	55	221	6	217.7	844.8	78
3	4	37	36	145	4	139.3	548.2	51.2
4	8	75	72	289	8	280.7	1.1m	101.5
5	5	58	52	209	6	203.0	796.8	74.2
6	5	45	41	163	5	158.8	624	58
7	6	60	49	195	5	187.5	736.4	69
Total	15	70	356	1,425	40	1.38m	5.4m	£503.3m

* Assuming 7 operators operating from different hubs. Cumulative on 105 UAM and 70 RAM routes. Revenues assuming LF of 80% and annual utilisation of 1500hr for RAM and 2800hrs for UAM. Cost structure based on EA Maven analysis derived from various OEM data.

Advanced Air Mobility Opportunities for Brazil

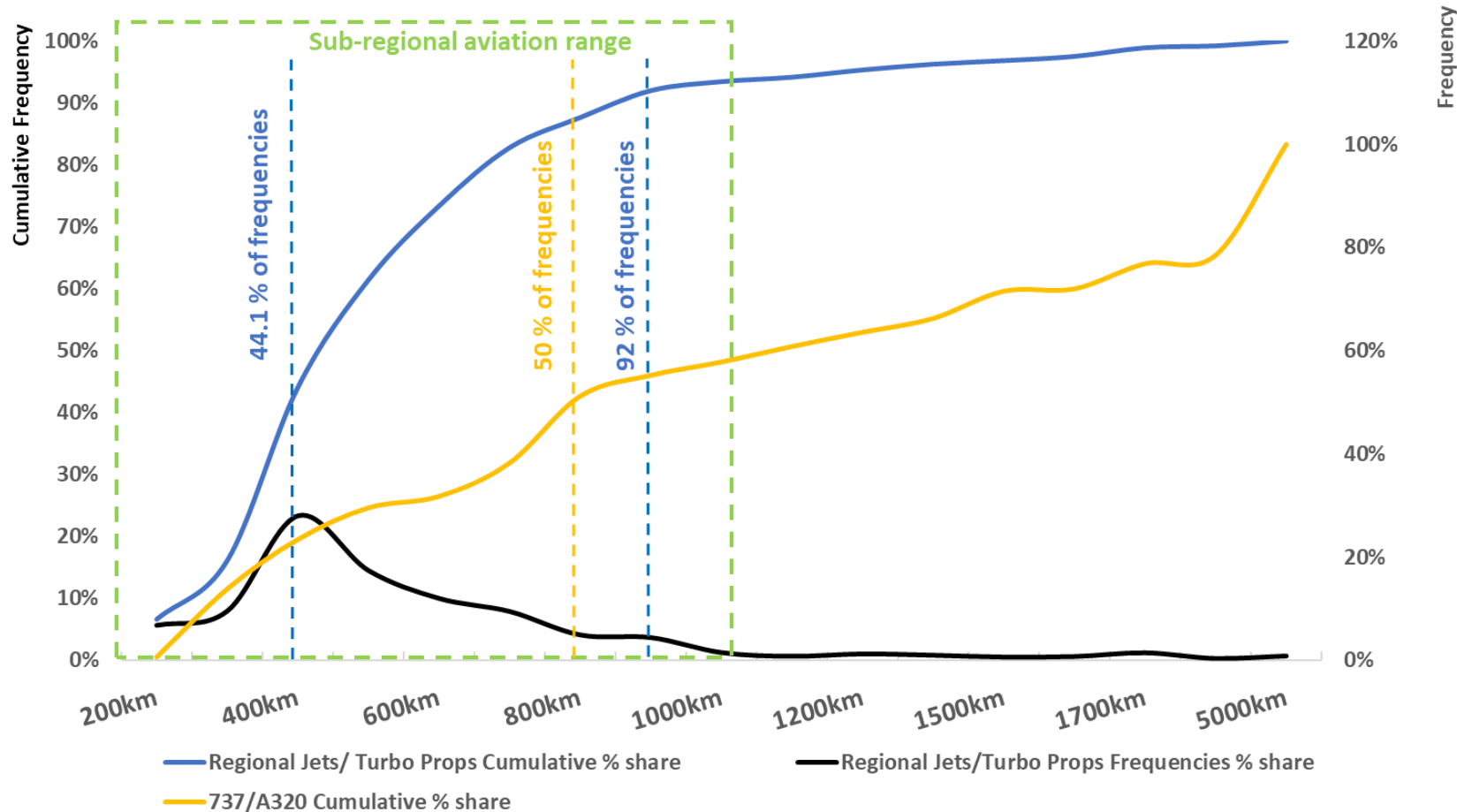
The Rise of Distributed Aviation

Brazil Aircraft Types Distribution

Regional Jets/ Turbo Props vs 737/A320

Frequencies distribution vs cumulative frequencies - Brazil domestic

Source: OAG Brazil 2024, EA Maven analysis



- 44.1% of frequencies on regional jets/turbo props in Brazil (domestic) are offered within 400km, and 92% of frequencies on the same types are within 900km.
- There is a clear demand for sub-regional services up to 1000km.
- 50% of all frequencies on 737/A320s are within 800km.

Brazil Domestic Aviation

OAG Data 2024



168 airports with commercial scheduled services*



590 domestic routes in service

233 routes solely served using regional jets/turbo props
(only 39% of frequencies)



792k/120.6m frequencies/seats offered in 2024
(15k/2.3m of frequencies weekly on average)

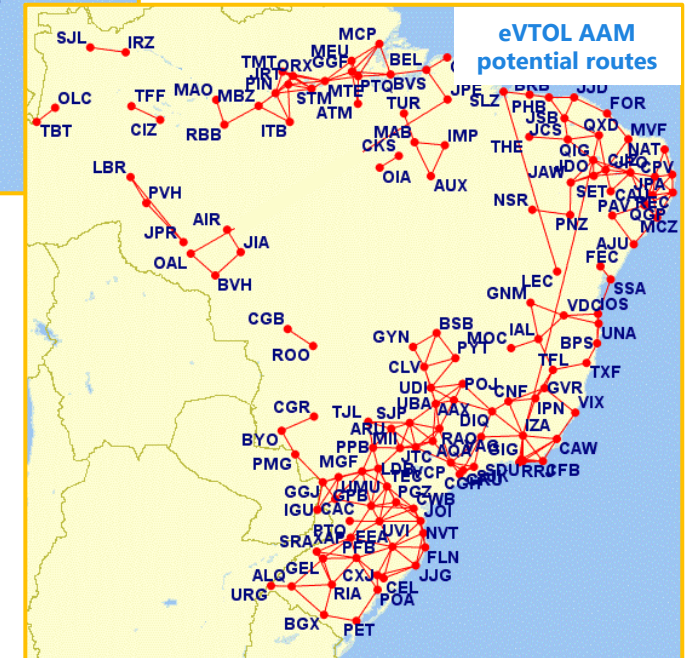


14k Possible domestic routes between 168 Brazilian airports
(only 590 served by traditional aviation, 29%! of all frequencies solely (and 60% jointly with regional jets/turbo props) operated by 737/A320 aircraft types)



284 airport connections identified as possible for eVTOL AAM
(up to 240km)

2.8k airport connections identified as possible for eC/STOL
AAM *(240km-1000km)*



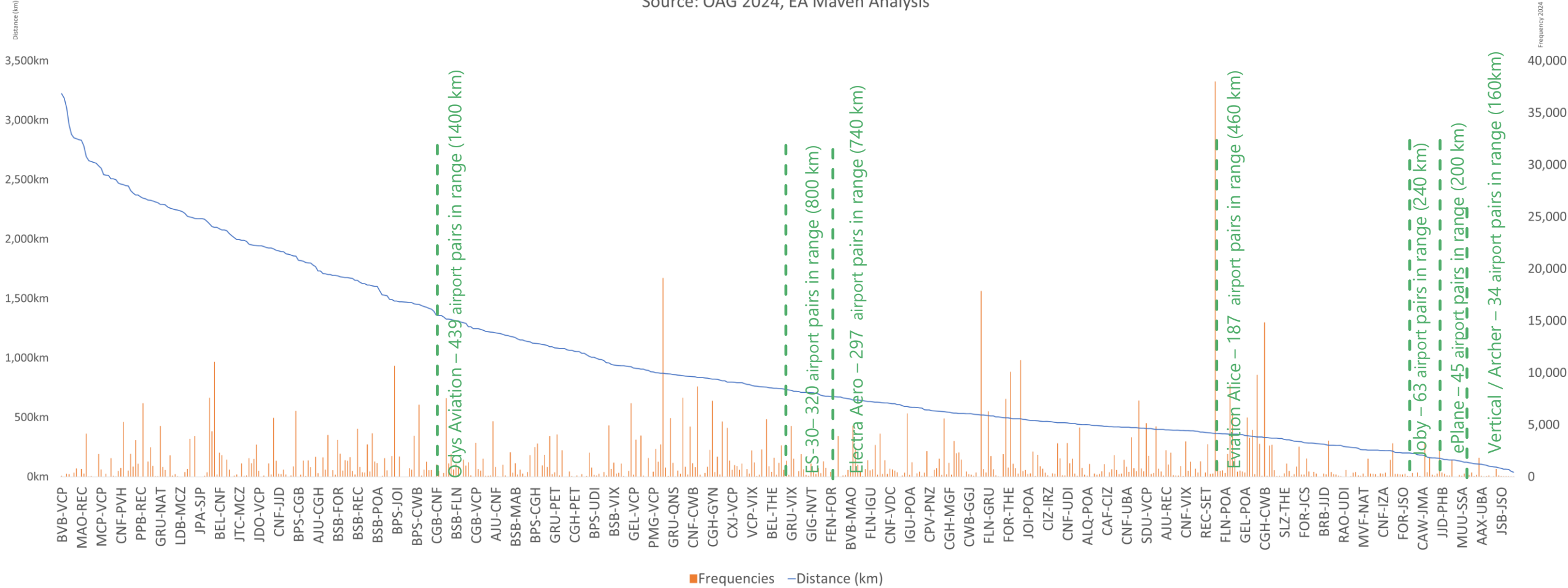
* Based on OAG 2024 data

Brazil Domestic Flights

OAG 2024

Brazil Domestic Flights - Distance & Frequencies (roundtrip)

Source: OAG 2024, EA Maven Analysis

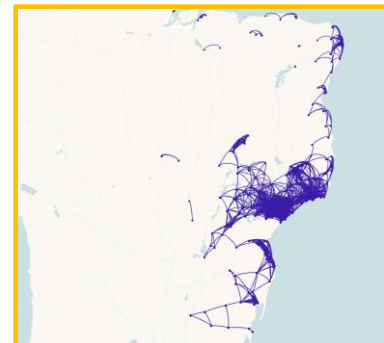
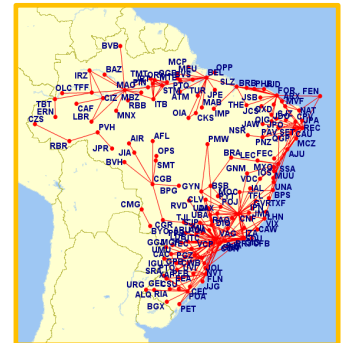
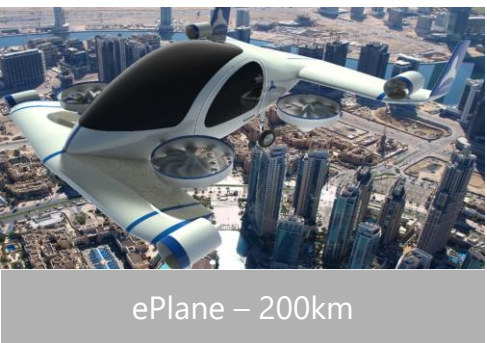
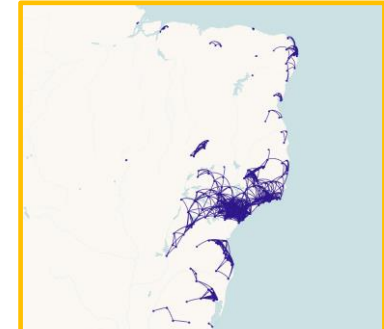
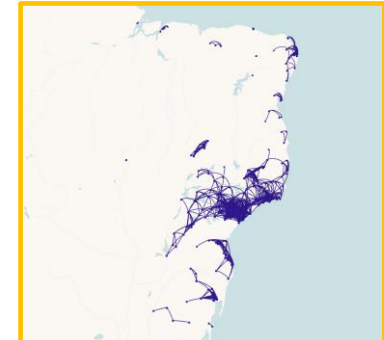


Electric Aircraft (eVTOL)

Services Offered in 2024

Airport Pairs in Range*

City Pairs in Range**



* Based on all possible routings from/to Brazilian Airports (OAG Data analysis)
 ** Based on all possible routings between largest 300 Brazilian cities.

Electric Aircraft (eVTOL)



Services Offered in 2024



63 Airport Pairs with Traffic

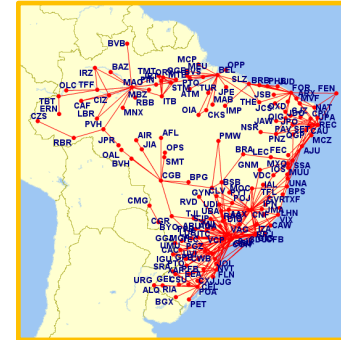


146 Airport Pairs with Traffic



187 Airport Pairs with Traffic

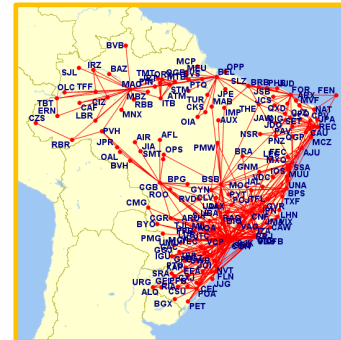
Airport Pairs in Range*



343 Airport Pairs in Range

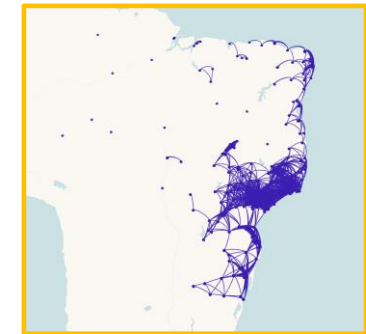


878 Airport Pairs in Range



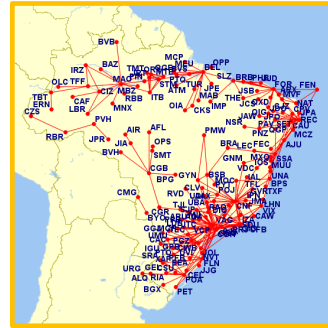
1120 Airport Pairs in Range

City Pairs in Range**

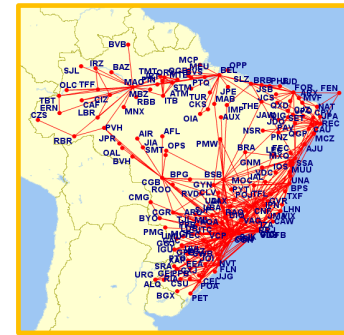


4331 City Pairs in Range

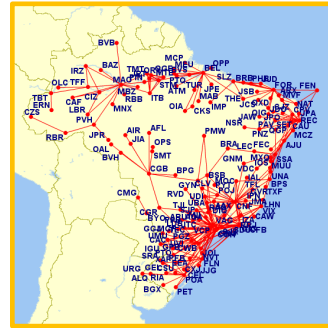
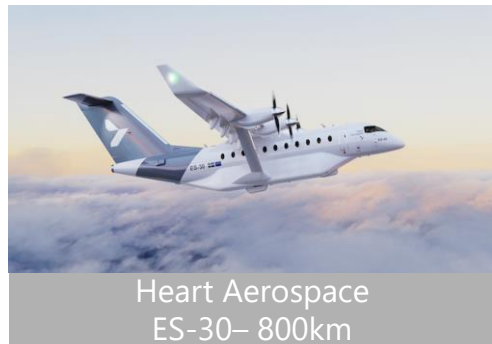
* Based on all possible routings from/to Brazilian Airports (OAG Data analysis)
 ** Based on all possible routings between largest 300 Brazilian cities.



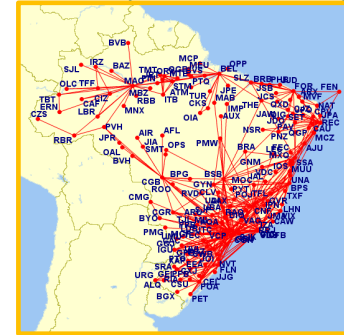
297 Airport Pairs with Traffic



2317 Airport Pairs in Range



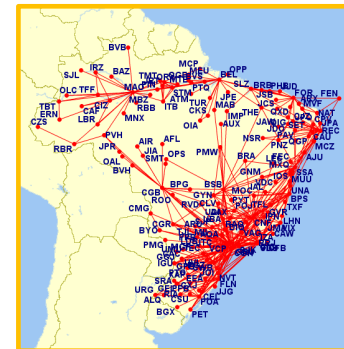
320 Airport Pairs with Traffic



2576 Airport Pairs in Range

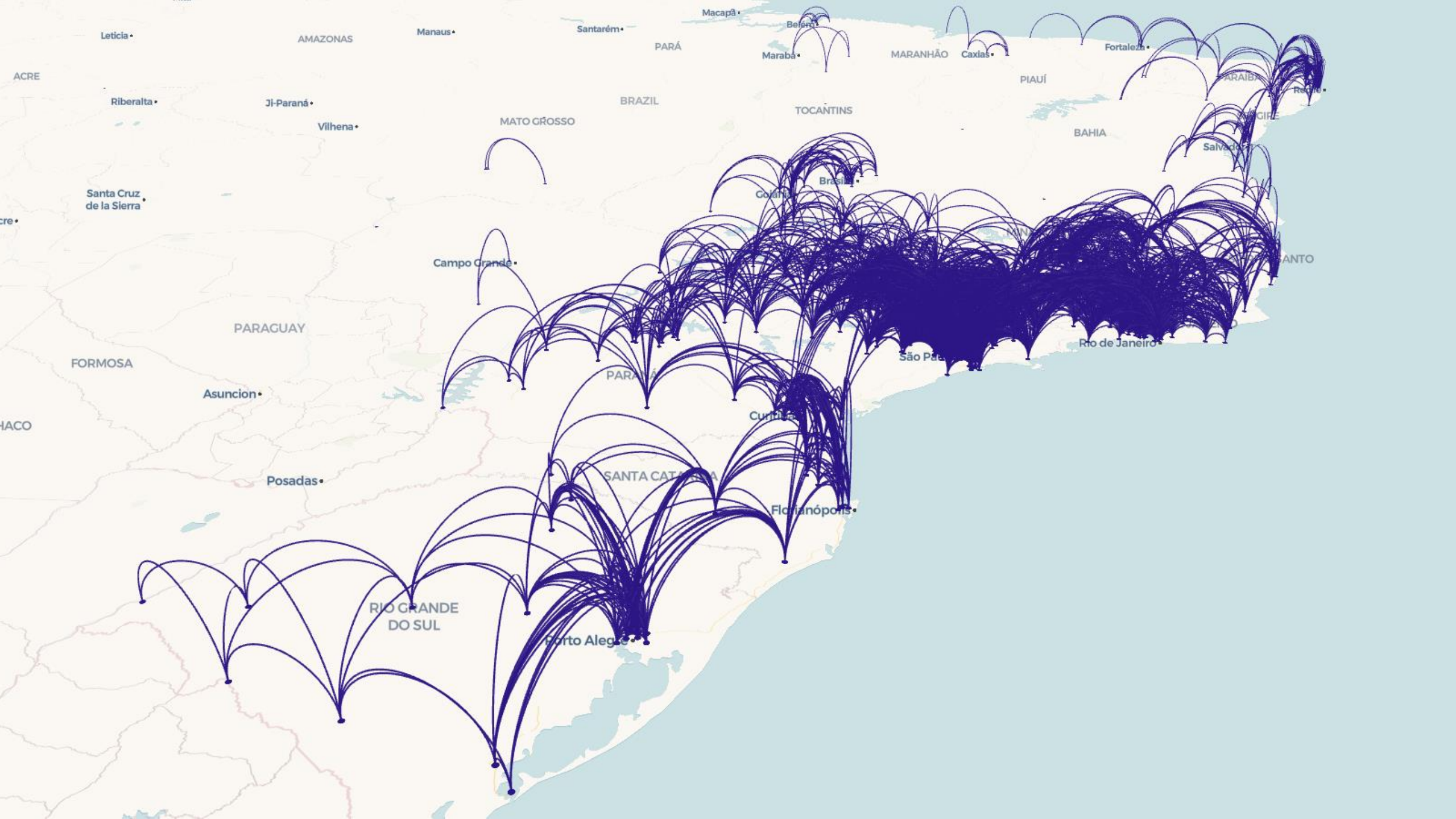


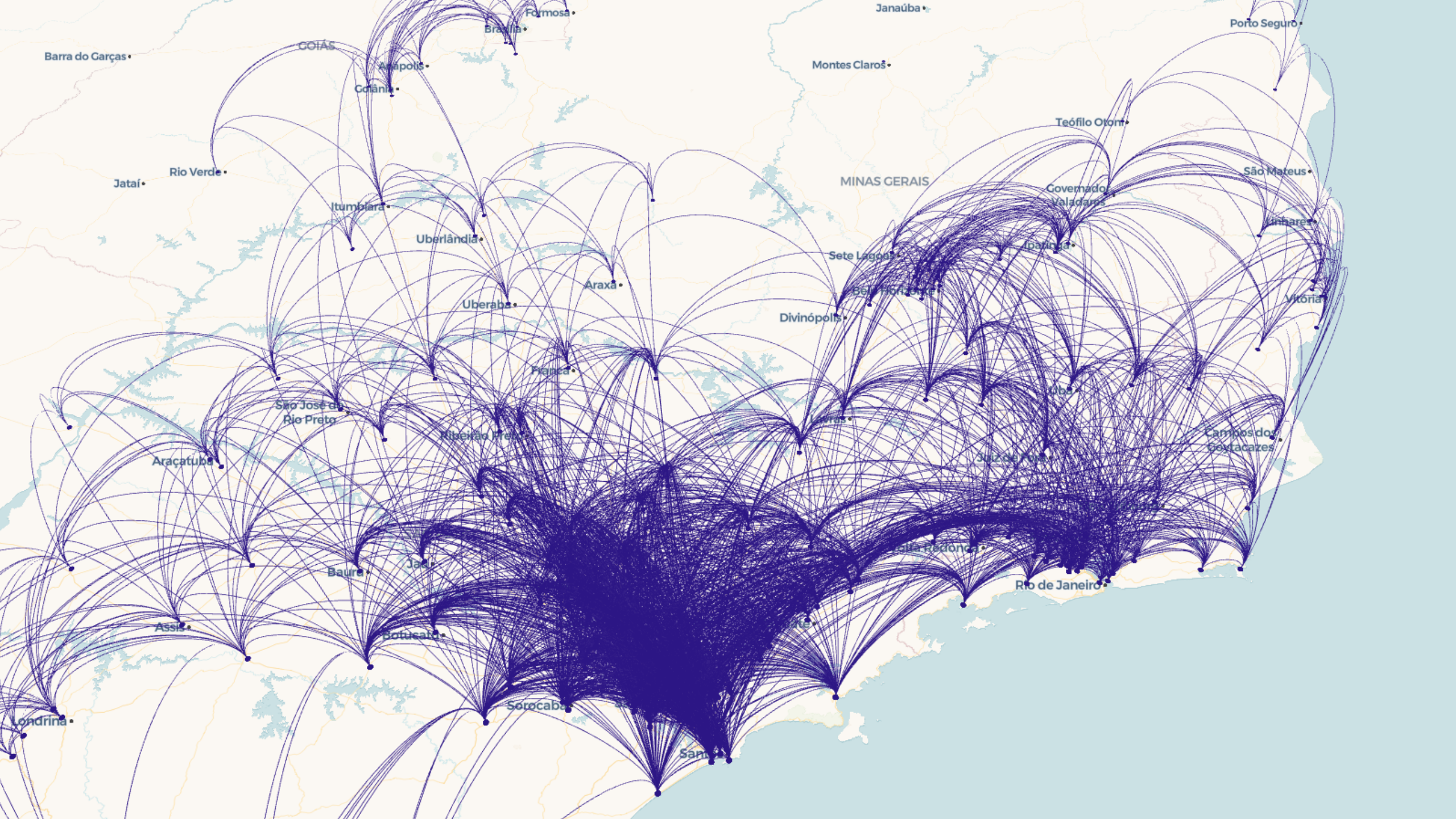
439 Airport Pairs with Traffic



5294 Airport Pairs in Range

* Based on all possible routings from/to Brazilian Airports (OAG Data analysis)
 ** Based on all possible routings between largest 300 Brazilian cities.







Thank you.

Darrell Swanson
Director | Co-Founder
EA Maven

darrell@eamaven.com
www.eamaven.com

Jarek Zych
Director | Co-Founder
EA Maven

jarek.zych@eamaven.com
www.eamaven.com

